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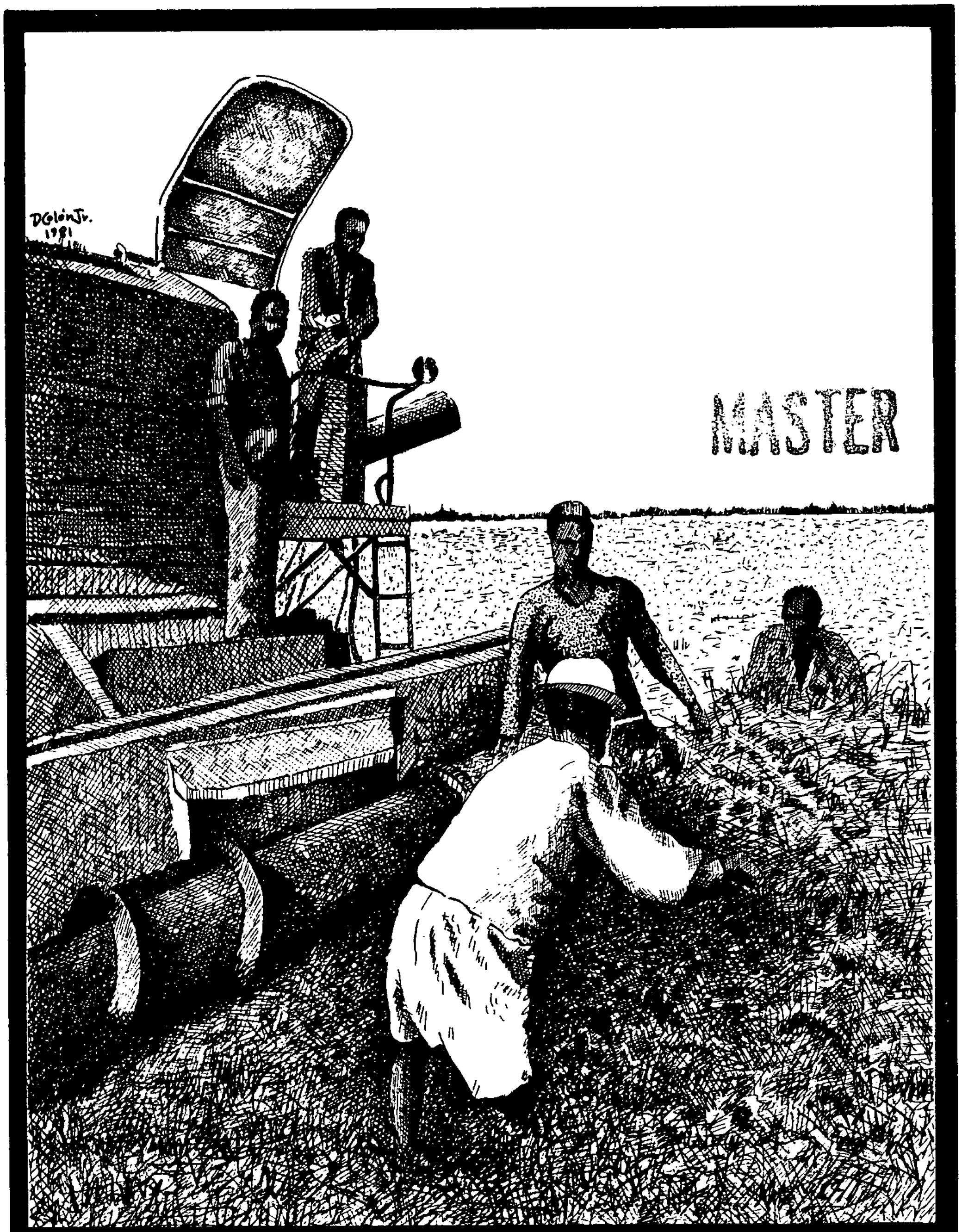
U.S. Department of Energy

Solar Energy Education

January 1982



Activities & Teacher's Guide

SOCIAL STUDIES

Field Test Edition

Information on the Solar Energy Education curriculum may be obtained from:

Solar Energy Project
c/o New York State Education Department
Albany, New York 12234

Your comments on and evaluation of this field-test edition are solicited.

The Solar Energy Education Curriculum

The booklet in your hands is just one part of a series. The Solar Energy Education materials include

a Solar Energy Text

a Solar Energy Reader in four parts:

I. *Energy, Society, and the Sun* (general),

II. *Sun Story* (history and literature),

III. *Solar Solutions* (practical applications), and

IV. *Sun Schooling* (classroom-oriented readings).

Solar Energy Education Activities for

Science,

Industrial Arts,

Home Economics,

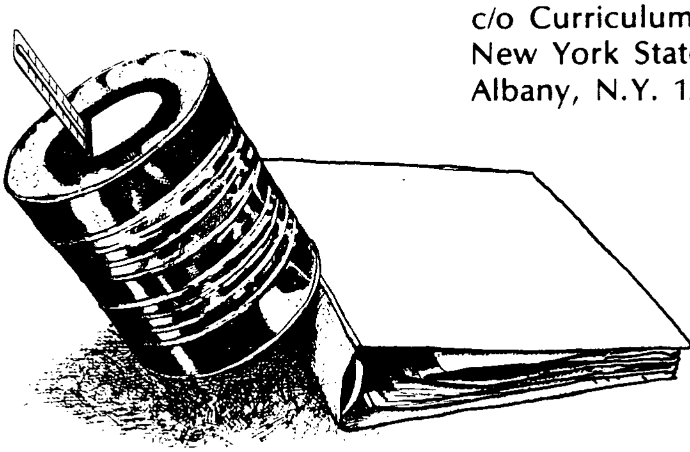
Social Studies, and

Humanities (Art, Music, and English), and

Solar Energy Education Teacher's Guides
to accompany the above activity booklets.

For more information on the Solar Energy Education curriculum, contact

Solar Energy Project
c/o Curriculum Services
New York State Education Department
Albany, N.Y. 12234



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Solar Energy Education

SOCIAL STUDIES

Activities & Teacher's Guide

Field Test Edition

Prepared for the
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American, 20th CY
Bronze
13.380, Gift of Peter C. Brooks and Others

Introduction

For the teacher with a full workload and dozens of important topics to cover and skills to teach, the question that may occur in picking up this booklet is

Why Teach About Energy?

If you are asking that question, try to think of an area of human existence that is not affected by energy resources. Energy permeates our lives; it shapes our careers, our leisure, and our aspirations as well as providing food, clothing, and shelter.

Students are aware of this reality and they see that, as available energy resources change, their lives will also change, in ways as yet unknown. This is why students are deeply interested in energy, especially in solar and other forms of renewable energy. They recognize energy as a factor that will have an impact on them personally, for the rest of their lives, and they want to understand their energy options.

Subject Skills/Energy Content

You can capitalize on your students' strong interest in the topic of energy. With renewable energy as the content matter, the following activities are designed to give students practice in the subject skills that are high on your teaching agenda. Whether it's musical improvisation, reading for comprehension, report writing, photographic technique, or group decision-making, you'll find here a renewable energy activity, ready to use.

Table of Contents

To Teachers

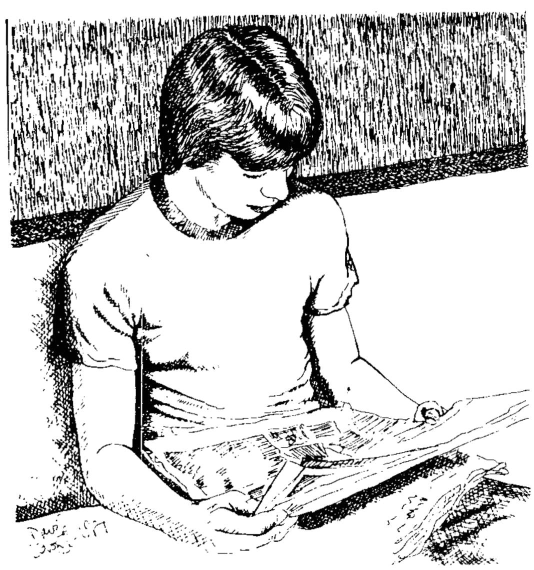
The yellow pages in the front and back of this booklet are intended especially for you. You'll also find a teacher information section (the grey-edged pages) in each student activity.

Energy Language

In beginning to understand renewable resources, students need to learn the names of those resources. New words are introduced in several of the activities in this booklet. For your convenience an energy glossary is given at the back of the booklet. The glossary should prove especially useful to students who are doing independent reading or research.

Finding Information

The last few years have witnessed a flood of energy information from public and private sources. Unfortunately, material has been most abundant and available on topics about which people already know a fair amount: fossil fuels and nuclear power. The renewable forms of energy have had a much lower profile.



The "Sources of Information" section at the back of this booklet lists not only books and magazine articles but also newspapers, audio-visual sources, clearinghouses, and other wellsprings of renewable energy information. You will also find a list of specific references at the end of each activity.

Using Copyrighted Material

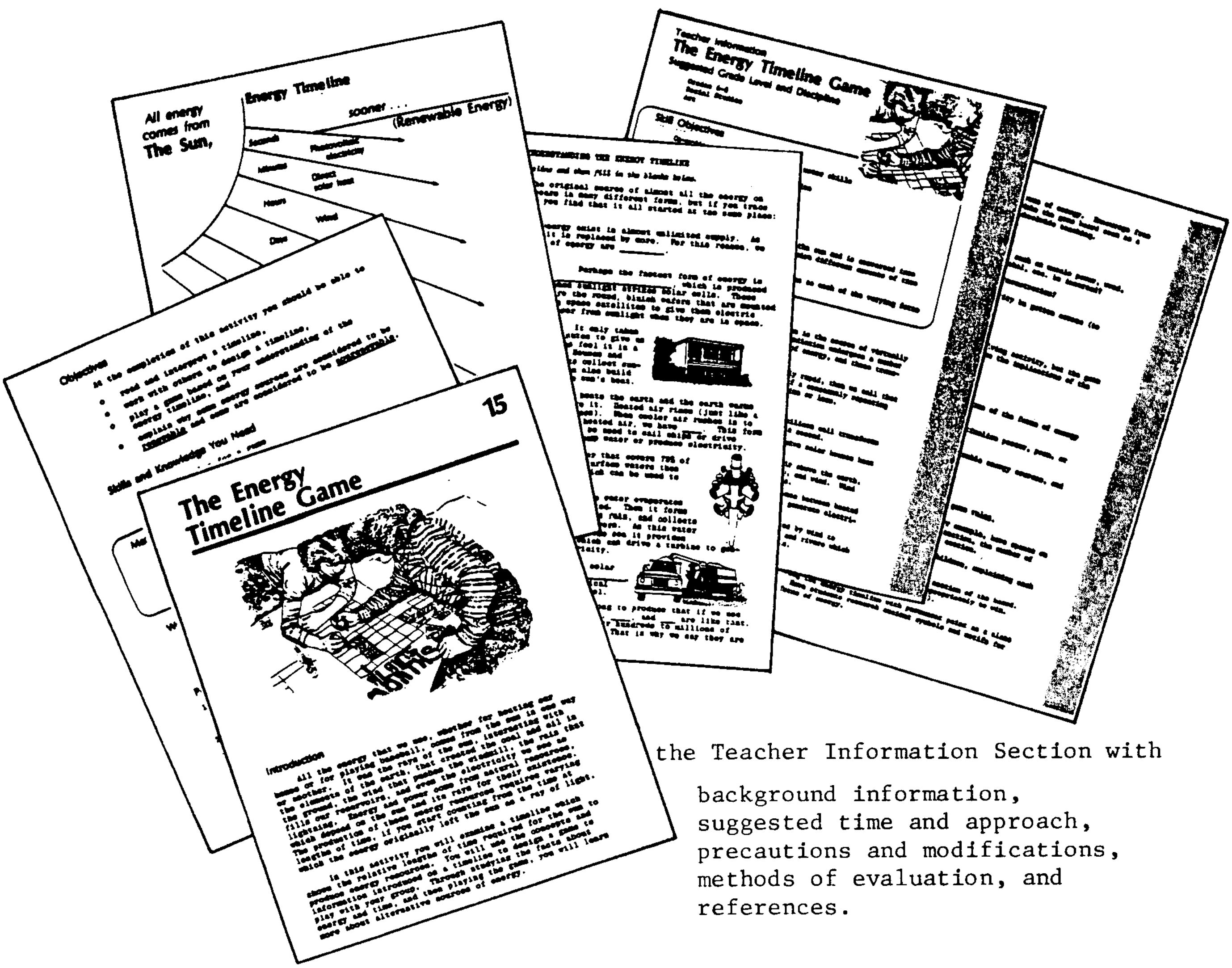
In the rapidly changing energy picture, your best reading material for students can often be found in newspapers and magazines. But what is your legal right to copy these materials to provide your students with up-to-date information? You may be surprised to find how broad your rights are. The Congressional guidelines on copyright are included at the end of this booklet. Asterisks indicate sections that claim your special attention.

How to Use the Activities

The teachers who wrote these activities were considering your convenience. Every activity is complete and ready to use, in two parts:

the Student Activity with

- introduction,
- objectives,
- prerequisite skills and knowledge,
- procedure for the activity,
- worksheets (diagrams, maps, readings, etc.),
- comprehension questions,
- summary ("Looking Back"), and
- enrichment activities ("Going Further"); and



the Teacher Information Section with

- background information,
- suggested time and approach,
- precautions and modifications,
- methods of evaluation, and
- references.

NOTE ESPECIALLY:

All worksheets have a grey tab. These are the essential parts of the activity for the student, and they are keyed so that you may extract these pages and duplicate them at your convenience.

Approaches to Teaching Energy

The excitement of a new learning topic evolves in part from the new teaching techniques that it may encourage. If you plan to teach about energy, consider the following techniques:

Flexible grouping: Suit the group size to the demands of the activity.

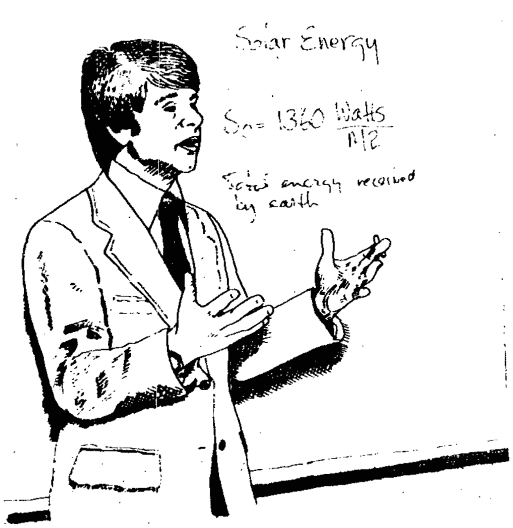
Individualization: Give a whole activity, as is, to a selected student.

Mainstreaming: Use the procedure to break the activity into small steps.

Teaching the Gifted and Talented: Use the "Going Further" section for enrichment ideas.

Teaming: Energy as a topic crosses boundaries; try linking with industrial arts, science, or home economics teachers.

Field trips: Study local energy sites: utilities, homes, architectural firms, etc.



Guest speakers: Identify homeowners, manufacturers, consumer advisors, and utilities with energy messages.

Outreach: Capitalize on public interest in energy with

- an energy fair with student projects, media, etc.;
- an energy workshop for parents or the public in general;
- a resource center: books, brochures, and magazines displayed at PTA meetings, or in the school or public library.

Using the Matrix

Energy is essentially an interdisciplinary topic. Each activity was written by an individual teacher, but with no subject barriers in mind. A glance at the activity matrix will show you the relevance of each activity to a variety of disciplines. The grade level indicators are broad because each activity would appeal to a range of students. Remember, too, that an activity targeted at grades 9-10 could be used for gifted eighth graders or remedial students in grades 11 and 12.

Activity Matrix

	GRADE LEVEL(S): 6-8	9-10	11-12	SUBJECT AREAS: Social Studies	English/ Language Arts	Reading	Art	Humanities	Science	Mathematics	Industrial Arts	Home Economics	Multi-disciplinary
Activity 14	O	O	O	O	O	O		O	O		O	O	O
Activity 15	O			O	O		O		O				O
Activity 16	O	O	O	O	O				O	O		O	O
Activity 17	O	O	O	O	O	O		O	O				
Activity 18	O	O	O	O					O	O	O		O
Activity 19			O	O	O				O				O
Activity 20		O	O	O	O	O			O		O		O
Activity 21	O	O	O	O					O			O	O

Sending for Energy Information 14

Introduction

The use of solar energy could be one solution to our country's energy crisis. It is to our advantage as a nation to look to solar and other renewable energy sources instead of continuing to rely on nonrenewable sources such as oil, natural gas, or coal. One major problem in accomplishing this shift of emphasis is that many people are still ignorant about alternative energy sources. They don't even know where to look for accurate and understandable information.

These problems need not deter you from becoming informed about alternative energy sources. There are many experts, publications, and agencies prepared to serve you in your search for information about these new energy technologies. This activity will enable you to write letters requesting information about alternative energy.

DRAFT

Objectives

At the completion of this exercise you should be able to

- o select information to include in the body of a business letter,
- o properly lay out and write a business letter, and
- o name the different forms of renewable energy.

Skills and Knowledge You Need

Writing complete sentences

Following directions

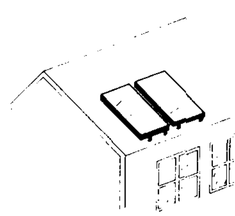
Materials

pen, paper (scrap and 8½ x 11), a legal envelope, and a stamp

Words You'll Learn

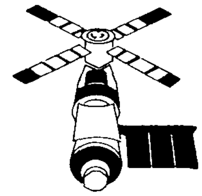
Renewable energy--derived from resources that replenish themselves within a human lifetime. Direct sunlight, wind, and falling water are examples.

solar energy--radiant energy from the sun falling upon the earth's surface, which can be used to heat, to cool, or to generate electricity.

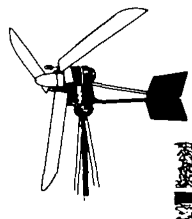


active solar system--a solar heating or cooling system that requires external mechanical power to move the collected heat.

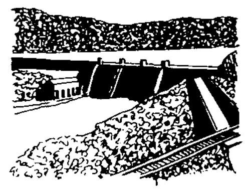
passive or direct solar system--a solar heating or cooling system that uses no external mechanical power to move the collected solar heat. Sunlight enters a building through a window and is absorbed and stored inside.



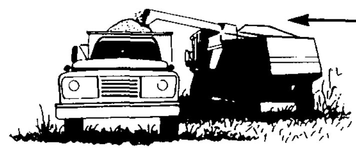
photovoltaics--solar cells which convert sunlight to electricity directly.



wind power--moving air, containing energy of motion which does work.



hydropower--energy created by falling or moving water.



biomass--plant materials in any form from algae to wood, which contain energy stored in chemical form.

Procedure

1. Study the words for the different kinds of renewable energy in the list above. Decide which form of energy you would like to know more about. Ask your teacher for an address you can write to to find out about the form of energy you are interested in.

2. Before you write your letter you will study a model business letter. On Worksheet 1 is a business letter that was written by a student who was trying to obtain information about industries in New York. This information was needed for a report that he was writing about geography and its effects on selecting sites for factories. Read the letter carefully.

3. Look at the letter again and see if you can find the following information. As you read the letter, place the number of each part below next to the proper place in the letter where that information can be found. Bring the labeled letter to the teacher when you finish.

    1. Heading (Your return address)

    2. Inside address (The address of the person to whom you are writing)

    3. Salutation (Dear somebody)

    4. Body -- should contain all of the following information:

        a. Who the student is

        b. Why the student wants assistance

        c. What information is needed

        d. An expression of appreciation

5. Closing (Sincerely yours, or Very truly yours,)

6. Legible signature

7. Envelope (Your home address in the upper left hand corner)

4. Now it is your turn. Look at Worksheet 2. You are going to plan and write a business letter asking for information about solar energy. Write each part of the business letter on the worksheet to suit your needs. Remember, you are trying to find information about some form of solar energy. When you are finished have your teacher check your worksheet.

5. Now that your teacher has checked your business letter worksheet, take a blank sheet of stationery and an envelope and set up your business letter like the sample. This time use the information that you have on your worksheet. It is a good idea to write a pencil copy first. Then write your final copy on the stationery, have your teacher check it, address the envelope, stamp it, and mail your letter.

Questions

1. What are the parts of the business letter?

2. When is it appropriate to observe the formal convention of a business letter?

3. What qualities of the writer appear in the business letter?

4. Why might you want to send for information about solar energy?

Looking Back

Whenever you write something, you should consider the appropriate way to write it. After a pleasant dinner, a "bread-and-butter" note is in order. When ordering from a mail order catalogue, the order form must be accurate and legible. Just as it is unlikely that a bride and groom would expect their guests to arrive in jeans, it is unacceptable to use the same style of writing for each writing purpose. The business letter, properly executed, is often your introduction to your audience. How you present yourself on that paper may determine how willing they are to help you.

If you did a good job on your letter you should soon receive information through the mail as a result of your efforts. The material you receive about solar energy can be shared with family and classmates.

Active people are constantly taking in new information and trying to find ways of sharing what they know. The business letter is one way of gaining useful information.

Going Further

Gather the materials the class receives and plan and execute a bulletin board about active and passive solar energy, wind energy, or some other form of renewable energy.

Find a partner and set up a table of information in the cafeteria to encourage student interest in solar energy use.

Write two more business letters to experts in alternative energy fields, soliciting information about wind and hydroelectric power.

Invite a speaker in to talk to your class about insulation, new ways of tapping the energy from the sun, or construction principles which are emerging as a result of our new knowledge about depletable resources.

Worksheet 1

Sample Business Letter

22 Fairwood Place
Latham, New York 12110
May 19, 1981

Bernard E. Dempsey, Commissioner
Department of Commerce
Rockefeller Plaza
Albany, New York 12223

Dear Mr. Dempsey:

I am an eighth grade student and I am writing a report about the effect of geography on the selection of sites for factories. I am using New York State as an example because it has so many different types of land forms.

I would appreciate any information that you could send me, free of charge, that you feel would be of value to me in my research for my report.

Thank you for your help in this project.

Sincerely yours,

Chris Fowler

Chris Fowler

Sample Envelope

Chris Fowler
22 Fairwood Place
Latham, New York 12110

Bernard E. Dempsey, Commissioner
Department of Commerce
Rockefeller Plaza
Albany, New York 12223

Worksheet 2

Practice Business Letter Worksheet

1. Heading -- Write your address here.

____
____
____

2. Inside address -- Write the name and address of the person to whom you are writing here.

____
____
____

3. Salutation -- Write your "Dear Somebody" here. (If you have the person's name, use it. If not, use "Dear Sir or Madam".)

____

4. Body -- Include all of the following information:

   a. Write a sentence that tells who you are.

   ____
   ____

   b. Write one or two sentences that tell why you need help.

   ____
   ____
   ____

   c. Write two or three sentences that tell what information you need, *(Caution: Mention here that you are writing for free information)* and how you intend to make use of it (maybe making a dictionary of terms, a quick report to your class on what you learned, etc.

   ____
   ____
   ____

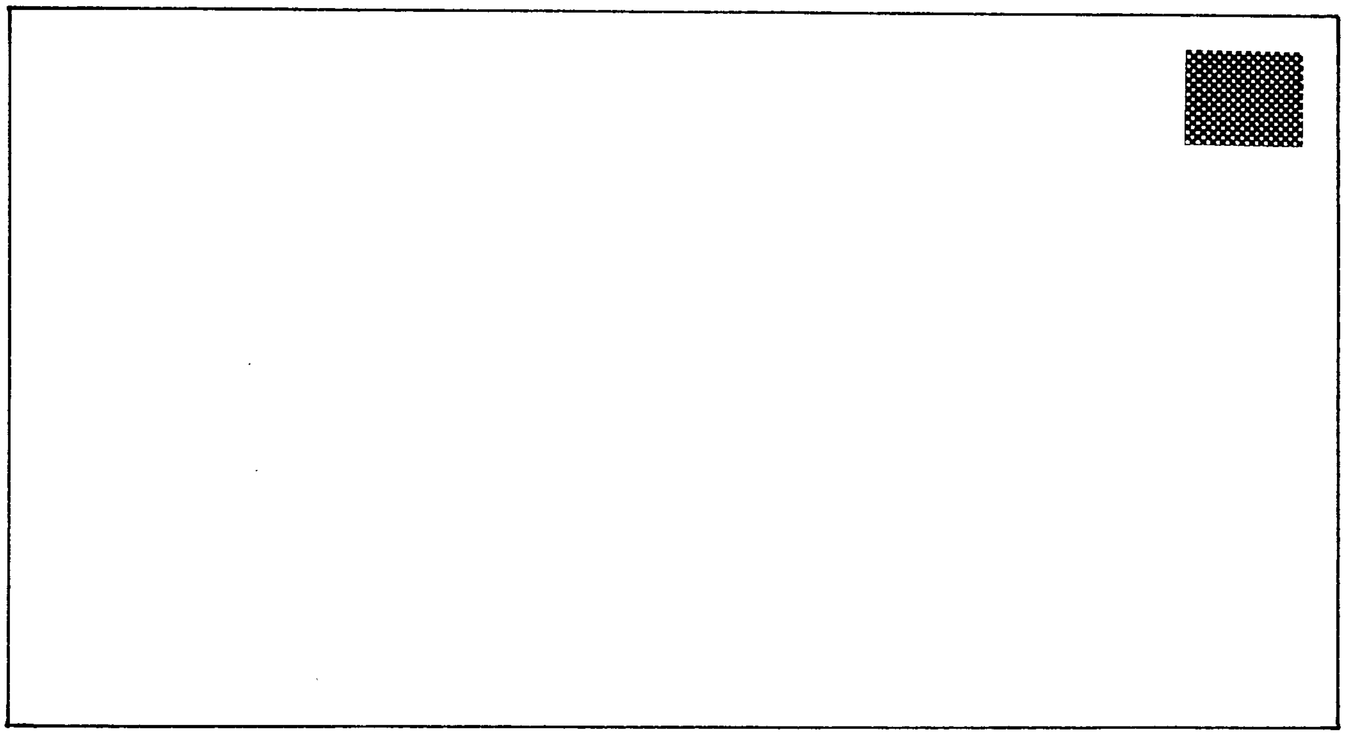
   d. Write a simple sentence that says thank you.

   ____
   ____

5. & 6. Write your closing (Very truly yours,) and your signature here.

____
____

7. Practice your envelope below:



Teacher Information

Sending for Energy Information

Suggested Grade Level and Discipline

Grades 6-8, all students
Grades 9-12, remedial students
Social Studies and English

Skill Objectives

Selecting the kind of information to include in a business letter

Identifying the basic parts of a business letter

Properly laying out a business letter

Major Understandings

When writing anything formal, prior thought and effort must be directed towards the type of information to be included.

The business letter opens up new sources for student research.

Reading content materials is more enjoyable when the students have solicited the information themselves.

There are several different forms of renewable energy.

Background

The gasoline lines of 1974 and 1979 should have convinced us that the days of plentiful and cheap fossil fuels are gone. We should also be aware that a fantastic find of oil or natural gas, to keep us going forever, will just not happen. As a nation and a world, we must begin looking for alternative fuel supplies. Renewable energy can be one major source. This activity should be part of a process of getting young people concerned about and interested in renewable energy. Using a business letter to write for materials about renewable energy can build skills in language arts, social studies, and science.

There is an abundance of free or very inexpensive material on renewable energy presently available. The problem is that it takes time to find the sources and to write for the materials. This is where a student business letter writing project is helpful. This activity can be very motivating. Students will be more interested in practicing the business letter format if they know that the resulting letter is actually going to be sent. In addition, they will be more interested in reading something that they personally received through the mail.

Advance Planning

Check to see whether your school will pay the postage for the letters that your children will be writing. Most schools have school or curriculum department funds available for small projects that occur during the year. If this is not the case with your school, prepare your students a week in advance by instructing them to bring in postage stamps.

Paper and envelopes can be handled in the same manner as the stamps. Blank sheets of school duplicating paper make excellent sheets for business letters. Pick up some extra sheets from your school's workroom. Legal envelopes can be obtained from your school office. Ask for the plain envelopes without the school letterhead.

The Reference section at the end of this activity lists several catalogs containing the addresses of numerous manufacturers and agencies involved in renewable energy. For local sources, look in the Yellow Pages under "solar" and "energy." Call your state energy office. The bibliography at the end of this booklet lists other agencies to contact.

Suggested Time Allotment

Allow approximately 3 days for the initial writing and mailing. Students may do additional letters as homework. The first day should be devoted to explaining the task and determining the content of the letters. The next two days should be used for the actual letter writing, editing, and rewriting.

Suggested Approach

Ideas for the body of the letter should be generated by class discussion prior to receiving the business letter forms. Students must feel that they know enough about the topic to write the letter.

Plan with the class some use of the materials received. The response itself is a reward, but more learning is likely to ensue if the materials are used for oral reports, a bulletin board, a class file on energy, a table of materials set up at a PTA meeting, etc.

Precautions

Have only two students write to any one agency to prevent its being inundated with requests.

Make sure that your students mention that they are requesting free information in their letters.

Gather brochures, glossaries of solar terminology, some samples from agencies offering free literature in the event that a student does not get a response to his letter.

Make sure that you have postage stamps for those students who can not buy them, or check to see if your school will pay for the postage.

Make sure that your students use their home address as their return address for three reasons:

a. they will stand a better chance of receiving the materials,

b. they will learn the proper use of their own addresses in writing business letters, and

c. they will be more likely to share the information with their parents.

If each student writes 2 letters, everyone should get at least 1 response.

Points for Discussion

What value does the business letter have in today's informal society?

Why not simply use the telephone to communicate more quickly?

Can students make a list of people/agencies likely to be impressed by their ability to express themselves effectively in a business letter?

There may be students unconvinced that this reliance on renewable energy sources is the right path to take. A debate, even if some students were to argue against what they actually think, would inform and reinforce the learning.

Typical Results

The materials should spark some enthusiasm when received and some reading in the content area will be likely to ensue. Students are likely to feel more comfortable and competent about letter writing when they see that a real letter gets results.

Evaluation

Have students unscramble a scrambled business letter.

Ask them to list the parts of a business letter.

Modifications

Have students follow up this activity with a business letter requesting information from an agency about a topic of especial interest to them; a fan letter might even be appropriate.

Bring in experts on windmills, hydropower, or a local construction company representative to discuss the value of alternative energy sources. Everyone likes to sell his product. Perhaps students could write the invitations and thank-you notes.

References

Consumer Guide, eds. Energy Savers Catalog (Publications International, Ltd., 3841 West Oakton Street, Skokie, IL 60076, 1977).

Rain, eds. Rainbook: Resources for Appropriate Technology (New York: Schocken Books, 1977).

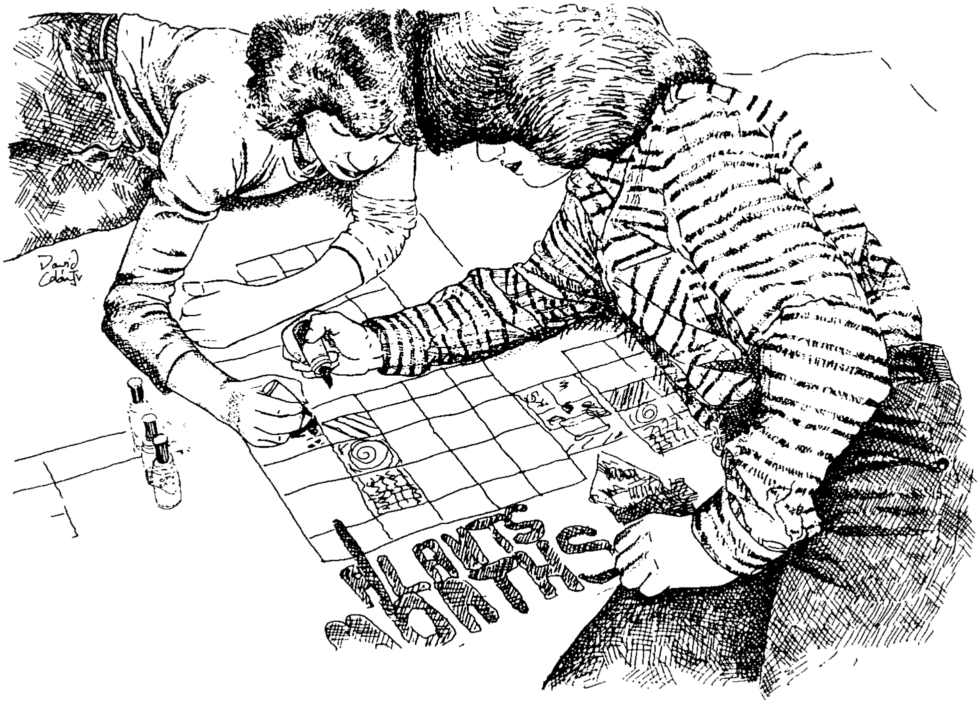
Solar Age Magazine, eds. The Solar Age Resource Book (Everest House, 1133 Avenue of the Americas, New York, NY 10036, 1979).

Solar Usage Now, Inc. Peoples' Solar Sourcebook (Solar Usage Now, Inc., Box No. 306, 420 East Tiffin Street, Bascom, OH 44809).

U.S. Postal Service with the National Council of Teachers of English. All About Letters (National Council of Teachers of English, 1111 Kenyon Road, Urbana, IL, 1979).

Wolfe, Ralph and Peter Clegg. Home Energy for the Eighties (Charlotte, VT: Garden Way Publishing Company, 1979).

The Energy Timeline Game 15



Introduction

All the energy that we use, whether for heating our homes or for playing baseball, comes from the sun in one way or another. It was the rays of the sun, interacting with the elements of the earth, that created the coal and oil in the ground, the wind that pushes the windmill, the rain that fills our reservoirs, and even the electricity we see as lightning. Energy and power come from natural resources, which depend on the sun and its rays for their existence. The production of these energy resources requires varying lengths of time, if you start counting from the time at which the energy originally left the sun as a ray of light.

In this activity you will examine a timeline which shows the relative lengths of time required for the sun to produce energy resources. You will use the concepts and information introduced on a timeline to design a game to play with your group. Through studying the facts about energy and time, and then playing the game, you will learn more about alternative sources of energy.

Objectives

At the completion of this activity you should be able to

- o read and interpret a timeline,
- o work with others to design a timeline,
- o play a game based on your understanding of the energy timeline, and
- o explain why some energy sources are considered to be renewable and some are considered to be nonrenewable.

Skills and Knowledge You Need

Following rules for a game

Working as a member of a team

Materials

long sheet of durable paper (5 to 6 meters), preferably from a roll

magic markers or crayons

"Sunbeams": poker chips, checkers, pennies, etc.

Energy Timeline Worksheet

Words You'll Learn

solar
photovoltaic
ocean thermal energy
hydropower
photosynthesis
renewable energy
nonrenewable energy

Procedure

1. Study the Energy Timeline Worksheet. Using the information in the diagram, fill in the blanks on the other side of the worksheet.

2. Form two teams.

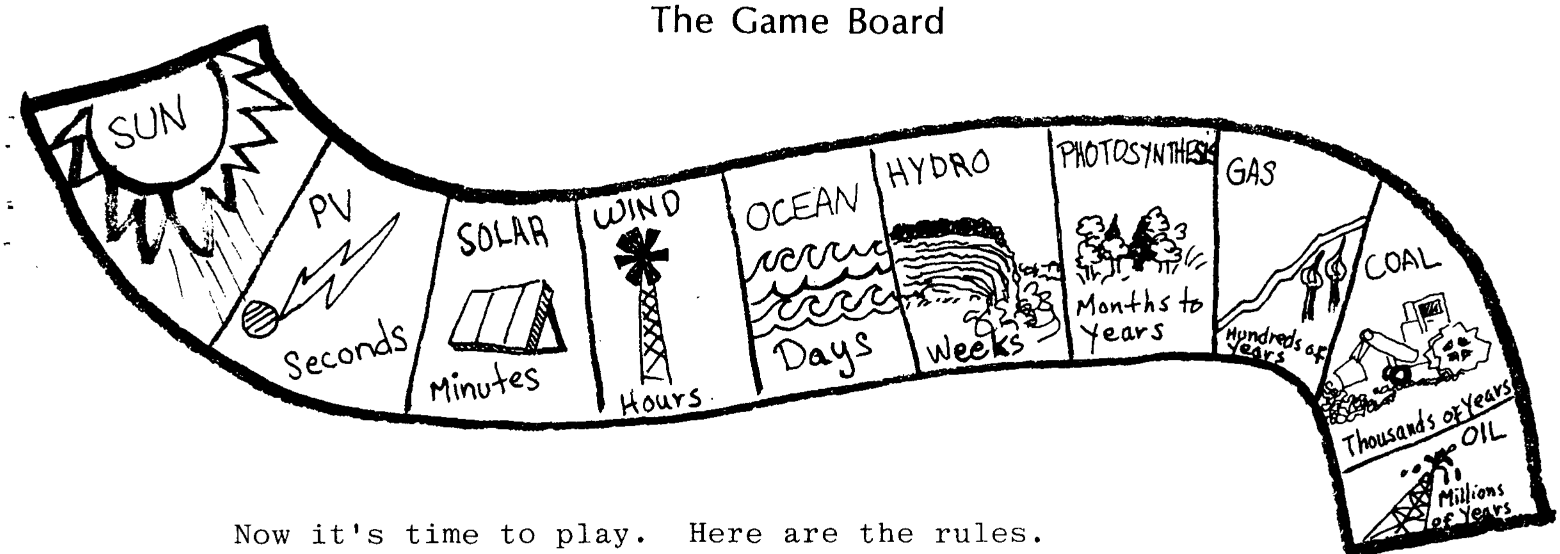
3. Unroll your long roll of paper between the two teams.

4. Divide the roll into equal sections with pencil markings. Start with the sun. Have a section for each kind of energy, with the kinds that take the shortest time close to the sun and the kinds that take the longest time farthest from the sun.

5. Appoint one or two people from each team to each section of the roll. Have them write the kind of energy, and the time required to produce it on the section reserved for that form of energy. Then have them decorate their section of the roll with appropriate designs and colors.

6. When the entire two-team energy timeline game board is completed it should look something like this.

The Game Board



Now it's time to play. Here are the rules.

1. Each team has the same number of players. If there is an extra person, he/she is the referee.

2. Each team has the same number of "sunbeams": poker chips, checkers, pennies, or whatever. The leader keeps these.

3. The team leaders stand side by side at "the sun," the beginning of the game board. Each person or pair stands at their section of the game board, with the two teams on opposite sides of the game board.

4. When the referee says "go," each leader hands one "sunbeam" to the first player on his/her team. He/she puts it on his/her section of the board and calls out the name of the form of energy. Then the leader can pass him/her another sunbeam, which can be passed to the next player. Each player has to leave a "sunbeam" on his/her section of the board before he/she can pass one to the next player on the team. The leader may not start the next "sunbeam" until the one before is on the board and the name of the form of energy has been called out.

5. The object of the game is to see which team can get a sunbeam on every section of the board first. BUT, you must start with the sections closest to the sun. The sections farthest from the sun must get their sunbeams last.

6. If you have extra sunbeams, continue the game by starting over again until they are all used up.

7. After saying "go," the referee should move to the end of the game board to see which team finishes first.

Questions

1. What did the game show about energy and time?

2. Why are the "slow" forms of energy (gas, coal, and oil) so popular today? What are the problems with these forms of energy?

3. What are the problems with the forms of energy that the sun produces quickly (like direct solar heat and wind)?

4. If you had to plan the best combination of energy sources for the world, what would you recommend?

5. Why isn't nuclear energy shown on the energy timeline?

Looking Back

Almost every form of energy we know on earth comes from the sun, directly or indirectly. No form of energy is "good" or "bad"; each one has advantages and disadvantages. We have to decide what energy is available to us, how we can get it, and what we are willing to pay for it. For some of us this is a moral, or practical, or political decision. But all of us make decisions about energy every day, whether we know it or not.

Going Further

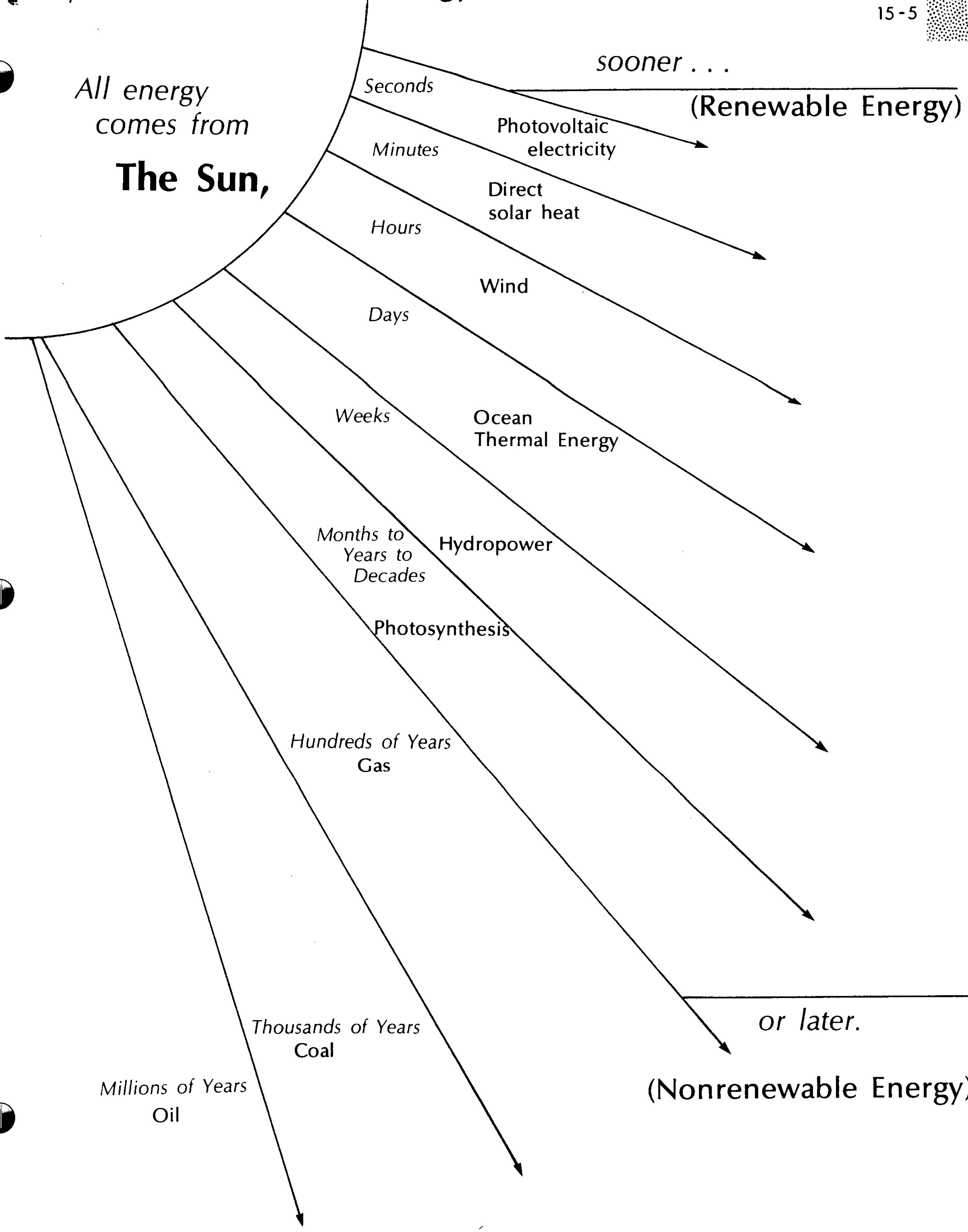
Analyze the energy decisions you make by

what you wear,
what you eat,
how you travel,
what you do for fun,
what you consume (disposable items), and
what your home is like.

Keep an energy journal. Log the energy consumption phenomena you observe every day. Try to make yourself more conscious of how you and your friends use energy.

Have a discussion with someone who lives quite differently from you. See how this person's lifestyle affects the way he/she consumes energy. (Examples: country vs. city dweller; young person vs. senior citizen; American student vs. exchange student.)

Energy Timeline

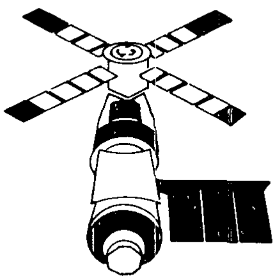


UNDERSTANDING THE ENERGY TIMELINE

Study the energy timeline and then fill in the blanks below.

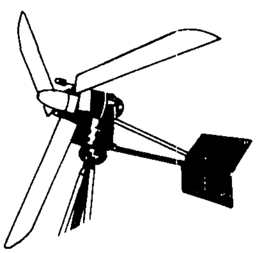
The ___ is the original source of almost all the energy on earth. Energy appears in many different forms, but if you trace it back far enough you find that it all started at the same place: the ___.

Some forms of energy exist in almost unlimited supply. As soon as we use some, it is replaced by more. For this reason, we say that these forms of energy are _________.



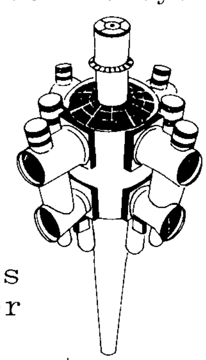
Perhaps the fastest form of energy is _________________________, which is produced when sunlight strikes solar cells. These are the round, bluish wafers that are mounted on space satellites to give them electric power from sunlight when they are in space.

It only takes the sun a few minutes to give us ________________. You can feel it in a car that sits in the sun. Houses and buildings can be designed to collect sunlight the same way. You can also build solar collectors to trap the sun's heat.



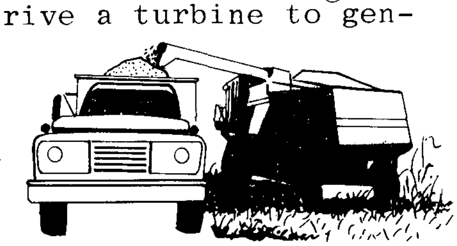
The sun heats the earth and the earth warms the air above it. Heated air rises (just like a hot air balloon). When cooler air rushes in to displace the heated air, we have ____. This form of energy can be used to sail ships or drive machines to pump water or produce electricity.

The sun also heats the water that covers 75% of the earth's surface. The warm surface waters then contain ______________ energy, which can be used to drive machines.



Some of the water evaporates when it is heated. Then it forms clouds, falls as rain, and collects in lakes and rivers. As this water flows back to the sea it provides __________ which can drive a turbine to generate electricity.

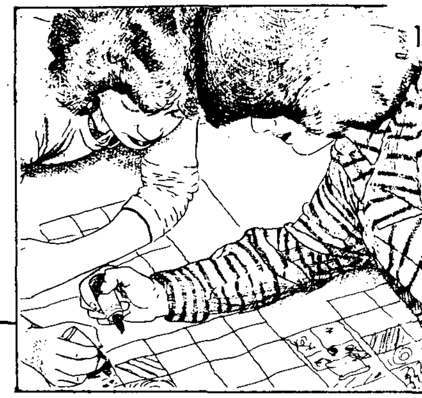
The plants of the earth are solar collectors. By the process of __________ they use sunlight to produce chemical energy that is used for food or fuel.



Some forms of energy take so long to produce that if we use them up they can't be replaced. ___, ____, and ___ are like that. Dead plants and animals must decay for hundreds to millions of years to produce these fossil fuels. That is why we say they are __________.

Teacher Information

The Energy Timeline Game



Suggested Grade Level and Discipline

Grades 6-8
Social Studies
Art

Skill Objectives

Coordination of fine and large motor skills

Reading and interpreting a timeline

Developing teamwork

Major Understandings

Energy (in light waves) comes from the sun and is converted into different forms of energy which require different amounts of time to develop.

There are advantages and disadvantages to each of the varying forms of energy.

Background

The electromagnetic radiation of the sun is the source of virtually every form of energy found on earth. That radiation undergoes a number of transformations to produce various forms of energy, and those transformations take different lengths of time.

If a solar energy transformation is fairly rapid, then we call that form of energy renewable, because it is part of a constantly repeating cycle and can be replaced within a human lifetime or less.

Examples:

Electricity from photovoltaic cells: the silicon cell transforms sunlight to electricity in a fraction of a second.

Direct solar heat: solar collectors or passive solar houses heat up in sunlight in a matter of minutes.

Wind: the sun heating the earth warms the air above the earth, setting up pressure differences, convection, and wind. Wind can be used to drive machinery or generators.

Ocean thermal energy: the temperature difference between heated surface water and cold deep water is used to generate electricity.

Hydropower: water evaporated by the sun is moved by wind to other places. It falls as rain to fill lakes and rivers which flow back to the sea, driving hydropower plants.

Photosynthesis: the sun-fueled growth of plants, over months and years, produces food for animal life, and various fuels such as alcohol, methane, wood, and peat. Plant and animal remains are the basis for fossil fuels.

If an energy transformation takes hundreds or millions of years, we call that energy nonrenewable because it cannot be replaced within the human lifespan.

Examples:

Natural gas, coal, and oil: these fossil fuels result from the breaking down of plant and animal remains, under heat and pressure, over thousands and millions of years.

A few forms of energy are not considered specifically "solar," because they are thought to date back to the origins of the solar system, when the earth and the sun came into existence. Nuclear energy is the product of radioactive materials found in limited supply on the earth. Because of this limited supply it is regarded as nonrenewable in one sense, although breeder reactors which can produce nuclear fuel may make it a renewable resource in another sense.

Geothermal energy is heat drawn from the hot regions under the earth's crust. It can be used for heating or electric generation, and, because of the vast supply to be tapped, is considered to be a renewable resource.

Advance Planning

Investigate the forms of energy shown on the timeline, so as to be able to answer student questions. Go over vocabulary.

Reproduce the Energy Timeline and reading on the back.

Obtain the necessary materials for making and playing the game.

Suggested Time Allotment

One class period for introduction and discussion of energy timeline

One period to produce the game board and play one round of the game

Suggested Approach

Introduce the timeline on the blackboard or overhead projector. Try to emphasize the scale (through the use of calculators, etc.). For example: if one month is one foot, a million years is 2200 miles.

Go over the procedure for preparing the game board.

Initiate discussion of symbols for forms of energy. Encourage free expression on game board sections. Motivate students to think of the game board as a permanent artifact for display and schoolwide teaching.

Points for Discussion

Where should specific forms of energy such as muscle power, wood, methane, peat, geothermal energy, gasohol, etc. be inserted?

Was this really a game, or was it a demonstration?

How else could the point of this activity be gotten across (to adults, small children, etc.)?

Typical Results

The decorating of the board is an involving activity, but the game goes fast, and students are quick to see the implications of the activity.

Evaluation

Use the timeline as a test item, with some of the forms of energy or the time periods left blank.

Encourage students to create an energy timeline poster, poem, or musical composition.

Have students list renewable and nonrenewable energy sources, and explain the difference between them.

Modifications

Introduce and encourage modifications of game rules.

Create more sophisticated game rules. For example, have spaces on each section of the game board. On each section, the number of spaces doubles the number on the previous section.

Have students teach the game to smaller children, explaining each form of energy.

Create an individualized counter for each section of the board. Students must recognize it and place it appropriately to win. (Examples: photo cell, lump of coal, etc.).

Do a parking lot energy timeline with permanent paint as a class project. Have students research ancient symbols and motifs for various forms of energy.

References

Crabbe, David and Richard McBride, eds. The World Energy Book (Cambridge, MA: The MIT Press, 1979).

Hayes, Denis. The Solar Energy Timetable, Worldwatch Paper 19 (Washington, DC: Worldwatch Institute, 1978).

Stobaugh, Robert and Daniel Yergin. Energy Future: Report of the Energy Project at the Harvard Business School (New York: Ballantine Books, 1979).

Taking a Solar Survey 16

Introduction

It fills the headlines, dominates the TV news, upsets family budgets; it affects jobs of family and friends; it casts a shadow over all our futures; it is the issue of supplying and paying for our energy needs. How did energy become such a dominant concern?

As we industrialized and became a high consumption society, we bet our future on oil. It was the most convenient for transportation and the most versatile of all the fossil fuels. So we developed an economy and life style dependent on oil. It fueled our autos, heated our homes, powered our factories and was the raw material for a vast petro-chemical industry. Oil supplied almost half our energy needs.

But events such as the Arab oil embargo of 1973, the gas lines of 1973 and 1979, and the enormous increase in oil prices served to remind Americans that our supply of hydrocarbon fuels--coal, gas, and oil--is limited and once used is gone forever. This does not mean that we will run out of energy and have to starve in the cold and the dark. However, it does mean that we will have to change the way we get and use our energy.

DRAFT

Since we live in a democracy where public opinion helps to mold national policy, it is important for us to understand what the public knows about the problem and what it thinks should be done to solve it. In this activity you will be working in small groups to develop a survey that you will then use to determine public opinion. This poll will address two key questions: how much does the public know about the causes of our current energy crisis, and to what extent does the public see solar energy as part of the solution to this problem.

Objectives

At the conclusion of this activity you should be able to

- develop a survey,
- compile statistics,
- analyze the parts and results of a good survey,
- use alternative energy vocabulary, and
- explain the usefulness and limitations of national public opinion polls.

Skills and Knowledge You Need

Determining your survey audience

Identifying basic questions to consider

Using some simple statistics

Compiling results of a survey

Words You'll Learn

energy crisis, nuclear power, fossil fuels, flat plate collectors, wind power, wood stoves, photovoltaic cells, conservation, alternative energy, solar energy, hydroelectric power, passive solar heating, active solar heating, conventional or nonrenewable energy, biomass

Materials

note paper

access to basic typing and reproduction services (mimeo or xerox)

access to a phone (optional)

envelopes and postage (optional)

Procedure

You will be participating in the development and use of a survey about the public's knowledge of our current energy crisis and alternative energy. Therefore you must first do some background reading and learn some important energy terms.

1. Read the background material, "Solar Energy: What Is It?" As you read, think about the questions you should ask on your survey. Jot down the words and phrases you are unfamiliar with, and see if you can figure out the meanings from context. This is the beginning of your energy vocabulary.

2. Follow the instructions on the Solar Words Worksheet. When you finish that worksheet you should have a good energy vocabulary.

3. Now you will begin to develop your survey. Form a group with three or four others, and appoint a recorder. Discuss the questions below; brainstorm answers and record them. Don't try to make decisions yet. Just generate ideas and suggestions for how to do your survey.

   a. What do we want to know about the public's knowledge of the energy crisis and alternative energy?

   b. Whom should we ask?

      (1) Adults--who are making the energy decisions now and who still consume traditional energy supplies.

      (2) Students--who will make future energy decisions and may use non-conventional energy sources.

   c. What should we ask?

      (1) General questions such as: Why do you think we now have an energy crisis?

      (2) Specific questions such as: Can you see any disadvantages to the U.S. switching to alcohol powered cars?

   d. How should we ask the questions?

      (1) Should we ask questions that require a written answer?

      (2) Should only multiple choice questions or a check-off sheet of some kind be used?

      (3) Should we ask the questions in person, by phone, by mail, or by a combination of all the above methods?

   e. What should we do with the raw statistics?

4. Now that each group has its own list of possible answers, the teacher will call on you to dictate your suggestions so they can be written on the chalkboard. After each group has reported, select the most appropriate responses to your needs in each category and write them on a clean piece of paper.

5. Now that you know what you want to find out, whom to ask, what to ask and how, you are prepared to write your survey. Write your survey from the questions generated in Step 4. In your group select the 20 questions you feel must be asked to yield valid and conclusive results from your survey. Once they are written give them to the teacher. Write in pencil or black ink only.

6. With all of the questions from each group in front of you, decide as a class which 20 questions will make up the class survey. Have them typed, duplicated, and distributed to the population sample decided on by the class.

7. Distribute and collect the survey.

8. Compile the results as a class with your teacher's help.

9. Discuss and analyze the results.

Questions

1. What major information did your survey yield? What conclusions can you draw?

2. How do your conclusions compare with your earlier notions about the knowledge and logic of the group tested?

3. How knowledgeable was your sample about the energy crisis? About alternative energy?

4. What was the most serious flaw in your survey? Why?

5. Do you think your group will do anything about the new knowledge they were forced to deal with in your survey--even if that is only how little they know about solar energy?

6. In what way was your survey useful? What were its limitations?

7. What did this activity teach you about national opinion polls?

Looking Back

You have asked a population sample selected by you a series of questions about solar energy. The vocabulary and probably some of the ideas were new to you. Your questions have focussed attention, the audience's and yours, on the energy crisis and solar energy as a renewable energy source. The informed citizen must make new decisions about the way we get and use our energy. You have helped to make people think about those decisions.

Going Further

Try the survey on a school population only: the kids in your lunch group, all the freshmen, those taking economics, or everyone who is graduating.

Make a presentation of your findings to your social studies class or the student council in your school.

Suggest to your industrial arts or social studies teacher that a unit on renewable energy sources be added as an "extra-credit" assignment.

Graph the results of your survey and discuss the implications on "Sun Day" in your classroom or school.

Design an ad campaign addressed to a particular segment of your population to sell them on alternative energy resources.

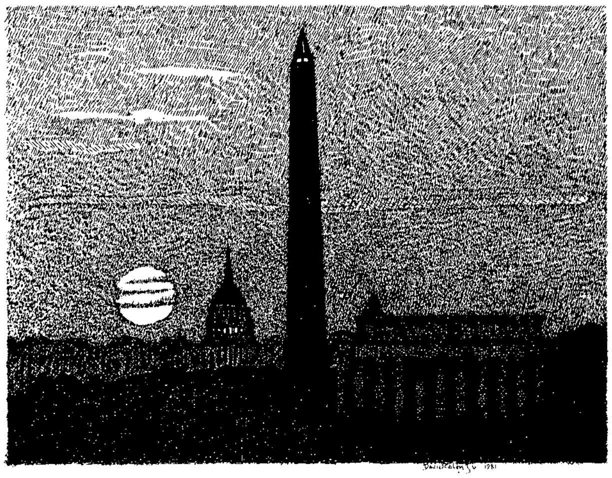
Solar Energy: What Is It?

Background

When the term solar energy is used, we generally think of direct heating from the rays of the sun. But solar energy refers to more than the heat that we can feel when we sit in direct sunlight. Actually, solar energy can be found in any energy that, at one time, was produced by sunlight. This would include wind movement, water passing over a dam, and the burning of wood, coal, and oil. All of our present sources of energy owe their origin to sunlight.

The most common division between what we call "conventional" or "nonrenewable" and "solar" or "renewable" energy is the answer to a simple question. Can the energy source replace itself in your lifetime? For example, if you cut down a tree to use it for firewood, you can, in your lifetime, grow another tree. If you consume all of the oil stored beneath your property, nature cannot replace it in your lifetime; it will take millions of years to do that job. Wood is considered a renewable resource; oil is not.

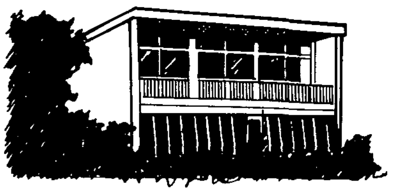
Each day, the sun delivers to the earth hundreds of times more energy than earth's people consume. The supporters of solar energy believe that we can capture enough of that energy to significantly help meet our energy needs.



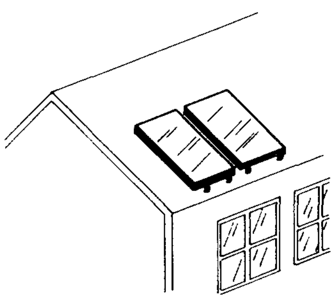
For the purpose of this exercise, solar energy will refer to those readily renewable sources such as direct sunlight for "passive" or "active" solar energy, biomass (corn, wood, etc.), hydroelectric power from falling water, energy that can be produced by harnessing the wind, and electricity from photovoltaic cells. Each source will be discussed separately.

Passive Solar Heating

One way to use the sun to heat residential and commercial buildings is "passive" solar heating. It is the direct use of the heat from the sun to assist in heating homes and factories. "Passive" collection of the sun's energy involves the use of windows or greenhouses and a heat storage mass, like water or stone. The sun shines through the glass and heats containers of water or brick and stone walls and floors. These substances heat up, and then give off their heat during the night when the house gets cooler. This is easiest to do in a new house which can be sited so that the glass faces south into the sun. The mass to store the heat is incorporated into the structure and the house is insulated and sealed to retain heat.

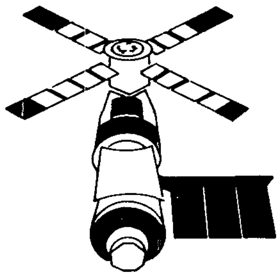


Active Solar Heating



Active solar units represent an effort to gain more of the sun's heat than can be obtained by a passive unit. In general, flat plate collectors (flat glass-covered rectangular boxes) on the roof or a sun-exposed wall carry tubes containing air, water, or another fluid. After this air or fluid is heated, it is pumped to a large storage area; it is later pumped or transferred to the area requiring heat. Entire houses can be heated in this manner. A similar system of solar collectors can be used to meet all or part of a family's hot water needs. In many cases, the most economical approach is to partially heat the water with solar energy and then use another energy source to boost the temperature of the water the last few degrees to the desired temperature. This requires less investment in collector and storage equipment.

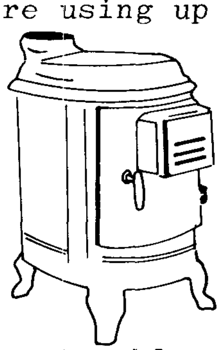
Photovoltaics



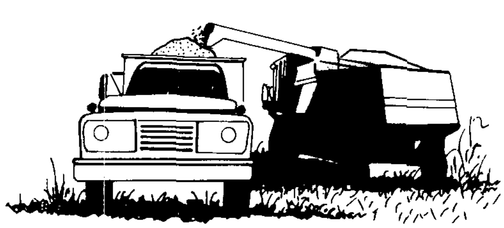
The sun's rays can be converted directly into electric current by means of photovoltaic cells--also called solar cells. Today's automatic cameras use solar cells in their light meters. Solar cells are also used to power satellites in space. Ordinary sunlight or light from a small lamp provides enough energy to generate current in one of these cells. Solar cells make use of two inexpensive and primarily inexhaustible raw materials, sunlight to power the cells and silicon to construct them. These cells can be used to produce electricity on a large scale by a power company, on house roofs to provide daytime power, or as an alternative to generators and batteries that are now used to provide power in remote places. Solar cells could extend the life of batteries and also be used to recharge them. This would decrease the need for fossil fuel energy.

Biomass

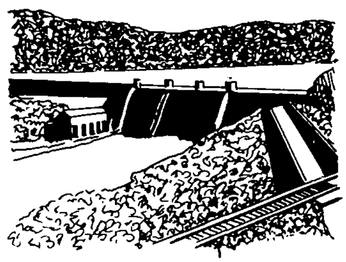
Each day a significant part of the sun's energy is locked up in vegetation through the process of photosynthesis. In fact, all fossil fuels were created in the same way ages ago. However, when we draw upon our fossil reserves, we are using up energy that is irreplaceable, but when we utilize living plants they are, under the right circumstances, renewable. Americans have been buying wood stoves, chain saws, log splitters, and the other paraphernalia of wood burning. In places where forests are plentiful, such as the Northeast, wood is making a significant contribution. Individuals with access to wood have made important personal savings. Biomass in the form of wood has the advantage of being storable. You can stockpile your wood for the winter when you will need it as a fuel source.



Another use of the energy stored in plants is to convert those plants into alcohol which can be used directly to power internal combustion engines or which can be mixed with gasoline to make "gasohol." Wastes can also be bacterially digested to produce methane gas. These are just some of the uses of biomass for energy.



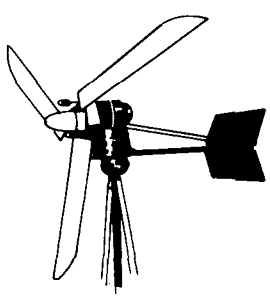
Hydroelectric Power



Hydropower results from damming water or diverting water from waterfalls, then running it through turbines to produce electric power. Hydroelectric power currently supplies about 3 percent of our nation's energy needs. It is an old, well-tested technology that provides one of the cleanest, cheapest, and safest sources of electric power in the U.S. Many old dam sites and hydro plants could be reactivated and run by local governments or cooperatives.

Wind Power

Wind power is an ancient power source used to turn windmills and propel sailboats. Early in this century windmills used to pump water were hooked to electric generators to provide power to farms in rural America. In recent years, there has been an increased interest in both small-scale wind generators for homes and large wind machines designed to serve whole communities. In some places, the local utility will buy wind-generated electric power from individual owners, and some utilities are experimenting with large wind generators themselves. Wind power generally is competitive with other forms of energy in highly remote areas that have average wind speeds of 15 km/hr. or better.



Solar Words Worksheet

Listed below are some of the words or terms that you should be familiar with after you have read the background material. Look up definitions for these words, fill in the sheet, and hand it to your teacher.

1. energy crisis

2. nuclear power

3. fossil fuels

4. flat plate collectors

5. wind power

6. wood stoves

7. photovoltaic cells

8. conservation

9. alternative energy

10. solar energy

11. hydroelectric power

12. passive solar heating

13. active solar heating

14. conventional or nonrenewable energy

15. biomass

Teacher Information

Taking a Solar Survey

Suggested Grade Level and Discipline

Grades 7-12
Social Studies
English
Mathematics

Skill Objectives

Working in small groups

Identifying the necessary parts of a survey

Learning simple survey sampling techniques

Evaluating results of a survey

Building alternative energy vocabulary

Major Understandings

A survey must ask the proper people the correct questions.

Surveys are useful but they have limitations and can be deceptive.

Surveys serve as a base for acquiring knowledge, drawing inferences, and making generalizations.

Alternative energy technologies must be recognized and defined as a topic for study.

Background

The energy crisis has been blamed on many things. Some people believe that the large multinational oil companies are at fault. Other people blame the greed of the OPEC nations. Still others blame our current energy crisis on our own misuse of what always were limited quantities of very precious substances. There are many Americans who still doubt that there really is an energy crisis.

The other side of the problem is the question of what should be done to correct our current energy situation. We would probably find many Americans equally ignorant of this aspect of the problem.

This activity is designed to get at these two sides of the energy crisis: how much the public knows about our current energy crisis and what they think should be done about the problem, with a focus on increasing awareness of alternative energy.

This activity will involve your students in developing their own survey, putting it into operation, and then analyzing the results. Through this process your students will gain insights into the problem of the energy crisis and into what makes a survey and what it can tell us.

Advance Planning

Duplicate needed quantities of the reading and worksheet.

You will need typing and duplicating facilities for the survey.

Familiarize yourself with survey techniques.

Suggested Time Allotment

1 class period to introduce activity and do reading

1 period for vocabulary worksheet

3 periods for small and large group discussion, and finalization of the survey

1-2 days (outside of class time) for editing and typing of the survey

3-4 days (outside of class time) for students to distribute and collect the survey

2-3 class periods to compile, analyze, and discuss results

Suggested Approach

Introduce survey-taking to your students with care. They must be cautioned that this is a very elementary research project and rather unrefined. In analyzing the survey questions students should not be enticed into thinking that their results carry great validity. Perhaps a statistical analysis by a knowledgeable person would be a suitable conclusion to the compiling of information.

A unit on propaganda might be introduced or concluded with this activity. Use of loaded language and statistics that lie to the untrained listener is rampant in our students' lives. This kind of activity can help them to clearer thinking.

Spend time discussing the reading and vocabulary.

After the small groups generate their 20 questions, these must be shared in some way with the larger group. If you plan to duplicate them, be sure students write with pencil or black ink. You could also have each group's recorder write on an overhead transparency.

Recruit students to type and collate the survey, and to compile the results.

Involve the full group in discussing the results and drawing conclusions.

Assign a reasonable but limited time period for data collection.

An ad agency might be willing to make a class presentation showing how surveys are used to define a market and then sell a product. Perhaps the representative could give an "on-the-spot" projection, based on the students' own survey, of the likelihood of growing reliance on alternative energy resources.

Precautions

Check to see whether your school system allows student surveys to be used.

Make sure that you provide guidance for any off-campus use of your surveys.

Point out that the nature of the sample reached will have a bearing on results, and caution students about the validity of results.

If the survey will be used with the public, make sure that the quality is high: no typos, spelling or grammar mistakes, and good reproduction quality.

Points for Discussion

In what ways is solar energy "free" to the consumer?

What are some of the disadvantages of depending on wood as your energy source? wind? the sun? alcohol fuels?

Typical Results

Results will vary depending on the type of questions asked, the polling sample used, and the method used to disseminate your survey. All of these aspects of the survey should be reviewed with your students as a conclusion to this activity so that they will better understand what works and what does not work when taking public opinion surveys.

Evaluation

The vocabulary worksheet can be checked by the teacher.

A grade could be assigned to the brainstormed list in Step 3 or the refined questions in Step 5 of the student procedure.

Perhaps a content test on reading for information could be given at the end of the background readings.

Ask students to list and explain their conclusions, and their ideas about the use and limitations of surveys.

Modifications

All the survey-creating steps could be done individually or in pairs.

Brainstorming could be a large group process. Overhead projectors lend themselves to this kind of brainstorming, and listing on transparencies allows everything to be kept until selections are made.

References

American Home Economics Association. Focus on Energy and Housing (American Home Economics Association, 2010 Massachusetts Avenue, N.W., Washington, DC 20036).

Hayes, Denis. The Solar Energy Timetable, Worldwatch Paper 19 (Washington, DC: Worldwatch Institute, 1978).

National Center for Education Statistics. Energy: Knowledge and Attitudes, a National Assessment of Energy Awareness Among Young Adults (Education Commission of the States, Suite 700, 1860 Lincoln Street, Denver, CO 80295).

Parten, Mildred B. Surveys, Polls, and Samples: Practical Procedures (New York: Harper & Row Publishing Company, 1950).

Resources for the Future. Energy: The Next Twenty Years (Cambridge, MA: Ballinger Publishing Company, 1979).

Warren, Roland L. Studying Your Community (New York: Russell Sage Foundation, 1955).

Analyzing Energy Cartoons

Introduction

The printed and spoken word bombards us every day with advice on what to eat or avoid, what exercise to do or how to relax, what we should be buying, whom we should vote for, and where our money earns greatest interest. We are being told what to read, what to wear, and what to think.

One way to communicate an opinion is through the use of cartoons. Although they may be simple and sometimes even funny, their message is often clear and sharp. Your job today involves interpreting cartoons about the energy crisis in the United States. As you look them over and answer the questions, think about your life 10, 20, and 30 years from now and how you hope to be living. If the message the cartoonists are conveying is correct, how can you work to create a better energy future for yourself and your children?

DRAFT

Objectives

At the conclusion of this activity you should be able to

- analyze and interpret political cartoons about energy, and
- suggest alternative energy paths for the U.S. to take to ensure a better future.

Skills and Knowledge You Need

General knowledge of the energy crisis and alternative energy sources

Materials

the cartoons and questions that are provided

Words You'll Learn

fossil fuels--coal, petroleum, and natural gas; this term applies to any fuels formed from the fossil remains of organic materials (plants and animals) that have been buried for millions of years.

nuclear energy--energy from radioactive decay or from fission or fusion reactions.

solar collector panel--an enclosed, glazed panel containing a dark absorbing surface that converts sunlight to heat without the aid of a reflecting surface to concentrate the rays.

solar concentrator--a reflector or lens designed to focus a large amount of sunlight into a small area, thus increasing the intensity of the energy collected.

solar energy--the electromagnetic radiation emitted by the sun.

Procedure

1. Study the word list above.
2. Examine each cartoon and then answer the questions about the cartoon.
3. Share your answers with your classmates, and discuss the implications of each cartoon for the future.
4. Write a one-paragraph statement that summarizes your opinion of the energy direction the U.S. and the world should follow in the future.

Looking Back

In sharp, satirical images, political cartoonists bring important ideas to our attention. In this activity we've seen cartoons that have suggested a number of ideas:

(1) that gas guzzling cars no longer fit into our world--let alone into our garages,

(2) that individual rights to the sun must be protected, and

(3) that research into new energy sources cannot come to a standstill.

The year 2000 need not be a bleak picture if we respond to the challenge that faces every new generation: the challenge to seek new answers.

Going Further

You may wish to do one of the following activities to become more involved in understanding the energy crisis and in communicating the issues to others:

(1) Research one of the alternative energy sources available to the U.S.--solar, nuclear, geothermal, wind, hydropower.

(2) Write a letter to your local newspaper encouraging people to become more aware of the energy choices we have before us.

(3) Try drawing your own cartoon with an energy message.

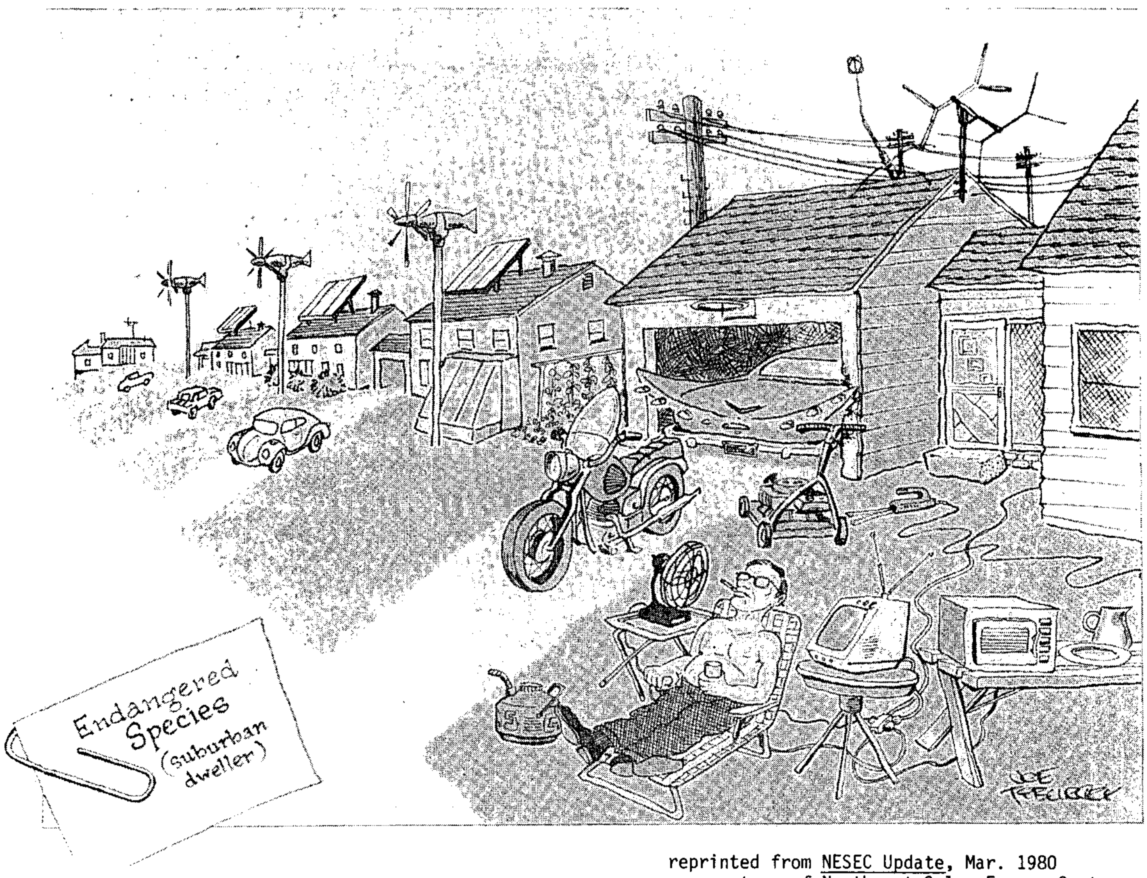
(4) Write a caption for someone else's illustration.

(5) Make a showcase presentation of an energy bulletin board collage with one theme.

(6) Find an energy theme other than solar, collect cartoons on that theme in a booklet, and present the booklet to the library.

Energy Cartoons & Cartoon Questions

#1

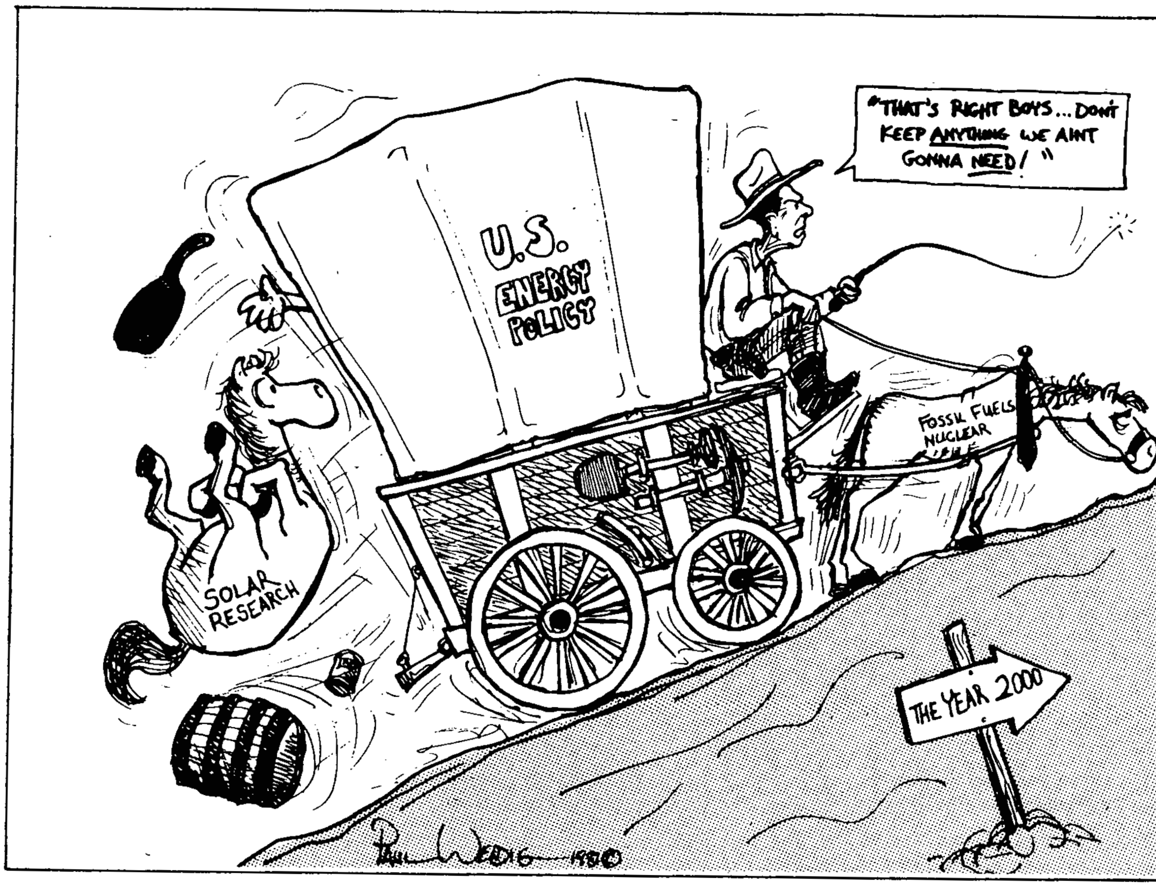


reprinted from NESEC Update, Mar. 1980
courtesy of Northeast Solar Energy Center.

Cartoon #1

1. What does "endangered species" mean?
2. Why do you suppose the suburban dweller is an endangered species?
3. How many of the energy users pictured do you have in your home?
4. List five differences between the house in the foreground and the four to the left.
5. What method does this cartoon rely on to carry its message?
6. What's "wrong" with this picture?

#2



reprinted from Solar Utilization News, Mar. 1981
with permission from Paul Weidig.

Cartoon #2

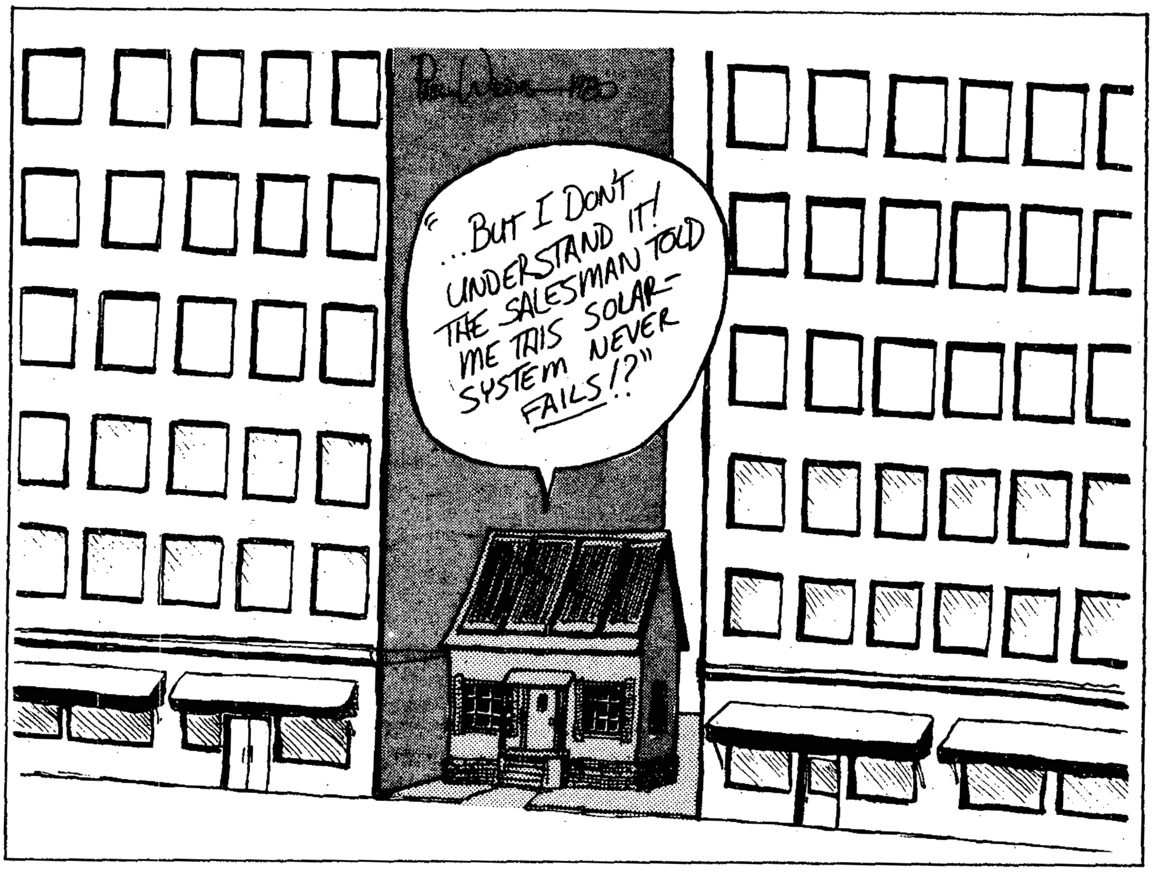
1. Explain what is happening in this cartoon.

2. What do you notice about the "energy source" for the wagon?

3. What will the whip snapper find out when he gets to his destination?

4. How does this cartoon compare to the old adage about discarding the baby with the bath water?

#3



reprinted from Solar Utilization News, Jan. 1981
with permission from Paul Weidig.

Cartoon #3

1. Why has the solar system on the house failed?

2. Which of these buildings do you suppose came first? Any clues?

3. What would you do as the homeowner? As the office building owner?

4. Should laws be made on the federal, state, or local level to prevent this from occurring?

5. Where does the right of the individual to sunlight come into conflict with the rights of others?

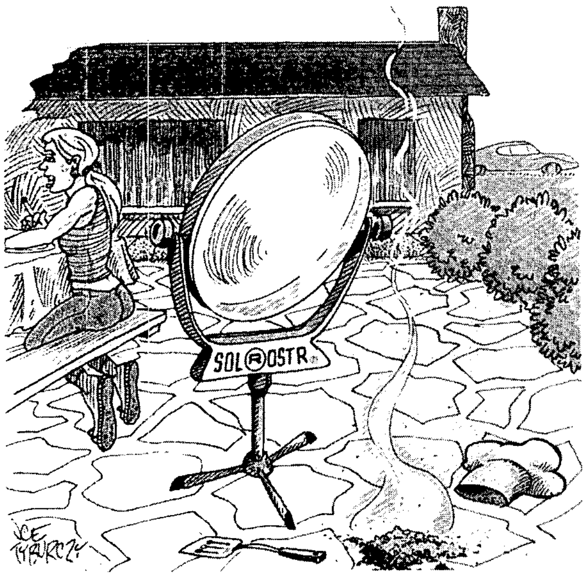
#4

reprinted from A.T. Times, Spring 1980
with permission from Paul J. Driscoll.

Cartoon #4

1. What word play does the cartoon contain?
2. How many extinct species do you see?
3. What is the youngster asking the grown-up?
4. Does this situation exist today?
5. What is the artist's message?

#5



"How are those hamburgers doing, Martin?"

Cartoon #5

1. Where are the hamburgers? Where is Martin?

2. Would you buy a Solrostr if it were available? Why or why not?

3. Tell what is happening in this cartoon.

4. What is the cartoonist implying about the power of the sun?

reprinted from NESEC Update, July 1980
courtesy of Northeast Solar Energy Center.

#6

Cartoon #6

1. What is in Ms. Liberty's right hand? What does that suggest?

2. What do you suppose she's looking at?

3. Why is she wearing glasses?

4. What is Ms. Liberty's (and the artist's) message?

5. Do you think our nation should heed Ms. Liberty's message? Why or why not?

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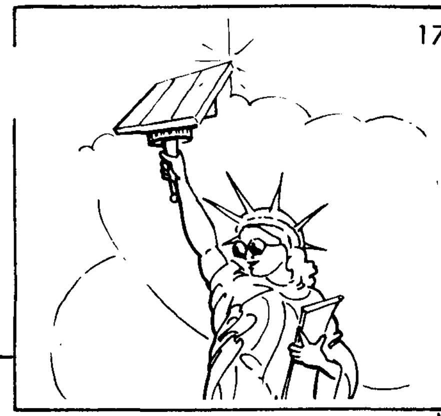
Teacher Information

Analyzing Energy Cartoons



Suggested Grade Level and Discipline

Grades 7-12
American Studies
Government/Civics
Current Events

Skill Objectives

Reading and interpreting political cartoons

Drawing conclusions and making inferences

Making generalizations from cartoon evidence

Writing a statement based on cartoon information

Major Understandings

Many factors have contributed to America's energy crisis.

Cultural factors (religion, education, social class) have an impact on how people view situations.

Artists draw political cartoons to convey a point of view.

Background

In order to understand the present energy crisis and the possibilities for our energy future, students must be skilled in analyzing and drawing conclusions about what they read. Interpreting political cartoons is an important part of this skill. The political cartoon exists to entertain, persuade, and inform. The author/artist uses the cartoon to express an opinion which may or may not be his own. Cartoonists help us distinguish between fact and opinion. They rely on devices like satire, melodrama, exaggeration, and references to people and events the reader is expected to recognize and appreciate. Caricature is a principal tool of political cartoonists. They want a total response from the reader/viewer and must offer all the clues possible to convey the intended meaning.

The United States is presently at an important turning point in its energy future. How much longer we will be able to remain dependent upon imported oil to meet our high energy demands is questionable.

There are energy alternatives; nuclear, solar, geothermal, and wind power are only a few of the sources available to the U.S. Turning our attention away from fossil fuels to these alternative sources is a risk and an adventure.

The purpose of this activity is to have students examine some current attitudes regarding our energy crisis and energy alternatives, as they are expressed in political cartoons.

Advance Planning

Duplicate class sets of the worksheets.

If desired, collect additional cartoons for class discussion.

Suggested Time Allotment

2 class periods

Suggested Approach

Begin with a class discussion of the energy crisis, and go over the vocabulary with the group.

If current events are dealt with on a regular basis, the students might be assigned to do some preparatory readings from Time or Newsweek on the energy crisis.

Point out the various tools available to the cartoonist (caricature, exaggeration, etc.) to mold his message. Have students pick from the collection of cartoons those which convey meaning to them and suggest a given theme.

You may wish to divide the class into small groups to answer the questions. Allow the students to analyze and interpret the cartoons. Move about from group to group to be sure they are working and understanding what they are doing (should take about 15-20 min.).

After the students have had the opportunity to discuss the cartoons and answer the questions, call the class together and review the various answers people arrived at. Answers could be written on the blackboard by a student. Overhead transparencies of the cartoons might facilitate the discussion.

As a concluding activity ask the class to summarize in writing the future energy direction the United States should take.

Precautions

If students work in small groups they have a tendency to wander from the discussion points, so be sure to walk around the room to keep them on the subject.

Try to encourage discussion of energy alternatives; students seem to concentrate solely on conservation.

Points for Discussion

How reliable are cartoons as a means of gathering evidence about energy?

How much influence do the citizens of the U.S. have in the determination of energy decisions?

How much influence do newspapers and other media have in shaping national energy policy?

Typical Results

Students enjoy the change of pace and, depending on the group, may come up with some creative answers.

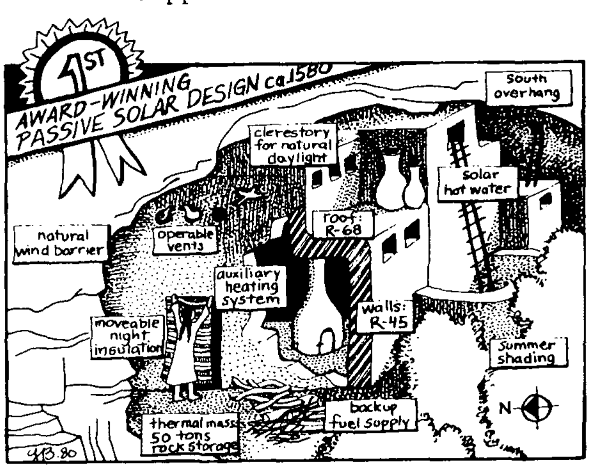
Evaluation

Included in this activity are six cartoons. Use 3 or 4 for class discussion. On the next test include one or two of the remaining cartoons and have each student interpret the message, or use one of the cartoons below and write your own questions.

Evaluate the written statement for reasonableness and consistency.

Modifications

Students could be asked to bring in newspaper or magazine articles to support or refute the cartoonists' messages.



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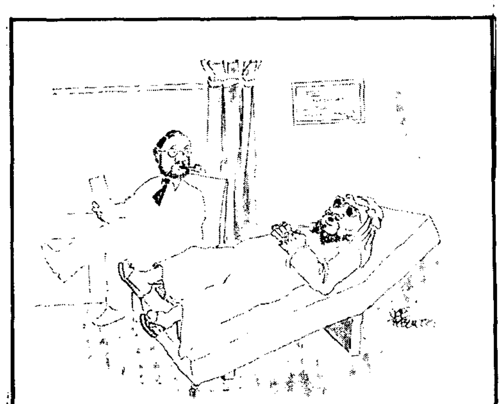


"—and in the dream, all these solar panels are closing in on me. . ."

reprinted from NESEC Update, Feb. 1980
courtesy of Northeast Solar Energy Center.

References

Bowman, William J. Graphic Communication (New York: John Wiley & Sons, 1968).

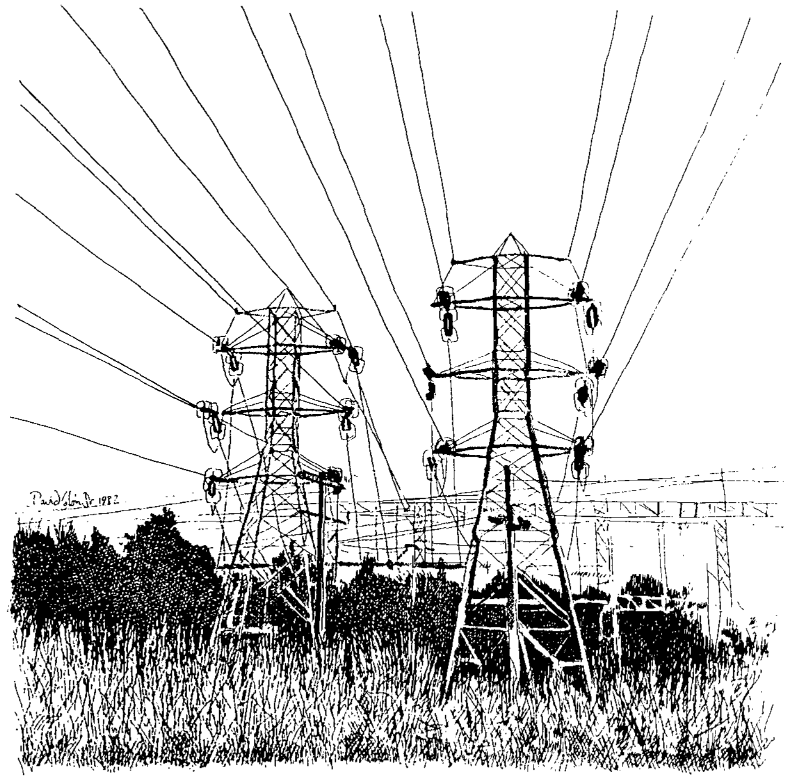
Buggey, Joanne and June Tyler. The Energy Crisis (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1976).

Hoff, Syd. Editorial and Political Cartooning (New York: Stravon Educational Press, 1976).

Murrell, William. A History of American Graphic Humor (New York: Whitney Museum of American Art, 1933).

Stobaugh, Robert and Daniel Yergin. Energy Future: Report of the Energy Project at the Harvard Business School (Cambridge, MA: The MIT Press, 1979).

Electricity from Sun and Wind



Introduction

Solar radiation is the driving force behind all the energy and life on the planet. You are probably aware of sunlight as a form of energy. But did you realize that wind is also energy, and that the sun causes the wind?

When the sun heats the ground, the ground heats the air above it. That air expands from the heat and becomes less dense and therefore lighter. Cooler, denser air from another area slides under it, pushing the warm, light air up. These movements of warm and cool air masses cause wind. So wind is an indirect form of solar energy.

Both sunshine and wind have energy potential. Both can be used to generate electricity, for example. Wind machines can be used to drive electrical generators. Photovoltaic cells, like those used on space satellites, can be used to transform sunlight directly to electricity. But sunshine and wind are not the same everywhere. Some regions have plenty of solar radiation, others have more wind. In this activity you will study maps of the United States to determine which regions would be able to use solar radiation or wind to produce electricity.

DRAFT

Objectives

At the completion of this activity, you should be able to

- correctly state which areas of the United States have the greatest wind energy resources,
- correctly state which areas of the United States receive the greatest amount of radiant solar energy, and
- distinguish between a direct form of solar energy and an indirect form of solar energy.

Skills and Knowledge You Need

Reading a map for zones of equality

Identifying the regions of the country: Northeast, Northwest, Central, Southwest, Southeast, Alaska, Hawaii, and Puerto Rico

Estimating amounts

Color coding regions on a map

Materials

paper

pencil

ruler

felt pens, crayons, or colored pencils

Words You'll Learn

isoline--a line on a map connecting zones of equality (equal average annual wind speed, for example).

kilowatt--a unit of power equaling one thousand watts (enough to power 10 100-watt light bulbs).

photovoltaic cell--a silicon cell which produces a direct and continuous supply of electrical energy whenever it is illuminated by light.

solar energy--the electromagnetic radiation from the sun which is received by the earth and which could be used for heat or electrical power.

watt--a unit of electrical power.

wind energy conversion system--a windmill which can capture wind energy and convert it to electrical energy.

Procedure

Part 1. ELECTRICITY FROM SOLAR RADIATION: The sun has a tremendous power output--170 billion megawatts. On earth the average radiant energy is about 1.365 kilowatts per square meter. Photovoltaic cells can convert that radiant energy directly to electricity, but their efficiency is only about 10%.

1. Look at Map 1: Solar Radiation. Each line connects points that receive equal amounts of solar energy. These lines are similar to lines on a contour map, and are called isolines. ("Iso" means equal.)

2. Look at the table "Estimating Solar Potential." Find each of the regions or states on the map. Using the numbers on the isolines (kilowatt hours per square meter per day) estimate the solar radiation for each region, and fill it in on the table.

3. Photovoltaic cells are about 10% efficient, so you must multiply each solar radiation estimate by 0.10. This will give you the electrical potential from sunshine for each region.

4. Identify and color the areas of your map that have the greatest solar electrical potential. Color code YOUR KEY with the same color.

5. Identify and color code the areas that have the least solar electrical potential.

6. What is the solar electrical potential for your region? Make an estimate using the data in Map 1. Be certain to express your estimate in the proper units. (Multiply by 0.10.) Fill in this information on your key.

7. Choose a suitable location for a solar electric generating station. Fill in the name of that area and its solar electrical potential on your key.

Part 2. ELECTRICITY FROM THE WIND: Windmills use the power of the sun, too. The sun's power heats the air causing air movement (wind). The rotors on the windmill are turned by the wind and electricity is produced. However, the rotors and generators are inefficient; the best windmill only converts about 30% of the available energy into electricity.

1. Look at Map 2: Available Wind Power. The lines on the map indicate locations in the United States that have the same quantity of wind power.

2. Look at the table "Estimating Wind Potential." Find each of the regions or states on the map. Using the numbers on the isolines (kilowatt hours per square meter per day) estimate the wind energy for each region, and fill it in on the table.

3. Wind machines are about 30% efficient (at best), so you must multiply your wind energy estimate by 0.30. This will give you the electrical potential from wind for each region.

4. Identify and color the areas of your map that have the greatest wind electrical potential. Color code YOUR KEY with the same color.

5. Identify and color code the areas with the least wind electrical potential.

6. What is the wind electrical potential for your region? Make an estimate using Map 2. Fill in this information on your key.

7. Choose a suitable location to develop a wind farm, an area where many windmills can be located together to generate electricity. Fill in the information about that area on your key.

Questions

1. Why do some areas have more sunshine on a daily average than others? Why do some have more wind than others?

2. Which area of the United States has the greatest potential for developing wind resources?

3. Which area has the greatest potential for developing electric power through the direct conversion of solar energy using photovoltaic cells?

4. Are there large population centers near the areas you named in 2 & 3? What difference does it make if the areas producing the electricity are near or far from the population centers?

5. Rank the geographic areas in order of their potential for wind-generated electricity and for solar cell-generated electricity.

6. Based on your knowledge of physical factors like mountains, ocean currents, and so forth, develop a hypothesis for the distribution of wind energy in the United States.

7. Is photovoltaic energy a direct or indirect form of solar energy? What about wind energy? How do you know?

Looking Back

You found that while wind energy and solar radiant energy are widely distributed over the United States, the amounts of energy vary a great deal. Some geographic regions of the U.S. are much more suited for wind energy development than for using photovoltaics to generate electricity.

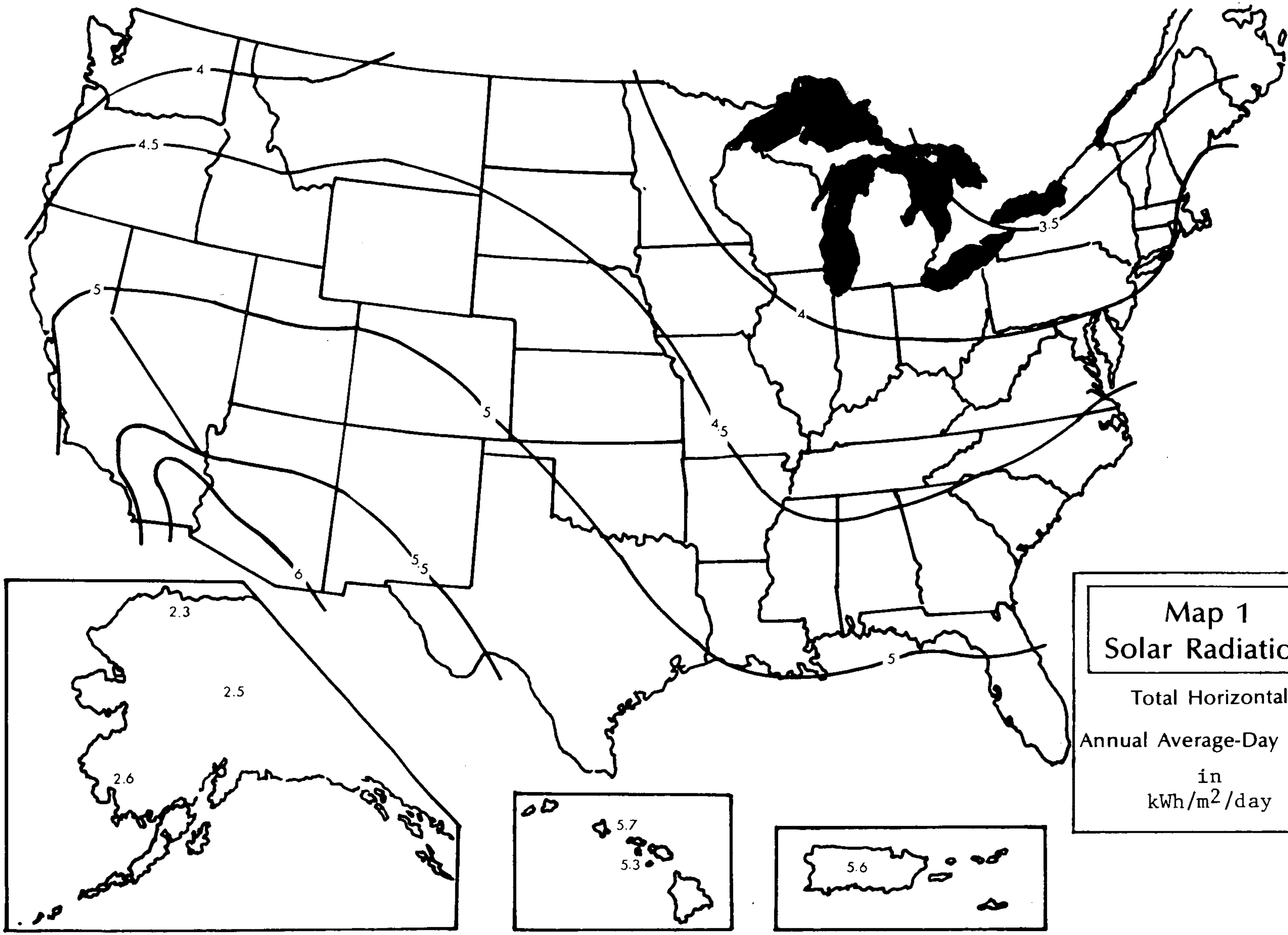
In your area, which option would be most productive: a windmill, photovoltaic cells, or a combination?

Going Further

Wind energy was an important resource prior to and during the early parts of the industrial revolution. Identify the locations and functions of windmills in pre-civil war America.

Many people believe solar cells will make dramatic changes in our social structure when they become common on individual house roofs. Identify some social changes that are likely to occur when homes become energy producers as well as energy consumers.

Develop an "energy map" of the U.S. or the world which identifies appropriate energy resources for each region or country.



Map 1
Solar Radiation

Total Horizontal

Annual Average-Day Values

in
$kWh/m^2/day$

Your Key

Most solar radiation (color) ○

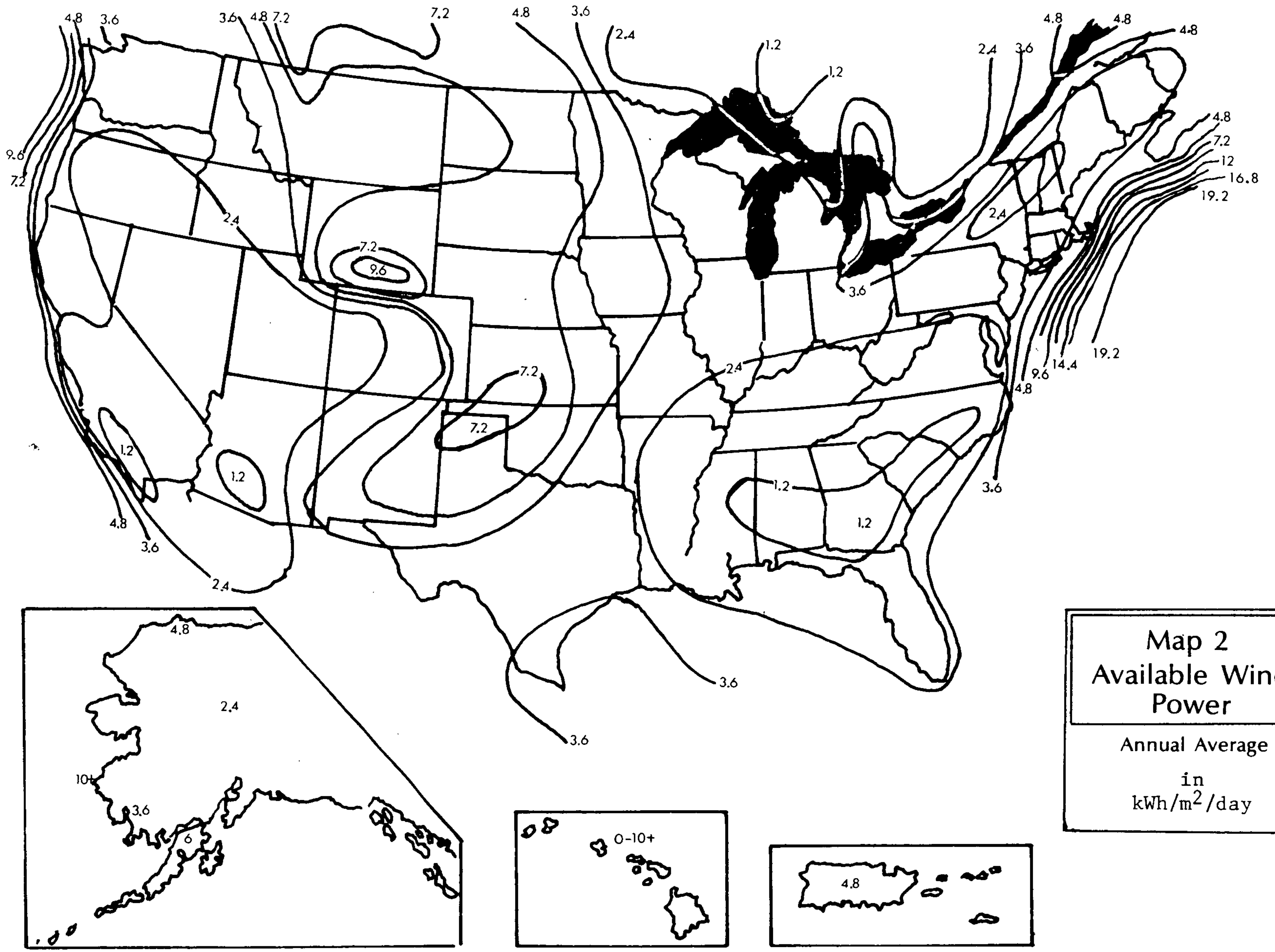
Least solar radiation (color) ○

	Name	Electrical Potential
Your area		
Your choice for a solar generating station		

Estimating Solar Potential

Locate each region on Map 1. Estimate the average solar electrical potential for each region.

U.S. Region	Solar Radiation	Conversion Factor for Photovoltaic Cells	Electrical Potential
NORTHEAST		X 0.10 =	($kWh/m^2/day$)
SOUTHEAST		X 0.10 =	
CENTRAL		X 0.10 =	
SOUTHWEST		X 0.10 =	
NORTHWEST		X 0.10 =	
ALASKA		X 0.10 =	
HAWAII		X 0.10 =	
PUERTO RICO		X 0.10 =	



Map 2
Available Wind Power

Annual Average

in
kWh/m²/day

Your Key

Most wind energy (color) ○

Least wind energy (color) ○

	Name	Electrical Potential
Your area		
Your choice for a wind power installation		

Estimating Wind Potential

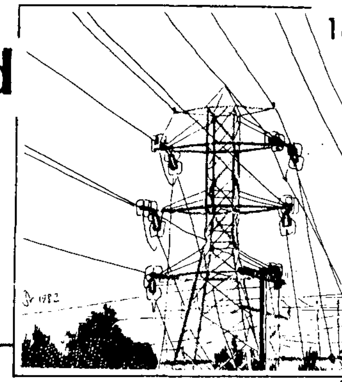
Locate each region on Map 2. Estimate the average wind electrical potential for each region.

U.S. Region	Wind Energy	Conversion Factor for Wind Machines	Electrical Potential
NORTHEAST		X 0.30 =	($kWh/m^2/day$)
SOUTHEAST		X 0.30 =	
CENTRAL		X 0.30 =	
SOUTHWEST		X 0.30 =	
NORTHWEST		X 0.30 =	
ALASKA		X 0.30 =	
HAWAII		X 0.30 =	
PUERTO RICO		X 0.30 =	

NOTE: Your wind map shows only broad general averages for areas. Within an area, however, there may be high-altitude locations such as high plateaus and mountain tops that have more wind electrical potential than the surrounding area.

Teacher Information

Electricity from Sun and Wind



Suggested Grade Level and Discipline

Grades 7-12
Geography
Meteorology
Earth Science

Skill Objectives

Reading maps and isolines

Collecting and interpreting data

Estimating quantities

Drawing conclusions

Major Understandings

Solar energy is available in both direct and indirect forms.

People are attempting to convert direct and indirect solar energy into electricity with varying degrees of success.

The amounts of solar and wind energy available vary considerably throughout the United States.

Background

Solar energy is rather diffuse and is therefore practical for low-intensity uses like space and water heating. But Americans have become very dependent upon a high-intensity form of energy: electricity. Fortunately, there are two renewable energy technologies which may soon enable people to produce electricity locally: photovoltaic cells and wind energy conversion systems.

Although still expensive, both technologies are becoming more cost-competitive, and are attracting the attention of major industries, utilities, and municipalities, as well as individual homeowners. Each, however, has to be evaluated in terms of local climate. Fortunately, regions that are worst suited for photovoltaics are often best suited for wind power, and vice versa.

In the photovoltaic effect, sunlight excites electrons in a thin layer of silicon, producing an electric current, so photovoltaic cells convert sunlight directly to electricity. They need bright, direct sunlight for the most efficient operation, but will generate some current even on an overcast day.

Wind systems use a wind driven rotor to turn the shaft of an electric generator. Most wind machines won't operate at very low wind velocities, and are most efficient at 15 to 20 m.p.h.

Some regions are more suited for photovoltaics and some for wind power, since the supplies of direct sunlight and strong wind vary from region to region. The purpose of the worksheets is to allow students to compare regions and determine how appropriate photovoltaic and wind power are for a given region.

Advance Planning

Duplicate maps and tables.

Obtain felt pens, crayons, or colored pencils.

Suggested Time Allotment

2 - 3 class periods

Suggested Approach

Before beginning the activity, go over the vocabulary and discuss the concept of isolines. Explain how to estimate average quantities for an area.

Discuss how photovoltaic cells and wind machines operate, and how wind comes from solar energy.

You may wish to team students for the estimating part.

Precautions

No precise answers can be determined from the charts, so reasonable estimates are acceptable.

Points for Discussion

Why are people considering the use of solar radiant energy and wind energy to produce electricity?

What changes might occur in our societal systems if each household produced most of its own energy and did not have to depend on a central power company?

Why are most people not now building windmills or putting photovoltaic cells on their property?

What are some potential disadvantages of large wind or photovoltaic installations? How do these weigh against the advantages?

Typical Results

Some students will not look closely enough at the maps to find those small areas of highest and lowest potential. Some may locate wind farms on the ocean, which could be a possibility for the future.

Evaluation

Check the color coding on the maps to see if each student located the areas requested.

The tables produced by the students will not be identical because estimates made cannot be precise. However, the tables should approximate a standard to be acceptable.

Modifications

Discuss other solar technologies--active solar systems, passive solar design, concentrator collectors, hydropower, wood, methane, ethanol, etc.--and evaluate them for regional appropriateness.

References

Eldridge, Frank R. Wind Machines, for the National Science Foundation (Stock No. 038-000-00272-4, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402).

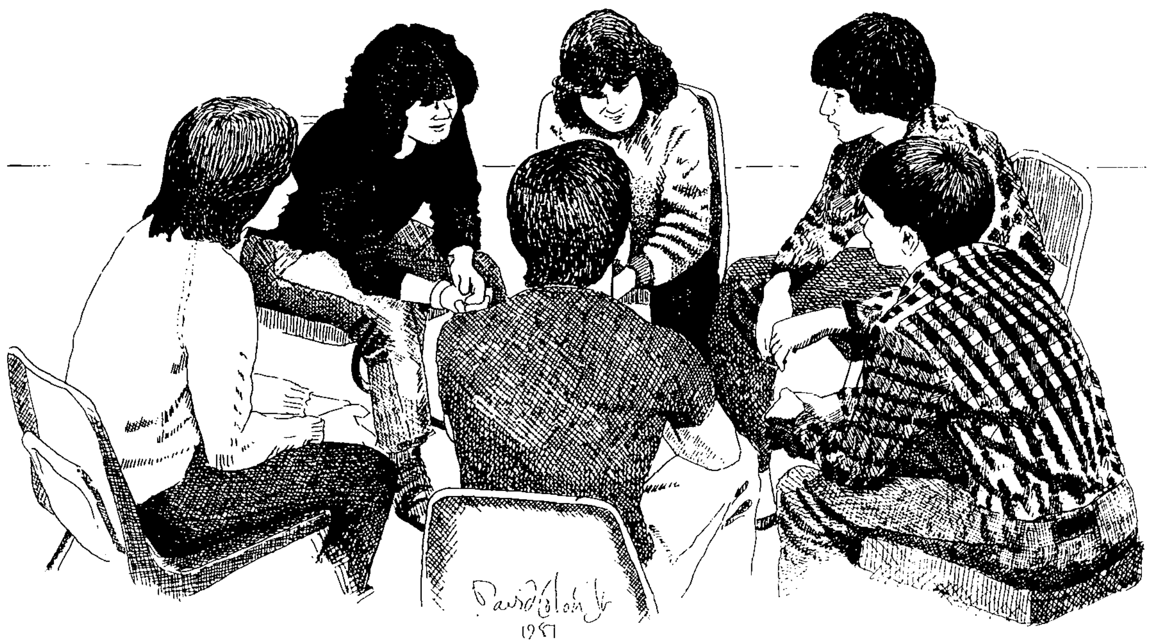
Howell, Yvonne and Justin A. Bereny. Engineer's Guide to Solar Energy (Solar Energy Information Services, P.O. Box 204, San Mateo, CA 94401).

Rowe, Delton J., ed. The Solar Almanac (Tricentury, 2036 Terra Kappa, Spring Valley, CA 92077).

U.S. Department of Commerce. Climatic Atlas of the United States (National Climatic Center, Federal Building, Asheville, NC 28801, June 1968).

U.S. Department of Energy. On the Nature and Distribution of Solar Radiation (Stock No. 016-000-00044-5, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, March 1978).

A Sun Rights Dilemma 19



Introduction

Everyone has heard of the energy crisis. Whenever we stop at a gas station it seems that the price of gas has gone up. Our dependence on oil imports continues and the people of the U.S. continue to pay dearly for it.

The energy crisis has forced us to look into alternative energy sources; and although we know that there is no one energy source that will satisfy all the energy needs of the U.S., people are coming to realize the importance of experimenting with possible alternatives. An energy source that has been with us since creation, but has been severely under-utilized, is the sun. Today more and more people are interested in harnessing the sun's energy to provide for some of our energy needs.

DRAFT

In this activity you will read about a town in the U.S. that has a dilemma. Some residents want to use solar and wind energy for their homes, but because the town is considered a historic site, zoning laws prevent this kind of change. Some citizens want to keep things just the way they are. A third group of residents feel very strongly that the energy problems of the U.S. can best be solved by stricter conservation methods.

As you read the dilemma, consider the need to protect the rights of all citizens: those who wish to develop alternative sources of energy, those who wish to preserve a historic site, and those who favor conservation.

Objectives

At the completion of this activity you should be able to

- list 5 possible options that the town should consider to solve the problem, and
- determine the impact of a specific decision.

Skills and Knowledge You Need

Listening, speaking, reading, and writing as a means of communication

An understanding of the Bill of Rights

Clarifying differences in behaviors and ideas

Making decisions and assessing their impact

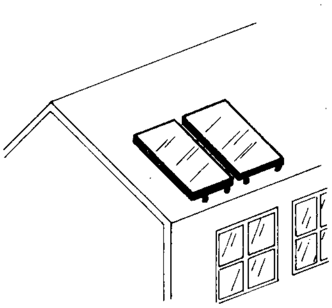
Materials

a copy of the dilemma

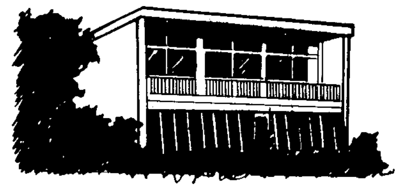
an overhead transparency

Words You'll Learn

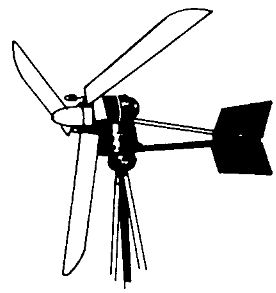
Active solar collector--
a box with one glass side specially designed to collect the sun's energy for space or water heating. Collectors are often mounted on the roofs of houses.



Passive solar--refers to a house or building that is built in such a manner as to capture the maximum amount of sunlight--which in turn naturally warms the house. Such structures usually have large window areas on the south side.



Wind-powered generator--a modern type of windmill used to generate electricity.



Procedure

1. Divide into groups of 4 or 5 and choose a leader for the group.
2. Read the dilemma.
3. Appoint a recorder to write your solutions on an overhead transparency to be shared with the class.
4. Discuss the "Pros" and "Cons" of introducing solar energy into the town--some have been given to you--and add to the list until you have 7 of each.
5. Discuss the possibility of introducing laws that might protect citizens wishing to use solar energy.
6. Come up with 5 possible solutions to the dilemma and have your recorder report them to the class.

Questions

1. Should Swift and Johnson have the right to install solar collectors and wind machines on their property? Do they already have the right?
2. Does Mr. Jones still have the right to plant his poplar trees, when he knows that eventually they will cast a shadow on Mr. Swift's solar collector?
3. Where should the responsibility for protecting the users of solar energy lie--with the town, the state, or the federal government? Why?
4. If a compromise with the historical society could be reached, do you think active or passive use of solar would be more beneficial? Why?

Looking Back

Coming to understand the energy crisis and how it affects each of us isn't simple. People don't always agree on the solutions, but it is important to understand all possible options and be open to change.

The situations faced by Swift and Johnson are not unusual. They are typical of towns where people are trying new things. In attempting to rely on renewable energy sources such people are challenging what other citizens have come to consider as their rights. How far the individual moves in the direction of meeting others' demands is sometimes a matter of preference, sometimes of negotiation, and sometimes of law.

Going Further

Develop a Solar Energy Bill of Rights that could be added to the Constitution of the U.S. to protect citizens who wish to use solar as an alternative source of energy.

Consider the zoning regulations in your own locality. Do they encourage or discourage solar and wind development?

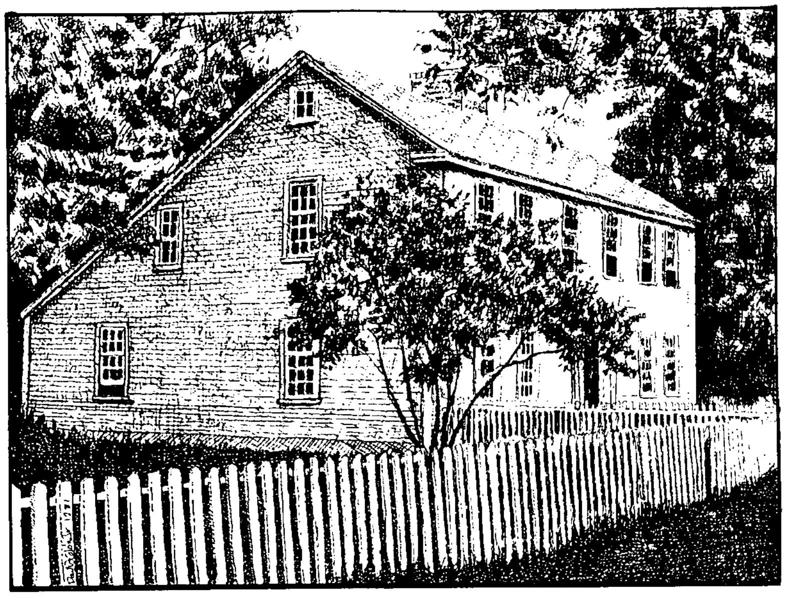
Do research to determine where the responsibility for protecting solar access currently lies.

Does the U.S. have a body of law protecting "sun rights" or "solar access"?

The Sun Rights Dilemma

The year is 1986; the United States' energy crisis has deepened. Gasoline now costs $3.29 per gallon and prospects are that it will hit $4.00 by 1987. The prices of home heating oil and natural gas continue to rise. The energy picture is not bright. Although a number of nuclear plants are still in operation, people have not yet forgotten the incident at Three Mile Island, and few new plants have gone into operation since 1980.

Anytown, U.S.A.



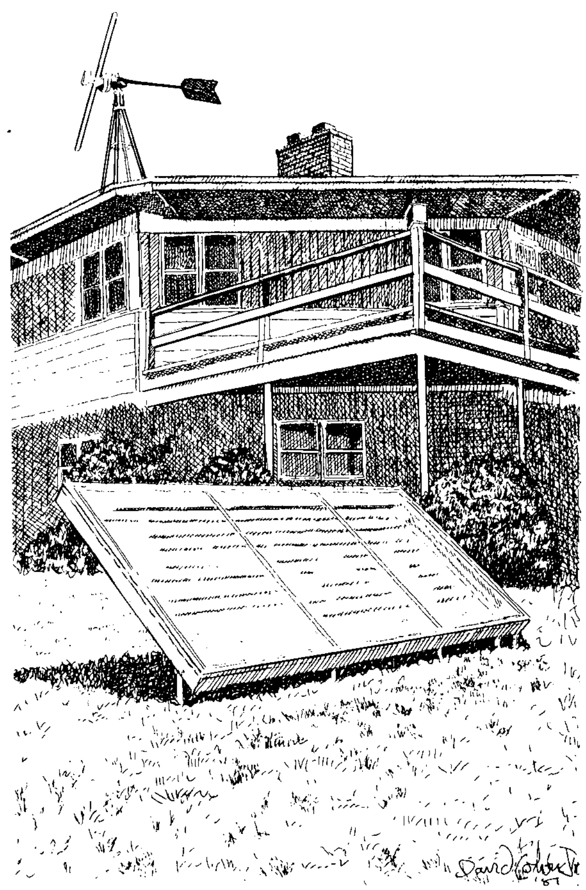
In a small town in the U.S., Anytown, the people are very much aware of the energy crisis that has reached into every home and business across the country. Anytown is a familiar spot to many people. Its history goes back to the 17th century when America was first being settled. The citizens of the town are proud of their heritage and have promoted the town as a historic site. They have preserved the historic character of all the buildings of the town. The town is a tourist attraction and during the summer many families come to enjoy the rich past that is preserved here.

The people of Anytown are conscious that something needs to be done about the energy crisis. Some strongly believe that the way to end U.S. energy dependence on oil (a problem the U.S. has been trying to deal with since 1973) is to enforce stricter conservation methods. Others feel there is a need to develop and emphasize more use of coal and nuclear power. However, another group of citizens in the town has been doing some investigation regarding alternative energy sources--particularly the use of solar and wind energy. One industrious individual, Mr. Swift, has even gone so far as to construct a small bank of solar collectors on his property to show his friends and neighbors how the whole town could benefit from the use of solar energy. At the present time, Mr. Swift uses his active solar collectors to heat the hot water in his home; but he has told his friends that it is also possible to construct a passive solar home which could save thousands of dollars in heating bills.

At the same time, Mr. Johnson is having problems with energy costs at his farm on the edge of town. In order to make himself more energy independent, Johnson intends to install a wind-powered generator on a 30-meter tower to meet most of his energy needs. He plans to contribute any excess to the town electric service.

Unfortunately, the desire on the part of some of the people to use solar energy has brought about a legal battle within the town. There are a few problems that have to be dealt with and the town council is about to hear the arguments of the people involved. First of all, there exist some strict zoning ordinances in the town regarding what can be built. Since this town is a preserved historic site, laws have been passed that prevent additions to already existing houses or the building of new houses that appear to be out of keeping with the history of the town. The Anytown Historical Society strongly opposes building passive solar houses or putting solar collectors on the roofs of peoples' houses, as well as the installing of windmills. They maintain that the law forbids such things and plan to see that the law is enforced.

In addition to this, a second set of problems has arisen. After Mr. Swift built his solar collector on his property, Mr. Jones, vice-president of the historical society, who lives next to Mr. Swift, promptly planted five poplar trees. Poplar trees take only a couple of years to grow and provide a great deal of shade. The result is that Mr. Swift's solar collector will soon be useless because of the poplar trees which will shade the collector from the sun. This might force Mr. Swift to abandon his project altogether.



Mr. Fagel, Johnson's neighbor, says that a windmill can make enough noise to bother him on his peaceful farm, as well as interfere with reception on his television. He wants Johnson to pay his bills like everyone else and forget about alternative energy sources.

The next town meeting will be the arena for discussing the following issues:

1. the historical committee wants stricter enforcement of the zoning laws in the town to prevent the introduction of solar collectors and other innovations to the town. They want present collectors dismantled.
2. Mr. Swift has decided to confront the town with his belief that he has a constitutional right to the sun, and if someone prevents him access to the sun, it is wrong. He wants Mr. Jones to take out the poplar trees which will shade his collector.
3. Mr. Johnson wants to establish just what his rights are as a property holder in his town. Does some group sitting in town office--elected by him--have the right to tell him what he can and can not build on his property?

Now the people in the town are divided into two camps--those wishing to preserve historic tradition and the financial gain that comes from tourism, and those who wish to introduce solar and wind energy into their homes and change existing laws so that they will be protected.

Now add more Pros and Cons to this list.

Pro-Solar	Anti-Solar
1. will cut down on dependence on oil and electricity	1. disturbs the historic beauty of the town
2. will ultimately be less costly	2. people will stop coming to the town--will mean a loss of revenue
3. ________________	3. ________________
4. ________________	4. ________________
5. ________________	5. ________________
6. ________________	6. ________________
7. ________________	7. ________________

Teacher Information

A Sun Rights Dilemma

Suggested Grade Level and Discipline

Grades 11 and 12
American Studies
Government and Civics

Skill Objectives

Understanding and applying constitutional rights to solar energy issues

Developing a number of possible options that could be followed to solve the dilemma

Making a decision and assessing its impact

Major Understandings

An alert citizen identifies different positions regarding energy alternatives.

A good decision-maker will analyze and evaluate the positions, weighing the advantages and disadvantages of using solar energy, and will attempt to predict the impact of a specific decision.

Background

We are all acutely aware of the need to conserve energy. More recently Americans are beginning to realize that conservation alone is not the answer to solving our energy crisis. Today we know that alternative energy sources such as solar, wind, or geothermal power do exist as viable energy alternatives. The potential of these sources must be investigated.

In this activity the students are asked to reflect upon two important issues:

1. the value of using solar energy to reduce U.S. dependence on oil
2. the importance of considering the rights of individuals who wish to experiment with solar energy, and of those who don't.

We must realize that some laws may have to be rewritten in order to protect individuals who wish to solve our energy problems in a more creative manner.

Finally, this activity boils down to having the students negotiate between two values positions: using solar energy to reduce dependence on oil and ultimately save money vs. preserving a historical town that brings in additional funds to the town because it is a tourist attraction.

Advance Planning

Duplicate needed quantities of the dilemma.

Obtain an overhead projector, transparencies, and marking pens.

Suggested Time Allotment

2 class periods

Suggested Approach

Students should be familiar with alternative energy sources; therefore it is recommended that they do some reading in this area. (However, the teacher may also give a brief summary of current developments).

Students should also be familiar with the Bill of Rights in order to apply the concepts to this activity.

Briefly review the relevant sections of the Bill of Rights.

Divide the class into small groups (4 or 5) and give them each a copy of the dilemma. Have them read the dilemma and then discuss the pros and cons of introducing solar energy into the town. (A partial list is given; they should add to it.)

After each group has had the time to discuss the problems and issues involved, they should come up with a minimum of 5 possible solutions to solve the dilemma.

When the class has completed their brainstorming, a spokesperson from each group could show the solutions on the blackboard or overhead for the entire class to review. The teacher could then lead a discussion to develop the direction the class is moving in. If time permits a simple vote may be taken.

Precautions

Move around from group to group making sure the students are aware of the legal issues involved.

Don't let them get bogged down on any one issue.

Push them to use their creativity when they brainstorm--brainstorming should be a free, creative exercise.

Encourage the idea of compromising as a means of satisfying the needs of all involved.

Points for Discussion

How do people determine their priorities?

In this case what levels of government might become involved in the issue? Would the problem remain on the local level or might the state or perhaps even the federal government step in to legislate here?

When there is no question of right or wrong, on what basis does a responsible person make decisions?

How absolute should a property owner's right to do whatever he/she likes on his/her property be?

Evaluation

Students could be evaluated on their next test with an essay question in which they must explain how citizens living in a democracy are protected by constitutional rights and yet must abide by the will of the majority.

Modifications

Students could be assigned to represent the two opposing groups in the town and then could debate the issue of introducing solar energy vs. preserving a historic town.

Students could role play the people involved in the dilemma in a simulated town meeting.

References

Alvord, Katherine and Michael R. Eaton. "A City Changes Its Energy Future" (Sierra, May/June 1979).

Butti, Ken and John Perlin. The Golden Thread (New York: Van Nostrand Reinhold Company, 1980).

California Energy Commission. Solar Access: a Local Responsibility (California Energy Commission, 1111 Howe Avenue, Sacramento, CA 95825).

Creps, E. The Energy Policy of the United States (Skokie, IL: National Textbook Company, 1978).

Marlatt, David, Jon Rubel and Richard Seedorf. Solar Site Planning for the U.S. Department of Energy (Southern Solar Energy Center, 61 Perimeter Drive, Atlanta, GA 30341).

Simon, Sidney and Jay Clark. Beginning Values Clarification: A Guide for the Use of Values Clarification in the Classroom (La Mesa, CA: Pennant Press).

Stobaugh, Robert and Daniel Yergin. Energy Future: Report of the Energy Project at the Harvard Business School (New York: Ballantine Books, 1979).

Solar Energy in Developing Nations

Introduction

The energy crisis is not just a problem for the United States. All nations of the world, particularly developing nations, are experiencing similar problems--having to pay for the high cost of using petroleum. For developing nations, however, the problem is more burdensome. They want to become industrialized and raise their standard of living, but very often the very materials they need--tractors, cars, machinery--rely on expensive petroleum.

This activity is designed to do two things. First, you will read about how developing nations might undertake to use solar energy to help supply their energy needs. Second, you will be asked to think about ways in which industrialized nations such as the U.S. might aid these third world nations in developing the use of solar energy in their countries.

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Objectives

At the completion of this activity you should be able to

- identify 5 renewable energy technologies,
- list at least 10 facts about renewable energy and the developing nations,
- give 5 reasons why the U.S. should or should not give assistance to nations wanting to develop renewable energy, and
- state the purpose and point of view of the article you have read.

Skills and Knowledge You Need

The ability to read and summarize a magazine article

Materials

the article "Solar Energy: the Third World First?"

the Renewable Energy Glossary

Procedure

1. Read the article on solar energy and the Third World. Look for any renewable energy terms you don't understand on the glossary sheet.

2. Answer the questions about the article provided in the guidesheets.

3. Be prepared to discuss these answers within small and large groups.

4. Summarize the main points of the article in your notebook.

5. Form small groups of 4 or 5.

6. Make a list of 10 facts about solar energy and developing nations that the group learned as a result of reading the article.

7. Think about the possibility of the U.S. giving aid to a Third World nation to develop solar energy. Imagine your group represents some developing nation, and give 5 reasons why your country should or should not ask for money to develop solar energy, and why the U.S. should or should not give the aid.

8. Share your responses with the rest of the class.

Questions

1. What was the author's purpose in writing the article? What was his point of view about renewable energy in developing nations?

2. For the most part what types of solar energy would be most beneficial to developing nations?

3. What implications does the development of solar energy have for the future of these nations?

4. Is it more important for developed nations or developing nations to start using solar energy? Why?

5. In what ways would the U.S. profit from using solar energy sources? How could our economy adapt to these changes?

6. What dangers can you list which flow from continued reliance on fossil fuels?

7. What possible reasons exist for the absence of mass production of solar energy systems?

Looking Back

Renewable energy in all its forms--sun, wind, geothermal, biomass, and hydropower--is a source of energy available in varying degrees to any nation. Development of these alternative forms of energy has been slow, unfortunately. In some countries the profit motive interferes with developing solar energy sources; in other nations lack of technical expertise prevents development of renewable resources. Both of these factors can be overcome in an effort to become independent of fossil fuels. Israel, Japan, and Chile are successfully developing renewable resources and other nations can do the same.

Going Further

Choose a particular developing nation and investigate more specifically how that nation is attempting to meet its energy needs.

Make a chart showing which forms of energy would be best for which nations. Give reasons for your choices.

Plan a program for implementing renewable energy development in a Third World nation.

Write an article justifying the development of alternative energy sources in some state or country in the Northern Hemisphere.

Role play a situation wherein a citizen of a country already using solar resources debates with a person from a country still depending on fossil fuels.

Guide Questions

for

Solar Energy: The Third World First?

A. According to the author, three problems face us if we continue to rely on our present fuels, because these sources of energy are

1. ______________________________,

2. ______________________________,

and 3. ______________________________.

B. Solar energy sources have several advantages over nuclear and fossil fuels. Among these advantages are the following:

4. ______________________________,

and 5. ______________________________.

C. There is a direct correlation between the quality of energy sought from the sun and the costs of collecting, converting, and storing that energy. "Direct correlation," in this case, means

6. ______________________________.

D. People tend to think of solar heating as impractical and inefficient. This is disproved by the fact that

7. ______________________________.

E. Solar collectors can be made of

8. ______________________________,

9. ______________________________,

10. ______________________________,

and even 11. ______________________________.

F. Sunshine can be easily used to heat

12. ______________________________,

and 13. ______________________________.

G. Space heating can be done using

14. ______________________________,

15. ______________________________,

or 16. ______________________________,

or a combination of the three.

H. Sunlight cools as well as warms. Solar absorption cooling systems work most effectively when

17. ______________________________.

I. Solar energy can help solve the problem of poor water quality through the use of

18. ______________________________.

J. Food and lumber drying with the sun can be done more quickly and safely using

19. ______________________________.

K. Even jobs requiring machine power can be done with

20. ______________________________.

L. The technology called

21. ______________________________

is not yet very efficient but can be useful where the unused heat collected can be applied to space heating or industrial purposes.

M. The principal power source of the telecommunications traffic is

22. ______________________________.

Six advantages of this solar-electrical device are that it

23. ______________________________,

24. ______________________________,

25. ______________________________,

26. ______________________________,

27. ______________________________,

and 28. ______________________________.

N. Solar energy can also be harvested indirectly in

29. ______________________________,

30. ______________________________,

and 31. ______________________________.

O. There are two main reasons why small-scale hydropower holds great potential in the Third World. They are

32. ______________________________,

and 33. ______________________________.

P. Two kinds of machines can tap the wind,

34. ______________________________,

and 35. ______________________________.

Q. In terms of how much wind energy is harnessed per dollar of investment,

36. ______________________________

produce power in slower winds and operate a higher percentage of the time.

R. Coconut husks, sugar cane, and firewood all contain solar energy and can be used for

37. ______________________________.

S. The chemical equivalent of natural gas,

38. ______________________________,

is easily produced by biogas technology.

T. Eighty percent of the world's oil supply will have been consumed during the lifetime of

39. ______________________________.

U. Instead of following the example of the industrialized countries which depend on cars fueled by petroleum, Third World countries might be wiser to accept only

40. ______________________________

and invest in communications systems rather than

41. ______________________________.

V. A hidden advantage of solar technologies for developing countries is

42. ______________________________.

W. If developing nations use solar technologies in a decentralized way, it will help overcome an already serious problem,

43. ______________________________.

X. Compared to setting up a national power grid,

44. ______________________________

out of the five main renewable technologies are already economically as good or better.

Y. Better planning and careful mechanization of agriculture will help to create new

45. ______________________________.

Z. If the Third World began widespread use of solar equipment it would be good for the industrialized nations because

46. ______________________________.

AA. There may be some problems with using solar energy in the Third World: for example,

47. ______________________________,

and 48. ______________________________.

BB. To have a successful solar transition people must know about

49. ______________________________.

CC. According to the author, only

50. ______________________________

is sustainable.

Solar Energy: The Third World First?

By 'thinking small,' Developing Countries can harness the sun's power--even now

by Denis Hayes

This article is excerpted and condensed from Worldwatch Paper 15, "Energy for Development: Third World Options," issued by the Worldwatch Institute, an independent, non-profit research organization created to analyze and focus attention on global problems.

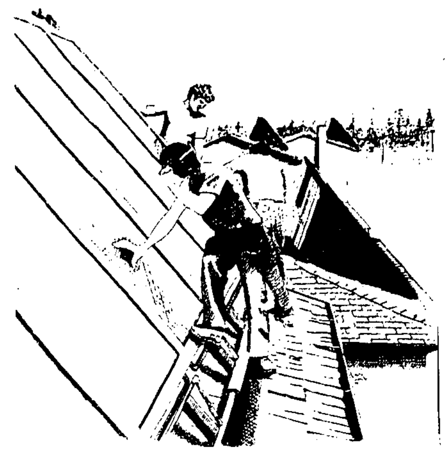
Every home is a solar home. People think they heat their homes with firewood, oil, or other fuel, but 95% of their warmth comes from sunlight. "Solar pioneers" simply squeeze a few more degrees from the sun than their neighbors do.

Every essential technological ingredient for a commercial solar energy system has existed for more than a decade, although many have not yet benefitted from economies of mass production.

The issue today is whether we will develop these resources, or whether vested interests will coerce our continued reliance on sources that are dangerous, vulnerable to disruption, and ultimately unsustainable.

Solar energy sources produce no bomb-grade materials or radioactive wastes. They do not pollute, explode, or cause cancer. Dispersed near the points of end use, they are not easily disrupted by acts of God or man. Had industrial civilization been built upon such forms of energy instead of on the energy stored in conventional fuels, any proposal to turn to coal or uranium for the world's future energy would doubtless be viewed with incredulous horror. The current prospect, however, is the reverse--a shift from trouble-ridden sources to safe, sustainable ones.

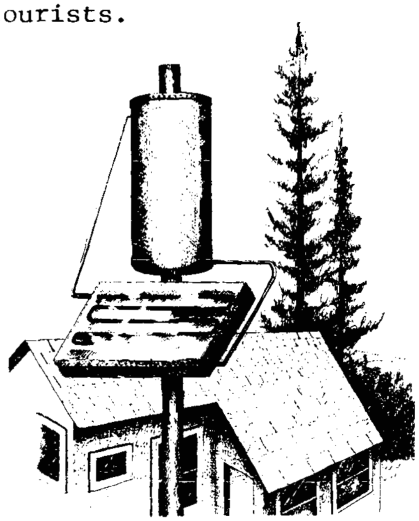
Many decentralized solar technologies already exist for both urban and rural application. These can provide energy as heat, liquid or gaseous fuel, mechanical work or electricity. The quality of energy sought from the sun and the costs of collecting, converting, and storing that energy usually correlate directly: the higher the desired quality, the higher the cost. Sources and uses must therefore be carefully matched so that expensive, high-quality energy (e.g., electricity) is not wasted on jobs that do not require it.



The simplest task to accomplish with sunlight is to provide heat. Sunshine can warm homes and work places, dry grain, or provide industrial process heat. Solar heating is often disparaged as a technology of little consequence, but the facts prove otherwise: Most of the fuel burned around the world provides heat at temperatures achievable with solar collectors.

Solar water heaters can be manufactured rather easily with materials that are either indigenous to the Third World or else recycled.

Collectors made of old window panes, scrap metal, wood, and bamboo have worked effectively in some places. More sophisticated collectors can be mass produced fairly inexpensively. Japan, Israel, Australia and the United States all have large and growing manufacturing capacities. About 20% of Israel's homes now have solar water heaters. In Australia, the technology is now required by law on new buildings in the Northern Territory. Japan today has about two million units installed, and annual sales amount to several hundred thousand. Niger makes commercial solar water heaters, but because they are costly, the devices are used mainly to meet the needs of tourists.

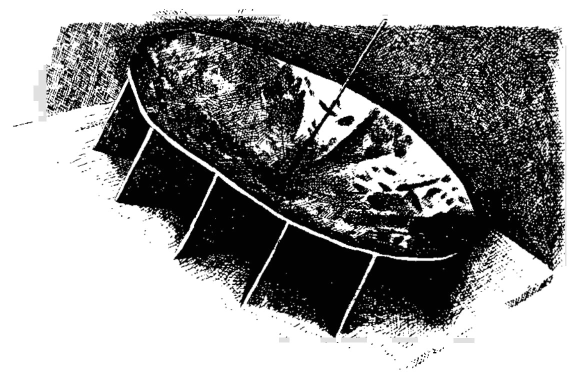


The United States has the world's most expensive solar water heating systems (with costs ranging from $10 to more than $30 per square foot of commercial collector) and comparatively inexpensive electricity. Yet recent U.S. studies have found solar water heaters to have an economic edge over electric water heaters. If water temperatures no higher than 50 degrees Celsius (about 120 Fahrenheit) are required, much cheaper systems will suffice. Where hotter water is needed, it may make more sense today to preheat the water with a simple solar collector, and then use combustible fuel to provide the additional heat.

Sunshine can also be used to heat buildings. Buildings in the Andes, the Himalayas, northern China and most Third World areas south of the Tropic of Capricorn have significant space heating requirements. These can be met using any of several solar options.

"Passive" solar heating systems store energy right where sunlight impinges on the building's walls and floors; such systems shield the structure from unwanted summer heat while capturing and retaining the sun's warmth during the winter. Such design, with most windows facing the equator, carefully placed overhangs, and reliance upon prevailing winds, are part of the architectural heritage of many developing countries. Fuel savings of 50% and increased comfort are common where such designs are used.

"Active" systems, in contrast, use solar collectors to capture sunlight and then transport it (using air or water as the medium) to a storage area, where it is later tapped as needed. Active systems are more expensive, and most Third World residents will find it cheaper to fill their remaining heating needs (after employing passive solar designs) with firewood or other combustible fuels.



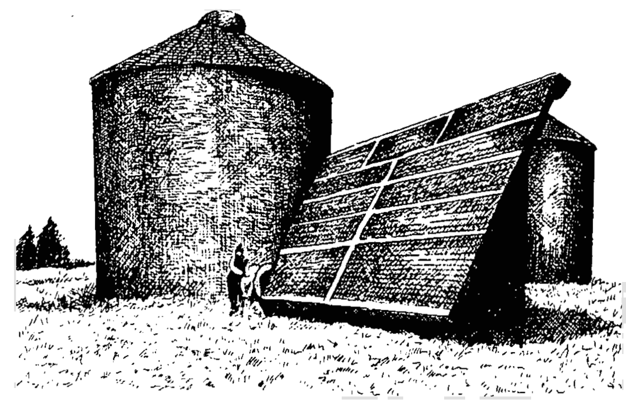
Solar cookers, most of which are parabolic mirrors that reflect and concentrate sunlight onto a grid or a pot, are simple and relatively cheap to build. Aimed toward the unobstructed sun, they cannot fail to work. Yet, for several reasons, they have never been successfully employed in the Third World. The use of solar cookers requires new methods of meal preparation and restricts cooking to daylight hours. So it is not entirely surprising that in Mexico and India the cookers failed to win acceptance even when they were given away.

Slightly more sophisticated approaches that require fewer sacrifices or adjustments on the part of the users are now under development. Volunteers in Technical Assistance, a U.S. group interested in developing and promoting appropriate technology, is working on an uncomplicated acid storage-battery. When heated with a simple Fresnel lens, water evaporates from the acid to a separate compartment. At meal-preparation time, the device is turned upside down, the water is gradually recombined with the acid, and great amounts of heat are given off. Other approaches receiving attention are slow reflective cookers, baking ovens, and stew pots.

Sunlight can be used to cool things as well as to warm them. Evaporative cooling for food storage and for personal comfort costs relatively little. It is particularly practical in hot, dry climates. More sophisticated technologies that produce lower temperatures are sold commercially in the United States and Japan. These solar absorption cooling systems are being employed in many new solar houses in industrial countries, and small versions could provide cost-effective refrigeration in developing lands, where keeping perishable foodstuffs and medicines is as difficult as it is important. Such systems have the advantage of working most effectively when the sun is brightest and cooling needs are greatest.

Poor water quality is a common problem in the Third World, and finding fresh water is perennially a major problem in the world's desert regions. The technology of solar stills is elementary: sunlight evaporates water, then the condensate is collected. Such a still operated successfully in Chile from 1892 for about three decades. Although maintenance costs are low and fuel costs are zero, the initial investment is very high.

Small solar stills are already competitive. The University of the Philippines is conducting innovative research on low-cost stills, and several industrial countries are experimenting with more advanced designs.



For thousands of years, people have been using the sun to dry grain, fruit, and timber. But traditional open-air methods are slow and sometimes conducive to decay. Simple solar collectors speed up the drying process and allow it to take place in confined structures where theft by rodents is minimized and rain is kept out.

Solar collectors and solar ponds can provide a power source for various heat engines that can, in turn, convert this energy into useful work--such as pumping water or generating electricity. A 37-kilowatt (50-horsepower) irrigation pump was built and operated in Egypt in 1912. An American company now sells 10-kilowatt pumps for $4,000 per kilowatt, and expects the price to fall to $1,250 per kilowatt with mass production.

Decentralized solar-thermal devices can be used to generate electricity, but conversion efficiencies are low. This technology appears to be most promising in applications where the unused heat collected can be productively employed, as for space heating or industrial purposes.

The most exciting solar-electric device is the photovoltaic (or solar) cell, now the principal power source of the telecommunications traffic. Such cells generate electricity directly when struck by sunlight. They have no moving parts, consume no fuel, produce no pollution, operate at ambient temperatures, have long lifetimes, require little maintenance, and can be fashioned from silicon, the earth's second most abundant element.

Solar cells are economical today only for remote applications, such as drilling rigs, pipelines, signal buoys, forestry stations, and Third World villages. They have been successfully employed to power educational television sets in India and Niger, radio transmitters in the Andes, water pumps in Upper Volta, and refrigerators for medical supplies on an Arizona Indian reservation.

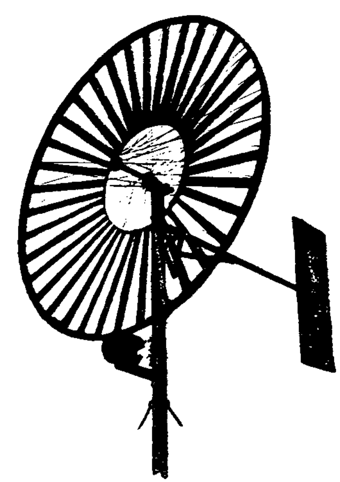
Photovoltaic cells are most sensibly applied in a decentralized fashion--perhaps incorporated in the roofs of buildings--so that transmission and storage problems can be minimized. With decentralized use, the four-fifths or more of sunlight hitting them that such cells currently cannot convert into electricity can be harnessed for space heating and cooling, water heating, and refrigeration.

The manufacture of photovoltaic cells is rather expensive. But costs fell from an astronomical \$500 per peak watt a few years ago to as low as \$13.50 in 1977. The U.S. Department of Energy expects price reduction to \$1-2 per peak watt by 1980, 50¢ by 1986, and 10-30¢ by 1990; at the 1990 price they could capture the lion's share of the international electrical generating market.

Solar energy can also be harvested indirectly in falling water, the wind, and plants grown as fuel. Waterwheels have been used for millennia. Water turbines spin much faster than water wheels and are used mostly to generate electricity. Units smaller than 100 kilowatts may account for one-third of all hydroelectricity in China.

The potential of small-scale hydropower technologies has never been thoroughly studied. Most research has focussed on huge dams and storage reservoirs. But now that these large facilities are running up against major problems--the flooding of good agricultural lands, the displacement of vast numbers of people, and the spread of schistosomiasis--new attention is being paid to alternatives of less elephantine dimensions.

Especially in the mountainous tributary regions of the Third World, small-scale hydropower appears to hold great potential. The units are relatively inexpensive, while local labor can build the needed dams and divert selected streams.



Machines to tap the energy in the wind, like those that harness water power, are of two basic types: mills and turbines. Windmills turn slowly and are used for high-torque work, like pumping water. Wind turbines turn much faster and are ordinarily used to generate electricity. Wind production increases with the square of a propeller's size, so large wind machines produce far more energy than do small ones. Moreover, wind power increases with the cube of velocity; thus twice as fast a wind produces eight times as much power. Some wind power enthusiasts therefore limit their dreams to huge turbines on very windy sites. But the crucial question is: how much energy is harnessed per dollar of investment? Smaller windmills would lend themselves more easily than large ones to mass production or to local construction from available materials. They also produce power in much slower winds, and thus can operate a higher percentage of the time.

Because of poor maintenance and shortages of parts, windmills have been abandoned in Mali and Uganda. In Tanzania, the selection of windmills unsuited for local wind conditions led to chronic problems, and most of those in isolated regions appear to have broken down. On the other hand, another Tanzanian program appears to have worked quite well, and success stories have also been reported out of Zambia and Argentina. The Geleb people in the Omo River region of Ethiopia have begun building a sail-wing windmill to pump water, adopting a design in use for hundreds of years on Crete.

Small-scale wind turbines to produce electricity cost as little as $500 per kilowatt for 15-kilowatt generators. When coupled with hydropower as a backup, intermediate-sized wind machines are an economical source of electricity, even in the industrial world, today.

A final option is to the solar energy stored in green plants. Firewood already contributes about 15% as much commercial energy each year as fossil fuels. Brazil hopes to grow sugar cane and cassava for their energy content and to convert them into ethanol. By the year 2000, it hopes to substitute the resulting alcohol for all its imported gasoline. The Philippines plans to use coconut husks as fuel for electrical power plants.

Biogas technologies employ anaerobic bacteria to digest animal dung, human excreta, and other organic wastes, producing methane, the chemical equivalent of natural gas. The residue of the process is a high quality fertilizer.

Biogas development has been carried farthest in China. In 1970-72, a few hundred biogas plants in Szechwan were so successful that a national program trained 100,000 biogas technicians by mid-1975, and last May the New China News Agency reported 4.3 million working units--many of them communal plants able to meet the needs of 50 Chinese peasants. Recent reports indicate that 17 million people use biogas for cooking and lighting in Szechwan province alone. The capital cost of a 10-cubic-meter tank to serve a five-person family is $15-20.

Direct sunlight, wind, water, and biological sources all hold great promise as Third World energy sources. All that is needed today is the political and economic commitment to build a sustainable energy system.

The Third World may enter the solar era before the industrial world does. Several features common to developing countries make such a prospect seem likely:

o Developing nations, by and large, are richly endowed with sunlight.

o Their populations are dispersed enough to make easier use of decentralized energy resources.

o In the Third World, the current high cost of conventional energy, especially electricity, has already made solar options economically competitive. Many simple and practical solar devices have already proven themselves.

A Third World decision to lead in harnessing the sun would be wise. Although the world is not running out of energy, it is running out of oil. World oil production is expected to turn downward within 10 to 18 years, and severe regional shortages are likely to develop well before then. Eighty percent of the world's oil supply will have been consumed during the lifetime of the current generation.

Consequently, it is critical (and morally obligatory) for all countries, rich and poor, to invest a large fraction of the remaining oil in building an energy system that can be sustained when the oil wells run dry.

The industrial world is designed to run on oil. Road building dwarfs all other public works; automobile production has become central to the economic well-being of whole nations. If the developing countries invest vast sums of scarce capital copying today's industrial powers, the petroleum era will have passed before their investments bear fruit. If instead they assess the prospects and make their investments accordingly, they may be spared major commitments to the petroleum era in its dying phase.

Rather than giving foreign interests tax breaks to set up automobile plants on their soil, Third World countries might, for example, accept only factories that produce vehicles that run on fuels other than oil. Rather than devote large portions of their budgets to highways, they might better invest in communications systems and railroads. Rather than laying out huge cities for the torrent of migrants fleeing the countryside, they might spend the same money making rural villages more livable.

Tomorrow, both the industrial world and the agrarian world are likely to be turning to solar resources--sunlight, wind, hydro-power, and biomass--for their commercial energy. The Third World, however, has an advantage: it can take a shortcut past fossil fuels.

Until recently, the strongest impediment to solar power in the Third World was probably the industrial world's pursuit of a different course. Most Third World policy-makers looked to the advanced industrial states as models, and they found no solar-powered societies to emulate.

Development theory has undergone profound changes in the last decade, and few Third World countries still seek to imitate the United States or the Soviet Union. It is now commonly recognized that more than one path leads from "underdeveloped" to "developing" to "developed." That the West does not use biogas as an energy source has not, for example, deterred China from building an estimated 4.3 million biogas plants in the last three years.

Solar technologies hold many attractions for developing countries. A particularly important social advantage is their potential for promoting development in previously ignored rural areas, which will probably be the source of most surplus labor in the next few decades. Without strong rural development programs based on decentralized energy sources, urban migration will become torrential--and urban problems are already dire.

Many solar technologies will make economic sense for the Third World before they do for the industrial world. Electricity produced from solar energy is a good case in point. In rural areas of poor countries no transmission and distribution system exists, so power from centralized plants is not available.

In August, 1977, a team from the United States National Academy of Sciences conducted a joint workshop on solar power with the Tanzanian National Scientific Research Council. The cost of village electricity from diesel generators and from the national power grid was compared with the cost of power from five decentralized, renewable sources: wind power, small-scale hydropower, biogas, solar refrigeration, and photovoltaics.

For some purposes, each of the five renewable technologies had an economic advantage over both the national grid and diesel generation. Three of the five were economically competitive under all circumstances; four out of five were competitive for uses in which the biogas could be burned directly rather than converted first into electricity. And even the least competitive technology--photovoltaics--will hold an economic advantage over conventional sources of electricity by 1983, if their costs drop in accordance with most recent forecasts.

One of the major functions served by development must be the creation of new jobs. At present, energy is often substituted for labor. At current U.S. prices, 2.5¢ worth of gasoline can perform as much work as a healthy adult working from dawn to dusk. One liter of gasoline burned in a one-horse-power engine will provide as much work as a human being can produce in seven days of hard, physical labor. Gasoline-derived power is not only cheaper, but also faster and more reliable than muscle power. Hence, the point is sometimes made that major increases in Third World energy may lead to mounting unemployment.

It needn't. The alternative is to view full employment as a central goal of development, rather than as just one of the variables to be mixed in pursuit of some other, more important goal (like a growing GNP). If full employment is pursued intelligently, energy growth can be absorbed in ways that increase, rather than restrict, total employment.

For example, in most developing countries agriculture is by far the largest source of employment, sometimes accounting for 70-80% of all jobs. But agricultural labor requirements peak sharply during plowing, planting, and harvesting. Most laborers are idle the rest of the year; hence, annual productivity and wages are low. Arjun Makhijani and Alan Poole suggest that the careful mechanization of plowing, planting, and harvesting could reduce the duration of these bottlenecks sufficiently to allow multiple cropping. Demand for labor would even out, agricultural production would increase greatly, and jobs could be created to handle this increased production, as well as the fertilizer and irrigation it would require. Without an increase in the available energy at times of peak demand for work, this would not be possible.

Widespread use of solar equipment in the Third World, where it is already cost-effective, would have positive effects in the industrial nations. With the rapid reductions in cost that assembly lines could bring, solar devices would find ever more applications in rich lands and poor alike. Such a state of economic affairs is so manifestly in the interest of the industrial world that it warrants granting Third World customers subsidies on early orders. France, aware of this fact and eager to attract large orders, is now marketing a subsidized solar irrigation pump throughout the Third World.

The international research and development community has finally begun to apply its genius to solar energy use. Annual expenditures on solar energy research by the U.S. Government have shot up from about $5 million to more than $300 million in five years. Third World research and development in this area has been improving steadily, and excellent programs now exist in Brazil, Mexico, India and others. The United Nations Environment Program is also promoting the use of renewable energy resources in poor countries by funding model villages that employ several different sustainable energy sources.

The Third World's transition to solar technologies will not be trouble-free. Many attempts have been made in the last half century to introduce solar technologies in the Third World. At times, the technology has been perceived as irrelevant to people's real needs (example: solar powered pumps that displaced water carriers for whom no other jobs existed). In other cases, maintenance personnel have been inadequately trained or crucial replacement parts have not been provided. Sometimes the recipients of the technology have simply not liked the solar gadgets or have not cared to adjust their daily activities to take advantage of the availability of sun. And in still other cases, the technologies have been used and have worked perfectly, but they have concentrated additional wealth in the hands of the elite.

A successful solar transition will require detailed knowledge about energy availability and needs in the Third World: How much energy of each kind is used for what purposes? How would any additional energy be spent? What levels of sunlight, wind, and biological productivity are available at various sites? What energy options are open to each locality? Finally, can political will and technical competence be mustered to build or acquire the necessary equipment and to keep it running?

The challenge of a solar transition is formidable. But the rewards of success make it a goal worth pursuing. Ultimately, only solar civilization is sustainable.

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Renewable Energy Glossary

active cooling--use of solar collectors to drive an air conditioning system.

active solar--collection of solar energy using solar collectors and a mechanical system to circulate and store the energy.

agrarian--having to do with farming.

ambient--surrounding.

biogas--gas produced by the breakdown of organic materials, containing methane and other gases.

combustible--capable of burning.

hydropower--energy created by falling or moving water.

passive cooling--using the design of a building to produce cooling by means of natural forces such as air circulation.

passive solar--collection of solar energy into the house or building itself, without mechanical aids.

photovoltaic cell--a device which converts solar energy directly to electricity.

renewable energy--energy derived from resources that replenish themselves in a short time. Examples are solar energy, wind, hydropower, and wood.

solar collector--an enclosed, glazed panel containing a dark absorbing surface that converts sunlight to heat.

solar energy--radiant energy from the sun.

solar pond--a shallow pond of layered water, with concentrated salt water on the bottom and fresh water on top, used to collect solar heat.

solar still--a device that uses solar heat to evaporate water, thus removing impurities.

solar thermal device--a system for concentrating solar energy to produce high temperatures for electric generation or industrial processes.

technological--having to do with machines.

vested interest--a group that has special concern about something, in hope of private benefit.

wind turbine--a wind machine which converts mechanical energy from the wind to electricity.

Teacher Information

Solar Energy in Developing Nations

Suggested Grade Level and Discipline

Grades 9-12
Social Studies
Asian, African, and Latin American studies

Skill Objectives

Reading and interpreting material relating to solar energy

Determining an author's purpose and point of view

Identifying different types of renewable energy

Identifying and summarizing factual content in reading

Major Understandings

The energy problem is a worldwide concern.

Energy technologies should be tailored to needs, conditions, and end use.

Geography has affected the development of Third World nations.

There are economic, political, and social impacts of alternative energy use in emerging nations.

An informed citizen can develop an understanding of Third World nations, especially their energy needs, and of the role of the U.S. regarding the energy needs of the Third World.

Background

The increase in the cost of energy in recent years has brought with it the realization of the need to develop alternative sources of energy. The United States and other industrialized nations have begun to look at alternative sources but continue to maintain their dependence on oil.

Although richer industrialized nations may still be able to afford higher fuel prices, developing countries have a much more difficult time of it. Third World countries want to industrialize but cannot always afford to keep up with the high cost of petroleum on which industrial development depends.

According to a paper published by the World Bank, developing nations must look to alternative energy sources. One possibility is the direct use of the sun. The World Bank maintains that a firm technical basis exists for the introduction of solar power, although greater exploration is needed to assess its full potential. They maintain, however, that water heating with solar collectors is the solar technology most ready--technically, economically, and commercially--for widespread applications. Flat plate solar collectors can be an economical source of hot water for residences and industry; they can also provide heat for drying crops and for certain other agricultural uses. Water, wind, and geothermal sources of energy also have potential for developing nations.

However, students should also be encouraged to consider another point of view. Since the developed nations have already consumed a high percentage of the world's fossil fuels, it can be argued that they should now turn to renewable energy, leaving the world's remaining fossil fuel resources to the developing nations for fueling their growth.

The purpose of this activity is two-fold. First, an article on solar energy and the developing nations is presented to acquaint students with the possibility of solar technology for developing nations. Second, students brainstorm and suggest reasons why the United States should or should not give assistance to nations wanting to develop their solar potential.

Advance Planning

Study the attached glossary.

Duplicate the article, glossary, and guidesheets.

Suggested Time Allotment

Part of one class period to introduce new vocabulary and explain the assignment

Two days for reading, answering guidesheet questions, and summarizing the reading

One or two class periods for discussion

Suggested Approach

Introduce energy as a concern of all nations, not just the United States.

Discuss the concept of renewable energy, and go over terms that may be unfamiliar from the glossary.

Distribute the article and guidesheets. Give the assignment to read the article, answer the guidesheet questions, and write a brief summary of the article.

After the students have read the article, begin the class by making a list on the blackboard of all new vocabulary they have learned.

After the students have completed their discussion in small groups, they should come together as a class and share their results.

Precautions

The teacher should make sure that the students understand the basic vocabulary connected with solar energy before discussion begins.

Points for Discussion

Why haven't industrialized nations taken more time to develop solar energy? Why haven't they given more aid to developing nations for this purpose?

What implications does the introduction of solar energy to the Third World have for its future? Will development of alternative energy sources aid in the overall development of these nations, thereby reducing poverty in the world?

Some people say that the Third World is being pushed toward renewable energy so that the industrialized world can keep fossil fuel resources for themselves. What do you think?

Typical Results

Students have little difficulty in understanding the article. Most believe it is in the best interests of the United States to give aid for the development of solar and other forms of renewable energy.

Evaluation

Evaluate the guidesheets and written summary for correctness and comprehension.

After the class discussion, students could be evaluated by means of an essay in which they would defend or refute the value of developing solar energy in the Third World, citing specific facts from the article to support their stand.

Modifications

Have the students engage in a debate, taking positions for or against foreign aid of this type.

Have each student research the needs and energy potential of a different developing nation. Then present panels of "experts" to discuss the issue of solar energy uses in emerging nations.

References

Ashworth, J. "Renewable Energy for the World's Poor" (Technology Review, 82:42-9, November 1979).

Critchfield, Richard. "Energy Outlook for the Third World Starts to Flicker" (The Christian Science Monitor, December 4, 1981).

"The Dangerous Imbalance: the Growing Hazards of Ignoring Third World Problems" (World Press Review, 27:39, March 1980).

"Energy Solutions for Developing Countries" (Humanist, 39:4, July 1979).

Hayes, Denis. Energy for Development: Third World Options, Worldwatch Paper 15 (Washington, DC: Worldwatch Institute, 1977).

Kurian, George, ed. Encyclopedia of the Third World (Facts on File, Inc., 119 W. 57th Street, New York, NY 10019).

National Science Teachers Association. Energy in the Global Marketplace prepared for U.S. Department of Energy (U.S. Department of Energy, Technical Information Center, P. O. Box 62, Oak Ridge, TN 37830, November 1978).

"Solar Energy for Village Development" (Science, 199:651-7, February 10, 1978).

"Stemming the Third World's Rush to Oil" (Technology Review, 80:20-1, May 1978).

Swierczek, B. and D. Tyler. "Energy and the Poor" (Current, 208:40-4, December 1978).

"World Energy Resources" (National Geographic, v. 159, February 1981).

Mapping a Meal 21

Introduction

All food is made up of nutrients--proteins, carbohydrates (sugar and starch), fats, vitamins, and minerals--that nourish your body to give you energy and to help you grow. Your body needs over 40 different nutrients to stay healthy. It is important that you eat a wide variety of foods to get these nutrients.

Think about the foods that you might choose as your favorite meal. Perhaps it would be pizza, milk, and a salad, or fried chicken, mashed potatoes, green beans, cheese, and apple pie. Before they ended up on your plate, whatever foods you chose had to go first through a complicated series of steps (production, processing, distribution, and preparation). If you're like an average American, the foods you chose may have traveled hundreds or even thousands of miles before they got to you. All that traveling uses energy! In this activity, you are going to plan a well-balanced meal, find out where each food item in this meal was produced, measure the distance each food item traveled to your home, and calculate the total distance traveled by your imagined meal.

Objectives

At the completion of this activity you should be able to

- plan a well-balanced meal,
- use a map and scale of miles or kilometers,
- discuss the problems and promise of your food future, and
- evaluate the food production potential of your own area.

Skills and Knowledge You Need

Mapping and measuring skills

Planning skills

Basic arithmetic skills

A knowledge of the Basic Food Groups

Materials

paper

pencil or pen

ruler

a map of the United States or the world

access to books giving origins of foods (encyclopedias, world almanacs, cookbooks, books about food)

worksheet "Mapping Your Meal"

Words You'll Learn

calorie
geographic origin
map
menu
nutrient
spice

Procedure

1. On the "Mapping Your Meal" worksheet, list the food items that would be included in your favorite well-balanced dinner meal. Try to make sure that your meal contains things from several of the seven basic food groups, which are

   Meat, Fish, Eggs, Nuts, and Beans
   Leafy, Green, and Yellow Vegetables
   Citrus Fruit, Tomatoes, and Salad Greens

Potatoes, Other Vegetables, and Fruits
Bread and Cereal
Butter and Margarine
Milk, Cheese, and Ice Cream

2. Check your list. If you have chosen a food that is a combination of items, list the main item and then list the major items that go into making it.

   For example: Pizza

   a) cheese
   b) bread dough from wheat
   c) tomato sauce

3. Research where each of your food items was grown or produced. The World Almanac, food packaging, cookbooks, and encyclopedias are good places to start.

4. Locate on a map the geographic origin of each of your listed foods. Then write the origin next to each food on your list, in the column headed "Source." Is more than one state or country listed for a food item?--Look at the map and choose the closest state or country.

5. Using a ruler or piece of paper, measure the distance on the map from the center of each state or country of origin to your hometown. Use this measured distance and the map scale of miles or kilometers to find out the actual distance the food may have traveled. Write the distance traveled by each food item in the third column, "Distance," next to the source.

6. When you have finished locating the geographic origin of each food and have calculated all distances, total all of your distance figures to come up with a total figure for the distance traveled by your meal.

Questions

1. How far did the foods making up your favorite meal travel to reach you? How did this distance compare with those of your classmates' favorite meals?

2. How was total distance affected by your menu choice?

3. What could you do to shorten the total distance?

4. What are some of the forms of transportation used to transport food?

5. How might an energy-short future change your diet?

6. What are some foods that you eat that come only from foreign countries?

7. Would the total distance for your favorite meal be different in different seasons? Why?

8. How many of the foods on your menu could have been grown or produced closer to home? How much would that cut the distance of your meal?

9. What are some of the problems you see in your food future? What might be some promising developments in food in the future?

Looking Back

You have seen that many of the foods you eat travel a great distance before they come to your table. You may also have learned during your research about some of the complicated steps of production, processing, transportation, and preparation that were needed before the foods could be eaten. Perhaps now that you know something about where your foods come from, you'll enjoy and appreciate your meals even more. You might also consider what foods you like that grow closer to home. Maybe you'll even try "growing your own."

Going Further

Prepare a chart comparing your meal and distance with that of other students.

Keep a diary of the foods that you have actually eaten during a meal, a day, or a week. Calculate the distance of these foods or simply plot out how many states and countries you have eaten foods from.

Look at your family's total diet. Check to see that your meals are well-balanced. Try to think of ways to make them better balanced and more energy efficient. (Hint: seasonal foods, less processed food, a closer source of foods, and meat substitutes may be some ways.)

Plan a class meal that would use only foods produced in your state or nearby states.

Have a class competition for the best balanced meal with the shortest total distance traveled. Prepare and eat the winning meal.

Make a list of the spices that your family uses while cooking. Investigate to find out where these spices are from and what they are. (Did you know that cinnamon comes from the bark of a special tree from Asia?)

Organize and take part in a discussion of important topics such as "World Hunger," "Future Foods," "Making Our Diet More Energy Efficient," etc.

Find out more about the hundreds of jobs that are open to you in the field of agriculture or in the food service industry.

Visit a local farm, processing plant, or store and find out more about how it works to serve you.

Investigate a typical meal from another region, country, or historical period and make comparisons with your foods in terms of variety, seasons available, distance, nutrition, etc.

Think of new or future developments that could replace current ways of supplying our foods. Some examples might be community or family greenhouses, new crops, solar cooking and drying, etc.

Duplicate some of the processes that turn raw farm produce into table food. Make butter from cream, jelly or jam from fruit, or peanut butter from peanuts, and eat it on homemade bread!

Worksheet

Mapping Your Meal

Menu	Source	Distance

Total ______________

FOOD

Many nutritionists see a connection between a fatty diet and cancer. The National Cancer Institute recommends plenty of fresh vegetables and fruits.

Fifty years ago, more than 30 million people lived on farms in the U.S. Today only about 7.2 million do.

Fifty years ago we had 6 million farms, averaging 200 acres. Today we have 2.8 million, averaging 385 acres.

Eighty-five percent of U.S. agricultural land produces food for animals rather than humans.

Solar drying is inexpensive and preserves the nutritional value of foods. Many farmers are now using solar collectors to assist in grain drying.

Nearly a billion pounds of fertilizer (5 pounds per person) are used in the U.S. every year.

Soybeans are becoming popular as an inexpensive source of protein. Tofu, a soybean curd, can be used as a milk, cheese, or meat substitute in everything from ice cream to quiche.

Over 40 countries have had major famines in the last 20 years.

Doctors studying animal diet have found that the higher the carbohydrate-to-protein ratio, the livelier the animals. Animals on a high-protein, low-carbohydrate diet ate more and gained weight, while those on a high-carbohydrate, low-protein diet ate less and lost weight.

Almost all of our rice comes from just four states.

A large supermarket has about 9000 items on its shelves.

Eating fresh foods in their season uses less fuel energy than eating processed foods.

Some food-processing industries are now using agricultural wastes as fuel. In Hawaii, many sugar refineries burn sugar cane waste to fuel the refining process.

Reusing cans, bags, and bottles saves energy.

One apple tree produces enough apples each year for about 280 apple pies.

FACTS

The American food-processing industry uses as much energy as do the farms that produce the food.

The Calorie intake of the average American is 30% above the estimated human Calorie requirement.

In the Middle Ages, when Europeans began using spices from Asia, the sailing trip to get the spices and return took as long as two years.

Until World War II most American farmers still used horses for plowing and harvesting.

A diet containing a lot of meat is an energy-expensive diet. It takes 20 pounds of grain to produce 1 pound of beef.

Ninety-five percent of the country's broccoli and 80 percent of its lettuce come from California.

Processing food takes energy! To produce a pound of frozen corn requires 3187 Calories, but that same pound of corn contains only 372 Calories for us to eat.

A single bushel of wheat produces about 47 loaves of bread.

You don't have to eat meat to get protein. Nuts, seeds, legumes (lentils or dry beans), and grains, as well as dairy products, have protein too, but to get good nutrition from them (the 8 essential amino acids) you have to eat them in combination:

- grain + legume, seed, or nut
- legume + seed or nut
- dairy product + seed, nut, legume, or grain

More grain is grown, worldwide, than any other kind of crop.

An average dairy cow produces about 62 glasses of milk a day.

Raising beef on the range is 7 times more energy-efficient than raising beef in feedlots.

Over the last 30 years, world food production has steadily increased--but world population has increased faster.

1 Calorie (capital C) = 1 kilocalorie = 1000 calories (small c).

About half the world's total supply of corn is grown in the U.S.

Teacher Information

Mapping a Meal

Suggested Grade Level and Discipline

Grades 6-12
Social Studies
Geography
World Problems
Home Economics

Skill Objectives

Mapping and measuring distances

Researching and recording data

Planning a well-balanced meal

Comparing and sharing information

Evaluating potential food production

Major Understandings

A variety of foods go into a well-balanced meal.

A meal is the result of a complex, energy-consuming series of national and international activities.

Many foods that are now transported long distances to the consumer could be produced locally.

Background

Only plants have the ability to use the sun's energy to manufacture food. Although we call this process photosynthesis--manufacturing with light--we really do not know how a plant absorbs solar energy and puts it to work. We do know, however, that without this process life as we know it would not be possible.

Food is the source of energy for our bodies, providing us with the energy to stay alive and to function. Food energy is measured in units called calories. An average adult needs about 16 to 18 calories per day per pound of body weight. To get this energy, the average American eats almost four pounds of food each day. In a year's time, an average person will eat 348 lbs. of dairy products, 156 lbs. of vegetables, 153 lbs. of fruit and juice, 81 lbs. of potatoes, 155 lbs. of meat, 51 lbs. of poultry, and 16 lbs. of fish.

Foods for the American table are produced nationwide and worldwide, and Americans have become accustomed to great variety in their diet. To a great extent, this varied diet is the product of fossil fuels. Fossil fuels provide the fertilizer, run the farm machinery, drive the processing plants, yield the plastic packaging, and transport the food products to market. Today, a great deal of thought is being devoted to how we can save fossil fuels and still provide a nutritious diet for all people.

Advance Planning

Be sure that a sufficient number of resource materials such as world almanacs, encyclopedias, or books about food are available for research.

Enlarge the attached poster to encourage student interest.

Give students some background information about the seven Basic Food Groups. An encyclopedia can be helpful. Look under "Nutrition." Cookbooks such as the new Fannie Farmer Cookbook can help you with seasonal availability of fruits and vegetables.

Read or examine all materials in this activity.

Duplicate the worksheet.

Suggested Time Allotment

Depending on how you choose to conduct this activity, it can be as simple as a one-period lecture/discussion or can be as complex as a week or two of research, planning, discussion, and sharing.

Suggested Approach

Spark student interest by giving them new information about food (see the food facts poster), by questioning them about food items such as spices and seasonings (what they are, where they come from geographically), or by having them look at foods differently. (Ask the students to name a vegetable they eat that is one of the following plant parts--root, tuber, stem, leaf, bud, seed, pod, or fruit.)

Continue to stimulate interest by asking them to name other foods and to guess where they come from geographically. Emphasize the long distances some foods travel.

When students begin the worksheet, encourage the planning of well-balanced meals. Help them with the map scale if necessary.

When worksheets are completed, use the Questions and Points for Discussion to stimulate further thought. Discuss why locally grown food may become important to our food future.

Precautions

For ease of measuring and comparing:

1) establish the guidelines for where to begin and end measurements: for example, in the center of each state, at the state capital, or on the border.

2) have students measure straight line distance from geographic origin to home state.

3) point out that distance figures are the very minimum--only farm to table--and that they do not include side trips for processing and distribution.

Points for Discussion

What measures would be needed to deal with the following contingencies:

1) a multi-year drought in food supply areas,

2) wide-spread labor disputes in the food service or transportation industries,

3) an extraordinary rise in food prices, and

4) an energy shortage or cut-off?

What changes do you expect in your food future in terms of

1) new foods,

2) new technologies, and

3) world population pressures?

Typical Results

Students will find that the foods comprising a typical well-balanced meal will have traveled great distances to reach their tables. They will also find that many of these foods could be produced locally, at least seasonally.

Evaluation

Ask students to indicate the components of a well-balanced meal.

Ask each student to indicate on a map where one food originates and to state approximately how far it had to travel to reach him/her.

Have students list some of the problems foreseeable in our food future and some of the new developments which may help solve these problems.

Ask students to evaluate the food production potential of their own areas.

References

Boy Scouts of America. Food Systems: Merit Badge Pamphlet (Boy Scouts of America, 2109 Westinghouse Boulevard, Charlotte, NC 28210, 1978).

"The Geography of Hunger" (Time, November 11, 1974).

Roth, Charles E. and R. Joseph Froehlich. The Farm Book (New York: Harper & Row Publishers, Inc., 1977).

Tudge, Colin. Future Food (New York: Harmony Books, 1980).

U.S. Department of Agriculture. Cutting Energy Costs, the 1980 Yearbook of Agriculture (Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402).

U.S. Department of Agriculture. The Great American Farm, U.S. Department of Agriculture activity with facts, wall chart, and dittos (Available from: The Great American Farm, Box 385, Vandalia, OH 45377).

U.S. Department of Agriculture. What's to Eat? And Other Questions Kids Ask About Food, The United States Department of Agriculture Yearbook 1979 (Stock No. 001-000-04041-3, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402).

World Almanac, 1981. (Newspaper Enterprise Association, Inc., 200 Park Avenue, New York, NY 10166, lists major agricultural products for each state, plus has a chart of the nutritional values of foods).

An Energy Glossary

a

active solar energy system: a system which requires external mechanical power (motors, pumps, valves, etc.) to operate the system and to transfer the collected solar energy from the collector to storage or to distribute it throughout the living units. Active systems can provide space heating and cooling, domestic hot water, and/or steam for industrial use.

air pollution: the presence of contaminants (natural or manmade) in the air to such a degree that the normal self-cleaning or dispersive ability of the atmosphere cannot cope with them.

alcohol fuels: primarily grain alcohol (ethanol) and wood alcohol (methanol) which have been used for decades in some European cars and in race cars. Cheap and easy availability of gasoline in the past made them uneconomical. Engine modifications will be necessary if these liquid fuels are to be put into widespread use, but small amounts of ethanol (up to 10% mixture with gasoline, as in gasohol) can be used in most cars without alterations. Alcohol fuels can be made from a variety of materials including crop surpluses, lumber wastes, municipal sewage, and garbage.

b

backup energy system: an energy system using conventional fuels to supply all the heating and domestic hot water during any period when the solar energy system is not operating.

barrel: a liquid volume equal to 42 gallons or 159 liters. One barrel of crude oil has about the same heat energy as 350 pounds of bituminous coal, 5.8×10^9 joules or 5.5×10^6 Btu or 1.39×10^6 kcal.

bioconversion: a general term describing the conversion of one form of energy into another by living organisms. Examples are production of wood and sugars by green plants, production of alcohols and natural gases by microorganisms acting on organic materials, and transfer of energy in food chains.

biofuels: renewable energy sources produced by or from green plants. Examples are grain alcohol, wood, methane from anaerobic digesters, and all foods.

biomass: a volume or amount of plant material in any form: algae, wood, plants, crop residue, animal manure, etc.

breeder reactor: a more complex nuclear reactor than ones now in commercial use, a breeder converts non-fissionable uranium or thorium to nuclear fuel. Conventional nuclear reactors depend on fission of an uncommon form of uranium, U_{235}, which comprises less than 1% of uranium ore. To extend the use of uranium, breeder reactors may be able to change more abundant forms of uranium into fissionable elements. Higher operating risks, engineering problems, and waste disposal considerations have been factors in slow development of breeder technology.

c

coal: solid fuel formed by the decomposition of plants buried deep under the earth's surface. A group of naturally occurring, carbon and hydrogen-rich substances are called "coal". Various types are ranked by the percentage of carbon in dried samples or by the caloric value of moist ones. From least to most carbon-rich, the coal group includes peat, lignite, sub-bituminous and bituminous coals, and anthracite.

collector: any of a wide variety of devices (flat-plate, concentrating, vacuum tube, greenhouse, etc.) which collect solar radiation and convert it to heat.

compost: a mixture of decomposing plant refuse, manure, etc. used for fertilizing and conditioning the soil.

concentrator: a reflector or lens designed to focus a large amount of sunlight into a small area thus increasing the intensity of the energy collected. In wind terminology, a device or structure that increases the speed of the wind.

conservation: making the best use of natural resources by reducing waste, improving efficiency, and slowing the rate of consumption.

d

deciduous: describes trees and shrubbery that lose their leaves during the fall season of each year and produce new foliage in the spring.

direct solar gain: a type of passive solar heating system in which solar radiation passes through the south-facing living space before being stored in the thermal mass.

e

energy: the ability to do work or make things move; the application of a force through a distance. Energy exists in a variety of forms (electrical, kinetic or motion, gravitational, light, atomic, chemical, heat) and can be converted from one to another. Common units are calories, joules, Btu, and kilowatt-hours.

energy transition: a time in history when there is a significant change in the mix of energy resources on which people depend. An example is the transition in the U.S. from use of coal and wood primarily (as in 1900) to widespread use of gas and petroleum, in addition to coal, by 1950. Another example is the entry of nuclear power generation on the commercial scene and its increased contribution to total energy needs, up from 1% in 1973 to 4% in 1979. If the future brings greater reliance on renewable resources and less dependency on fossil fuels, OR if fission/fusion processes generate the major share of commercial electricity, either of these scenarios would be another "energy transition".

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

evaporation: the change from liquid to gas which requires extraordinary absorption of heat by the material undergoing this phase change. Liquid water, for example, absorbs 540 extra calories per gram at 100° C as is vaporizes. This heat will be released again if the water vapor condenses.

f

flat plate collector: an enclosed, glazed panel containing a dark absorbing surface that converts sunlight to heat without the aid of a reflecting surface to concentrate the rays. The collector transfers its heat to a circulating fluid.

fossil fuels: coal, petroleum, and natural gas; this term applies to any fuels formed from the fossil remains of organic materials (plants and animals) that have been buried for millions of years. The ultimate source of energy for those plants and animals was the sun.

g

gasohol: a fuel mixture composed of 90% unleaded gasoline and 10% ethanol (ethyl or grain alcohol).

generator: a device that converts heat or mechanical energy into electrical energy.

geothermal energy: heat trapped in the interior of the earth is called geothermal energy. Boreholes into the crust show an average temperature increase of 1° C for every 30 meters of depth, or about 100° F per mile. Geothermal heat is believed to come from the decay of radioactive materials deep in the earth as well as from friction of rock movements, tidal forces, and perhaps other sources. This heat keeps great quantities of buried rock molten and hot. Some of this energy escapes at the surface as hot water. Geothermal energy is available in four forms: dry steam, wet steam, hot rocks, and hot water.

h

<u>heat</u>: energy that flows between a system and its surroundings because of a temperature difference between them. Heat results from the motion of molecules of matter. Also, the word <u>heat</u> is often used to refer to the energy contained in a sample of matter (for example, kilocalories per unit of food).

<u>hydroelectric plant</u>: an electric power plant in which the energy of falling water is converted into electrical energy by a turbine generator.

i

<u>insolation</u>: the energy received by earth from the sun, a contraction of the three words: <u>in</u>coming <u>sol</u>ar radi<u>ation</u>. The total daily insolation is the equivalent of about 4.2 quadrillion kilowatt-hours. Local insolation depends on the position of the earth in its orbit, the thickness and transparency of the atmosphere, the inclination of the intercepting surface to the sun's rays, and the solar constant. Weather bureaus now keep insolation data or "sunshine statistics."

<u>insulation</u>: material with high resistance (R-value) to heat flow. Some commonly used materials for home insulation are fiberglass, cellulose, rock wool, and styrofoam.

m

<u>methane gas</u>: a colorless, flammable, gaseous hydrocarbon, emitted by marshes and by dumps undergoing decomposition; can also be manufactured from crude petroleum or other organic materials.

n

<u>natural gas</u>: a mixture of gaseous hydrocarbons occurring naturally in certain rocks. There are several kinds of gas trapped in porous rocks underground. One of these "natural gases" is methane, used as a commercial fuel. Petroleum deposits always include some methane, but natural gas deposits are not always accompanied by petroleum. Natural gas is commonly sold to individuals in hundreds of cubic feet (CCF), the unit appearing on household utility bills. One CCF of commercial methane has about 25,000 kilocalories, the equivalent of 8 pounds of coal or 0.7 gallons of crude oil. (See also: <u>methane</u>.)

<u>nonrenewable resources</u>: energy resources that are not being replaced during the time span of human history. Examples are coal, oil, natural gas, and uranium.

<u>nuclear energy</u>: energy from radioactive decay or from fission or fusion reactions. In a controlled situation it can be used to produce electricity.

nuclear reactor: a device in which a fission chain reaction can be initiated, maintained, and controlled.

O

ocean thermal energy conversion (OTEC): an energy technology in which the temperature difference (between cold deep water and the warm surface water 2,000 feet above it) in tropical oceans is used to generate electricity.

oil shale: a sedimentary rock containing solid organic matter (kerogen) that yields substantial amounts of oil when heated to high temperatures.

P

passive solar energy system: an assembly of natural and architectural components which converts solar energy into usable or storable thermal energy (heat) without mechanical power. Current passive solar energy systems often include fans, however.

peat: accumulated plant remains that decayed in a swamp, becoming a loosely packed mass of carbon-rich materials. It is usually brown, porous, and fibrous; has a high water content; and leaves much ash when burned. Nevertheless it is a valuable fuel. The U.S.S.R. has generated electricity from peat since 1914 and now has many peat-fueled power stations.

petrochemicals: chemicals removed from crude oil at the refinery and used to make a wide range of products such as plastics, synthetic fibers, detergents, and drugs.

petroleum: an oily, flammable liquid that may vary from almost colorless to black and that occurs in many places in the upper strata of the earth. It is a complex mixture of hydrocarbons and is the raw material for many products including gasoline, kerosene, lubricants, and waxes.

photosynthesis: green plants' process of using solar energy to convert simple molecules into complex ones with high potential energy. Carbon dioxide and water are combined, in the presence of sunlight and chlorophyll, into carbohydrates such as sugars, starches, oils, and cellulose.

photovoltaic cell: a device which converts solar energy directly into electricity. Sunlight striking certain materials (silicon is most common) causes the release of electrons. The migration of these released electrons produces an electrical current. The conversion process is called the photovoltaic effect.

power: the rate at which work is performed. It is measured as units of energy per unit of time, for example: calories per second, watts (joules per second), or horsepower (foot-pounds per second).

r

radiation: the method by which heat is transferred through open space. About 60% of the heat transferred to a room from a wood stove is by radiation. Sunlight travels to us by radiation through space at "the speed of light," 299,728 kilometers per second.

reclamation: the process of replacing the soil, clay, and rocks removed earlier to expose coal or oil shale for strip mining; compacting and contouring the site; and replanting it to restore its appearance and reduce erosion and drainage of waste materials.

renewable resources: materials that are recycled by natural processes within a relatively brief span of time (a human lifetime). Fresh water, wind, sunshine, and trees are some examples of resources that replace or recycle themselves within human time frames.

retrofit: to modify an existing building by adding a solar heating or cooling system or insulation to improve its energy efficiency.

R-value: the resistance to heat flow, reciprocal of U-value. The higher the R-value, the greater the insulating efficiency of the material. R-values are commonly stated per inch of building material. R-values are additive--thicker material or a combination of materials means increased resistance to heat flow. Some typical R-values per inch of material are 6.25 for polyurethane foam, 3.17 for fiberglass batts, 1.25 for fir and pine wood, 0.18 for plaster, and 0.08 for concrete.

s

solar access or solar rights: the right to receive direct sunlight without interference. The protection of solar access is a legal issue.

solar cell: see photovoltaic cell.

solar energy: the electromagnetic radiation emitted by the sun. The earth receives about 4,200 x 10^{15} kilowatt-hours of solar radiation per day.

solar furnace: a device using mirror reflectors or lenses to produce very high temperatures at a focal point or "hot spot." Small backyard furnaces generate temperatures as high as 1,100 degrees Celsius; the largest solar furnace in the world reaches 3,100 degrees Celsius.

storage: the device or medium that absorbs collected heat and stores it for later use.

sunspace: a living space enclosed by glazing; a sunroom or greenhouse.

t

thermal storage: a system which uses brick, rocks, concrete, water walls, salt ponds, eutectic salts, or other materials to store heat energy. Thermal storage is especially desirable for solar-heated homes.

w

watt: a unit of measure for electrical power equal to the transfer of one joule of energy per second. The watt is the unit of power most often associated with electricity and is determined by multiplying required volts by required amperes. One horsepower = 746 watts.

WECS (wind energy conversion system): a system which converts mechanical energy from the wind to electricity, heat, or fuel which is used directly or stored.

windbreak: a dense row of trees, or a fence or other barrier that interrupts and changes the local path of the wind.

windmill: a machine run on energy generated by wind blowing against blades or slats.

wind turbine generator: see WECS.

Agreement on Guidelines for Classroom Copying

in Not-for-Profit Educational Institutions with Respect to Books and Periodicals

The purpose of the following guidelines is to state the minimum and not the maximum standards of educational fair use under Section 107 of H.R. 2223. The parties agree that the conditions determining the extent of permissible copying for educational purposes may change in the future; that certain types of copying permitted under these guidelines may not be permissible in the future; and conversely that in the future other types of copying not permitted under these guidelines may be permissible under revised guidelines.

Moreover, the following statement of guidelines is not intended to limit the types of copying permitted under the standards of fair use under judicial decision and which are stated in Section 107 of the Copyright Revision Bill. There may be instances in which copying which does not fall within the guidelines stated below may nonetheless be permitted under the criteria of fair use.

Guidelines

I. *Single Copying for Teachers*

A single copy may be made of any of the following by or for a teacher at his or her individual request for his or her scholarly research or use in teaching or preparation to teach a class:

A. A chapter from a book;
B. An article from a periodical or newspaper;
C. A short story, short essay or short poem, whether or not from a collective work;
D. A chart, graph, diagram, drawing, cartoon or picture from a book, periodical, or newspaper;

II. *Multiple Copies for Classroom Use*

Multiple copies (not to exceed in any event more than one copy per pupil in a course) may be made by or for the teacher giving the course for classroom use or discussion; *provided that:*

A. The copying meets the tests of brevity and spontaneity as defined below; *and,*
B. Meets the cumulative effect test as defined below; *and,*
C. Each copy includes a notice of copyright

Definitions

Brevity

(i) Poetry: (a) A complete poem if less than 250 words and if printed on not more than two pages or, (b) from a longer poem, an excerpt of not more than 250 words.

* *(ii)* Prose: (a) Either a complete article, story or essay of less than 2,500 words, or (b) an excerpt from any prose work of not more than 1,000 words or 10% of the work, whichever is less, but in any event a minimum of 500 words.

Each of the numerical limits stated in "i" and "ii" above may be expanded to permit the completion of an unfinished line of a poem or of an unfinished prose paragraph.

(iii) Illustration: One chart, graph, diagram, drawing, cartoon or picture per book or per periodical issue.

(iv) "Special" works: Certain works in poetry, prose or in "poetic prose" which often combine language with illustrations and which are intended sometimes for children and at other times for a more general audience fall short of 2,500 words in their entirety. Paragraph "ii" above notwithstanding such "special works" may not be reproduced in their entirety; however, an excerpt comprising not more than two of the published pages of such special work and containing not more than 10% of the words found in the text thereof, may be reproduced.

Spontaneity

(i) The copying is at the instance and inspiration of the individual teacher, and,

* *(ii)* The inspiration and decision to use the work and the moment of its use for maximum teaching effectiveness are so close in time that it would be unreasonable to expect a timely reply to a request for permission.

Cumulative Effect

* *(i)* The copying of the material is for only one course in the school in which the copies are made.

* *(ii)* Not more than one short poem, article, story, essay or two excerpts may be copied from the same author, nor more than three from the same collective work or periodical volume during one class term.

* *(iii)* There shall not be more than nine instances of such multiple copying for one course during one class term.

* The limitations stated in "ii" and "iii" above shall not apply to current news periodicals and newspapers and current news sections of other periodicals.

III. *Prohibitions as to I and II Above*

Notwithstanding any of the above, the following shall be prohibited:

* (A) Copying shall not be used to create or to replace or substitute for anthologies, compilations or collective works. Such replacement or substitution may occur whether copies of various works or excerpts therefrom are accumulated or reproduced and used separately.

* (B) There shall be no copying of or from works intended to be "consumable" in the course of study or of teaching. These include workbooks, exercises, standardized tests and test booklets and answer sheets and like consumable material.

(C) Copying shall not:

(a) substitute for the purchase of books, publishers' reprints or periodicals;

(b) be directed by higher authority;

(c) be repeated with respect to the same item by the same teacher from term to term.

(D) No charge shall be made to the student beyond the actual cost of the photocopying.

Metric Conversion Table

Unit of Measure	English Unit	→ Multiply By / ← Divide By	Metric Unit	Symbol
Length	inches feet feet yards miles	2.54 30.0 0.3 0.91 1.61	centimeters centimeters meters meters kilometers	cm cm m m km
Area	square inches square feet square yards	6.5 0.09 0.8	square centimeters square meters square meters	cm^2 m^2 m^2
Mass (Weight)	ounces pounds	28 0.45	grams kilograms	g kg
Volume	gallons cubic feet	3.8 0.03	liters cubic meters	l m^3
Temperature	degrees Fahrenheit	→ 5/9 (after subtracting 32) ← 5/9 plus 32	degrees Celsius	°C
Heat	Btu	252	calories	c
Speed	miles per hour	1.61	kilometers per hour	km/hr

Energy Units

barrel: a liquid volume equal to 42 gallons or 159 liters. One barrel of crude oil has about the same heat energy as 350 pounds of bituminous coal, 5.8 x 10^9 joules or 5.5 x 10^6 Btu or 1.39 x 10^6 kcal.

Btu: British thermal unit, a unit for measuring heat; a Btu is the quantity of heat necessary to raise the temperature of one pound of water one degree Fahrenheit, about one-fourth of a kilocalorie (252 calories).

calorie(also: gram calorie): a metric unit of heat energy; the amount of heat needed to raise the temperature of one gram of water one degree Celsius. It equals 0.0039 Btu. One thousand calories make one kilocalorie (kcal), sometimes called a Calorie or food Calorie.

kilowatt: a measure of power, usually electrical power or heat flow; equal to 1,000 watts or 3,413 Btu per hour.

kilowatt-hour: the amount of energy equivalent to one kilowatt of power being used for one hour; equals 3,413 Btu, or about 860 kcal.

watt: a unit of measure for electrical power equal to the transfer of one joule of energy per second. The watt is the unit of power most often associated with electricity and is determiend by multiplying required volts by required amperes. One horsepower = 746 watts.

Sources of Energy Information

General Reference

Christian Science Monitor. "Energy '80"
(Reprints Service, Christian Science Monitor, P.O. Box 527, Back Bay Station, Boston, MA 02117).

The Ecologist staff, ed. Blueprint for Survival
(New York: New American Library, 1972).

Farallones Institute. The Integral Urban House: Self Reliant Living In the City (San Francisco: Sierra Club Books, 1979).

Leckie, Jim et al. Other Homes and Garbage: Designs for Self-Sufficient Living (San Francisco: Sierra Club Books, 1975).

National Geographic Society. Energy: A Special Report
(National Geographic, February 1981).

National Science Teachers Association. Factsheets
(D.O.E. Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830).

Prenis, John, ed. Energy Book I and II
(Philadelphia: Running Press, 1977).

Rain staff, ed. Rainbook: Resources for Appropriate Technology
(New York: Schocken Books, 1977).

Rosenfeld, Albert. "Star of Stars"
(Saturday Review, October 30, 1976).

Smithsonian Exhibition Books. Fire of Life: The Smithsonian Book of the Sun (New York: W.W. Norton & Co., 1981).

Wolfe, Ralph and Peter Clegg. Home Energy for the Eighties
(Charlotte, VT: Garden Way Publishing Co., 1979).

Especially for Students

Adams, Florence. Catch a Sunbeam: A Book of Solar Study and Experiments
(New York: Harcourt Brace Jovanovich, 1978).

"Behold, my Brothers"
(Curious Naturalist, April 1975).

Borgeson, Lillian. "The Star that Controls Our Lives"
(International Wildlife, July/August 1980).

Branley, Franklyn. Solar Energy
(New York: Thomas Crowell, 1975).

Buckley, Shawn. Sun Up to Sun Down
(New York: McGraw Hill Book Co., 1979).

Halacy, D.S. The Coming Age of Solar Energy
(New York: Harper and Row, 1973).

Houck, Oliver A. "The Best Present of All"
(Ranger Rick's Nature Magazine, April 1974 and May/June 1974).

Knight, David. Harnessing the Sun: The Story of Solar Energy. (New York: William Morrow, 1976).

"Ocean Energy: Scratching the Surface" (Current Energy and Ecology, January 1980).

Oxenhorn, Joseph M. Energy and Our Future (New York: Globe Book Co., Inc., 1979).

Ricciuti, Edward R. "The Energy of the Sun" (The Curious Naturalist, January 1975).

Ricciuti, Edward R. "Mighty Methane" (The Curious Naturalist, March 1975).

Zim, Herbert S. Waves (New York: William Morrow, 1967).

Energy and Society

Brown, Lester R. Building a Sustainable Society (New York: W.W. Norton & Co., 1981).

Clark, Wilson. Energy for Survival: The Alternative to Extinction (Garden City, NY: Doubleday & Co., 1974).

Council on Environmental Quality and the Department of State. The Global 2000 Report to the President, Volume 1 (Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, 1980).

Hayes, Denis. Rays of Hope (New York: W.W. Norton & Co., 1977).

Hayes, Denis. "The Transition to a Post-Petroleum World" (Journal of Home Economics, May 1978).

Schumacher, E.F. Small is Beautiful: Economics As If People Mattered (New York: Harper and Row, 1975).

Stobaugh, Roger and Daniel Yergin. Energy Future: The Report of the Harvard Business School Energy Project (New York: Random House, 1979).

Energy History

Butti, Ken and John Perlin. A Golden Thread (Palo Alto, CA: Cheshire Books, 1980).

Kranzberg, Melvin. "Energy, Technology, and the Story of Man" (The Science Teacher, March 1972).

Nef, John U. "An Early Energy Crisis and its Consequences" (Scientific American, November 1977).

Conservation

Albright, Roger. 547 Easy Ways to Save Energy in Your Home (Charlotte, VT: Gardenway Publishing, 1978)

Blandy, Thomas and Denis Lamoureaux. All Through the House: A Guide to Home Weatherization (New York: McGraw-Hill Book Co., 1980).

Clegg, Peter. New Low Cost Sources of Energy for the Home (Charlotte, VT: Garden Way Publishing Co., 1975).

Consumer Guide staff, ed. Energy Savers Catalog (New York: G.P. Putnam's Sons, 1977).

Office of Energy Conservation. 100 Ways to Save Energy & Money in the Home (Conservation Books, P.O. Box 3500, Station C, Ottawa, Ontario, Canada K1Y 4G1, 1979).

Rothchild, John. Stop Burning Your Money: The Intelligent Homeowner's Guide to Household Energy Savings (New York: Random House, Pubs., 1981).

U.S. Department of Agriculture. Cutting Energy Costs: The 1980 Yearbook of Agriculture (Sup't of Documents, U.S. Government Printing Office, Washington, DC 20402, 1980).

Solar Heating and Cooling

Anderson, Bruce and Michael Riordan. The Solar Home Book (Andover, MA: Brick House Publishing Co., 1976).

Baer, Steve. Sunspots (Zomeworks Corp., P.O. Box 712, Albuquerque, NM 87103, 1977).

Hand, Jackson. Home Guide to Solar Heating and Cooling (New York: Harper and Row, Pubs., 1978).

Kidder, Tracy. "Tinkering With Sunshine" (The Atlantic Monthly, October 1977).

Mazria, Edward. The Passive Solar Energy Book (Emmaus, PA: Rodale Press, 1979).

Scully, Dan et al. The Fuel Savers: A Kit of Solar Ideas for Existing Homes (Andover, MA: Brick House Publishing Co., 1978).

Shurcliff, William A. New Inventions in Low Cost Solar Heating (Andover, MA: Brick House Publishing Co., 1979).

Solar Age staff, ed. Solar Age Resource Book (New York: Everest House, 1979).

Photovoltaics

Beatty, J. Kelly. "Solar Satellites: The Trillion Dollar Question" (Science 80, December 1980).

D'Alessandro, Bill. "Milestones Passed, Miles Ahead" (Solar Age, December 1979).

Free, John. "Sunshine into Electricity" (Popular Science, April 1981).

Seltz-Petrash, Ann. "Energy from Space" (Civil Engineering, July 1979).

Wind

Beedell, Suzanne. Windmills (New York: Charles Scribner's Sons, 1975).

Dennis, Landt. Catch the Wind (New York: Four Winds Press, 1976).

Flavin, Christopher. Wind Power: A Turning Point, Worldwatch Paper 45 (Worldwatch Institute, 1776 Massachusetts Ave., N.W., Washington, DC 20036, 1981).

Reynolds, John. Windmills and Watermills (New York: Praeger Pubs.,"1975).

Biomass

Brown, Lester R. Food or Fuel: New Competition for the World's Cropland, Worldwatch Paper 35 (Worldwatch Institute, 1776 Massachusetts Ave., N.W., Washington, DC 20036, 1980).

Hanna, Thomas. "Thought Snacks" (Human Ecology Forum, Winter 1978).

Lockeretz, William. "Biomass Energy: The Promise and the Problems" (Sierra, January/February 1979).

Smith, Nigel. Wood: An Ancient Fuel with a New Future, Worldwatch Paper 42 (Worldwatch Institute, 1776 Massachusetts Ave., N.W., Washington, DC 20036, 1981).

Washington State Office of Public Instruction. Energy, Food, and You, (K-6) (Shoreline School District Admin. Bldg., NE 158th and 20th Ave., NE, Seattle, WA 98155, 1978-1979).

Washington State Office of Public Instruction. Energy, Food, and You, (Secondary) (Shoreline School District Admin. Bldg., NE 158th and 20th Avenue NE, Seattle, WA 98155, 1978-1979).

Hydropower

Deudney, Daniel. Rivers of Energy: The Hydropower Potential, Worldwatch Paper 44 (Worldwatch Institute, 1776 Massachusetts Ave., N.W., Washington, DC 20036).

Lanouette, William J. "Rising Oil and Gas Prices Are Making Hydropower Look Better Every Day" (National Journal, April 26, 1980).

McGuigan, Dermot. Harnessing Water Power for Home Energy (Charlotte, VT: Garden Way Publishing Co., 1978).

Other Forms of Renewable Energy

Michaelson, David R. Oceans in Tomorrow's World: How Can We Use and Protect Them? (New York: Julian Messner, 1972).

Oregon Institute of Technology. Geo-heat Utilization Center Quarterly Bulletin (Oregon Institute of Technology, Klamath Falls, OR 97601).

Schiefelbein, Susan. "Teaching Poseidon to Turn a Profit" (Saturday Review, January 6, 1979).

Swann, Mark. "Power From the Sea" (Environment, May 1976).

U.S. Department of Energy. Geothermal Energy (Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830).

Magazines and Newsletters

Alternative Sources of Energy
(107 South Central Avenue, Milaca, MN 56353).

A. T. Times
(National Center for Appropriate Technology, P.O. Box 3838, Butte, MT 59702).

Blair & Ketchum's Country Journal
(Country Journal Publishing Co., P.O. Box 1225, Brattleboro, VT 05301).

Christian Science Monitor
(Box 125, Astor Station, Boston, MA 02123).

Current Energy & Ecology
(Curriculum Innovations, Inc., 3500 Western Avenue, Highland Park, IL 60035, for students).

Energy Consumer
(D.O.E. Office of Consumer Affairs, Room 8G082, Washington, DC 20585).

Energy & Education
(National Science Teachers Association, 1742 Connecticut Avenue, Washington, DC 20009).

Harrowsmith
(Camden House Publishers, Camden East, Ontario, Canada KOK 1J0).

Rodale's New Shelter
(Rodale Press, 33 East Minor Street, Emmaus, PA 18049).

Solar Age
(SolarVision, Inc., P.O. Box 4934, Manchester, NH 03108).

Solar Utilization News
(Alternate Energy Institute, P.O. Box 3100, Estes Park, CO 80517).

Audio-Visual Materials

Association Films, Inc.
866 Third Avenue, New York, NY 10022
(Lends 16mm movies free of charge)

Your local gas or electric utility

Library Filmstrip Center
3033 Aloma, Wichita, KS 67211
(Color and sound filmstrips with cassettes on solar energy)

Modern Talking Picture Service
200 L Street NW, Washington, DC 20036; 16 Spear Street, San Francisco, CA 94105 (A selection of free films on energy-related topics produced by major industries)

New York State Alliance to Save Energy, Inc.
36 West 44th Street, Room 709, New York, NY 10036
Energy On Film (a convenient digest of over 160 energy-related films available from various sources)

Solar Energy Institute of America
P.O. Box 6068, Washington, DC 20005
(35mm slides on all aspects of solar energy @ $1.00 each)

Solar Lobby
1001 Connecticut Avenue, N.W., Suite 510, Washington, DC 20036
Solar Energy Education Bibliography (comprehensive energy A-V listing)

Your State Energy Office

3-M Company
Visual Products Division, 3-M Center, St. Paul, MN 55101
(Energy films)

Total Environmental Action
Church Hill, Harrisville, NH 03450
(Solar slides)

U.S. Department of Energy Film Library
P.O. Box 62, Oak Ridge, TN 37830
(Provides teachers with an annotated brochure on free energy films)

Zomeworks Corp.
Box 712, Albuquerque, NM 87103
(Solar slides)

Organizations and Agencies

American Forest Institute
1619 Massachusetts Avenue, N.W., Washington, DC 20036

American Section of the International Solar Energy Society
American Technological University, P.O. Box 1416, Killeen, TX 76541

Center for Renewable Resources
1001 Connecticut Avenue, NW, Suite 510, Washington, DC 20036

Citizens' Energy Project
1110 6th Street, N.W., #300, Washington, DC 20001

Consumer Action Now
355 Lexington Avenue, 16th Floor, New York, NY 10017

Your local Cooperative Extension Office

League of Women Voters of the United States
1730 M Street, N.W., Washington, DC 20036

The National Center for Appropriate Technology
Box 3838, Butte, MT 59701

National Wildlife Federation
1412 16th Street, N.W., Washington, DC 20036

New York Alliance to Save Energy
36 West 44th Street, Room 709, New York, NY 10036

Public Interest Research Group
P.O. Box 19312, Washington, DC 20036

Renewable Energy Information
P.O. Box 1607, Rockville, MD 20850

Resources for the Future
1755 Massachusetts Avenue, N.W., Washington, DC 20036

Sierra Club
Information Services, 1050 Mills Tower, San Francisco, CA 94104

Solar Lobby
1001 Connecticut Avenue, S.W., Suite 510, Washington, DC 20036

Your State Energy Office

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U.S. Government Printing Office, Washington, DC 20402

U.S. Department of Energy
Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830

VITA (Volunteers in Technical Assistance)
3706 Rhode Island Avenue, Mount Rainier, MD 20822

Worldwatch Institute
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