DOE/CS/34039--T5

Renewable Energy Activities for General Science

DOE/CS/34039--T5

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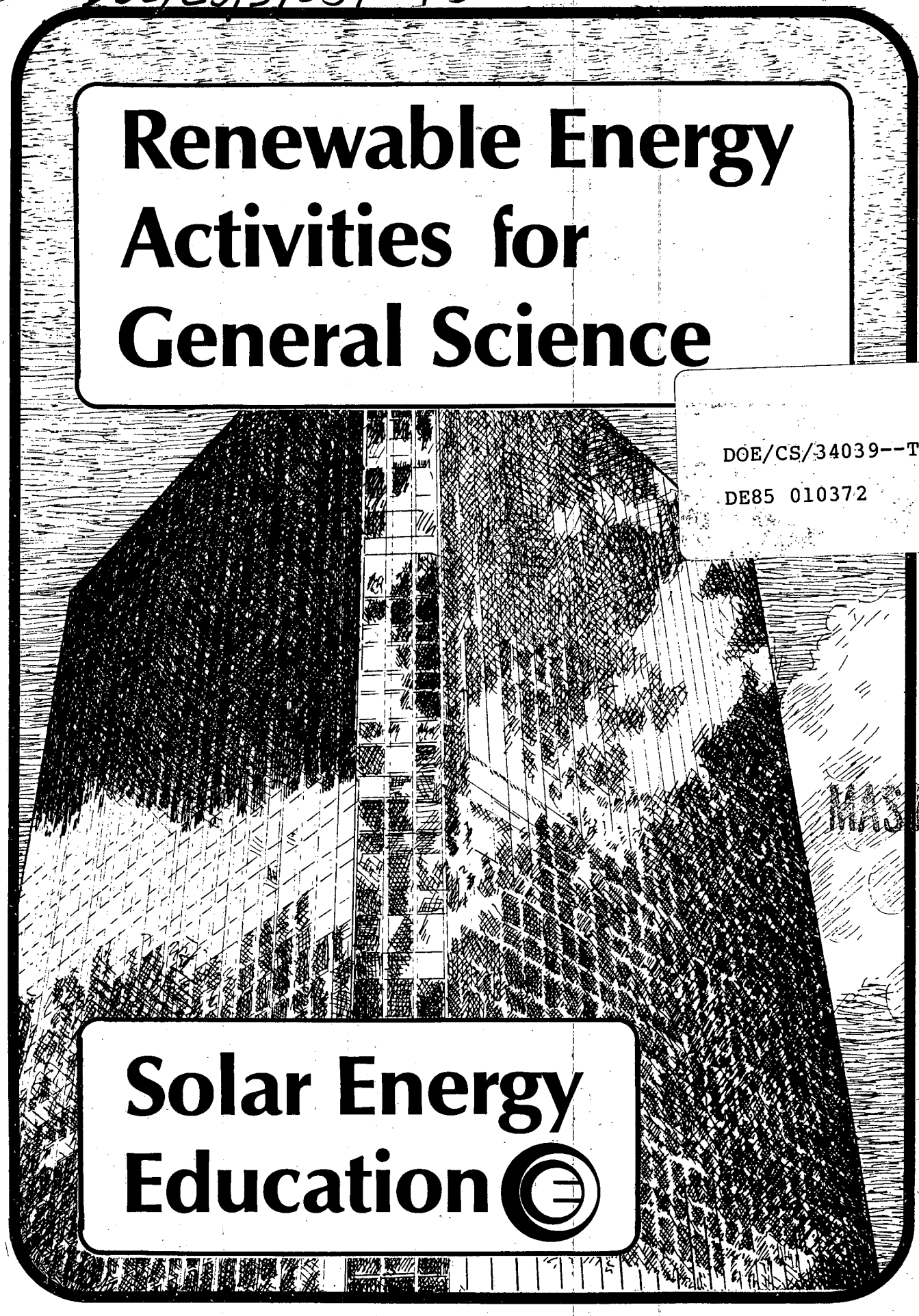

MASTER

Solar Energy Education

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THE SECONDARY SOLAR ENERGY EDUCATION CURRICULUM

was prepared for
The U.S. Department of Energy

under
Contract Number AC01-77CS 34039

by the
Solar Energy Project

in cooperation with the
New York State Education Department and
SUNY Atmospheric Sciences Research Center

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Date: 11/14/2006

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Metric Conversion Table and Energy Units 7

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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. They see that, as available energy resources change, their lives will also change, in ways as yet unknown. 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 observing, estimating and predicting, measuring, computing, graphing, or constructing apparatus, you'll find here a renewable energy activity, ready to use.

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The Activities

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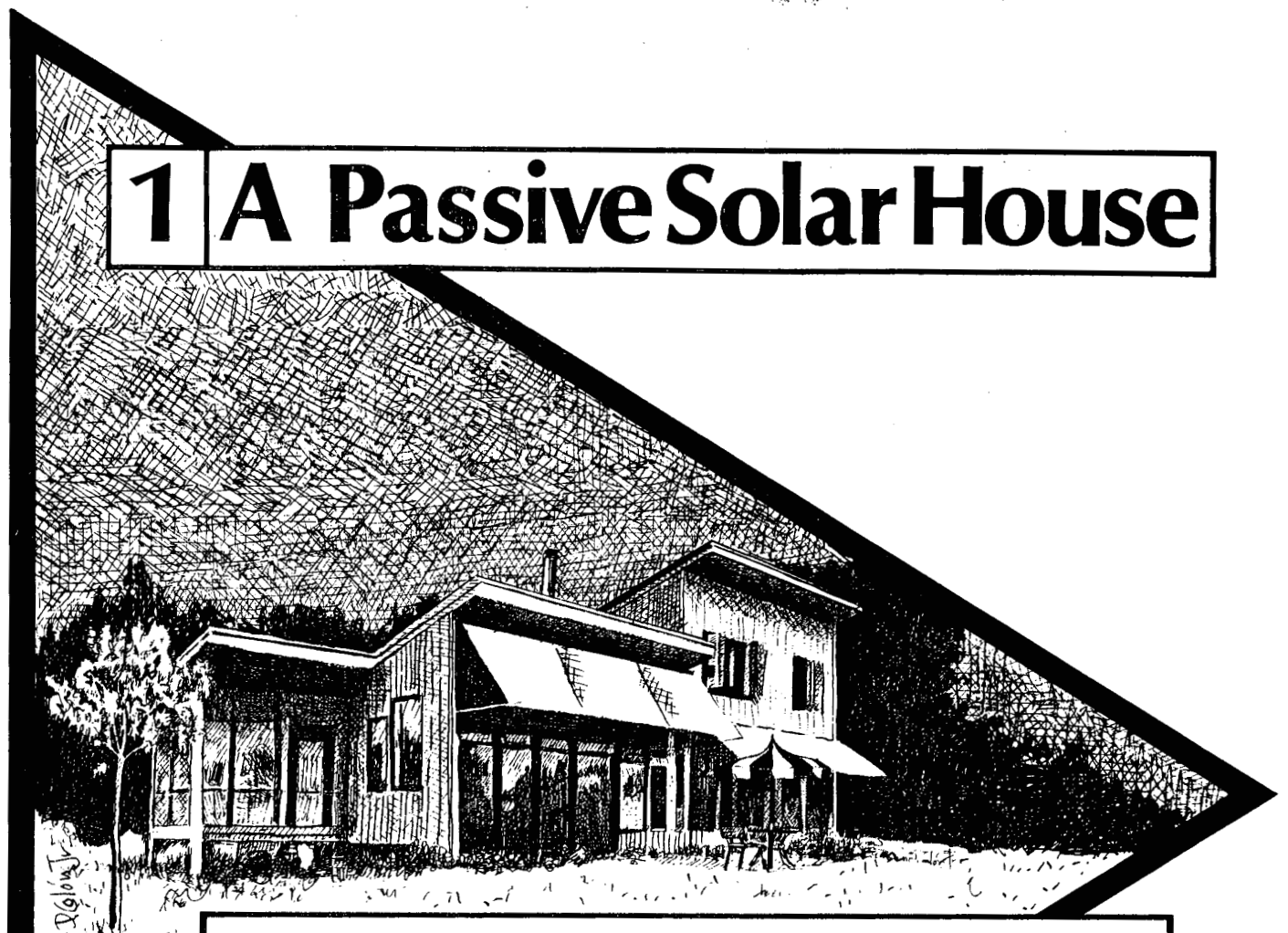
1 A Passive Solar House



Every house collects solar energy. Sunlight falls on the house, passing through windows and skylights and being absorbed by roof and walls. The sun helps to heat the house in cold weather, but it can overheat the house in warm weather.

Some houses are specially designed with the sun in mind. The designer plans the house so that it collects as much sunshine as possible in winter, and as little as possible in summer. Such houses are called passive solar houses, and they can save their owners a lot of expense in heating and air-conditioning.

Based on what you know about the sun and wind, you are going to assemble, locate, and landscape a model passive solar house. To help you get started, think about these questions.

What is the sun's path in the winter? In the summer?

Where does most wind come from in the winter? In the summer?

Where should most of my windows be?

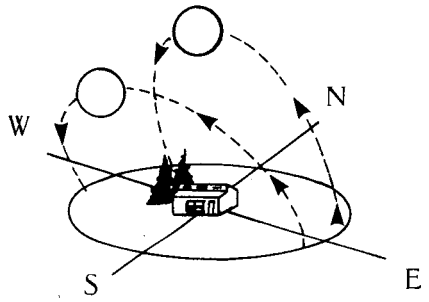
What kinds of trees and shrubs should I have around my house, and where should I place them?

objectives

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

- o recognize the basic features of a passive solar house,
- o use your knowledge of trees and shrubs to landscape your model house for energy conservation, and
- o use your knowledge of the angle of the sun during different seasons to determine how effective your model is as a passive solar house.

skills and knowledge you need



The skills of basic cutting, taping, and diagramming

The knowledge that the sun's rays strike the earth's surface at a lower angle in winter than in summer

The knowledge of the direction of the winter winds and summer breezes in your area

materials

scissors

tape

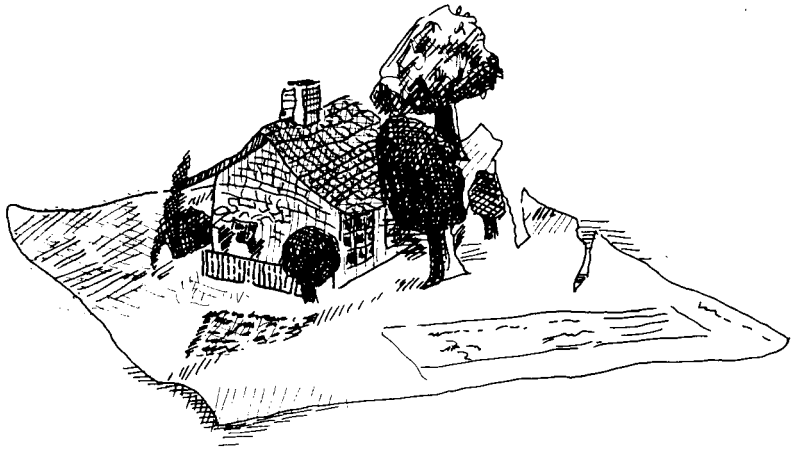
toothpicks

straight edge

Worksheets A, B, and C

a light source (flashlight, lamp)

crayons or markers (optional)



procedure

1. Select one model from the two model house drawings on Worksheet A. Cut out, fold, and assemble (without taping) the model you chose.

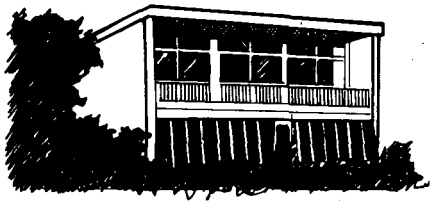
2. Place the folded model house on the plot plan (Worksheet B) and decide on the setting of the dwelling. In which direction will it face? Decide how many windows and doors your house should have and choose their locations based on the setting of the house. Then unfold the model and draw in the windows and doors neatly with a pencil and straight edge. Color the house if you wish.

3. Refold and tape the model together. Then tape the roof in place. Place the completed house on the plot plan.

4. Find out the directions of the winter winds and summer breezes in your area. Draw arrows in the proper corners of your plot plan to indicate these directions. Label each arrow.

5. Draw in fencing (if any), driveway, and sidewalks. Can you place these features to provide protection from winter winds?

6. Cut out the model trees and shrubs (Worksheet C) and use them to trace out as many additional trees and shrubs as you want to use in landscaping. Cut these out and fold their bases. For added strength, tape toothpicks to the backs of the trees. Keep in mind that deciduous trees lose their leaves in fall and that winter winds and summer breezes come mostly from one direction. Plan how you will landscape the plot, then tape the summer deciduous models in place. Tape the models of the winter deciduous trees directly behind the summer models. Tape all other models in place.



7. Find out the noontime angle of the sun in your area for winter and for summer. Set the light source at the noontime angle for the summer sun. Check your house and landscaping for the effectiveness of summer shading. How many windows receive direct summer sunlight? Do your deciduous trees shade the house to help keep it cool? Does your roof overhang provide shading from the summer sun? Does your landscaping channel cooling summer breezes toward your house?

8. Now fold down your summer tree models so that the winter models are visible. Set the light source at the noontime angle for the winter sun. Again check your house and landscaping, this time for the effectiveness of winter solar heating. How many windows receive direct winter sunlight? Do any trees block the sun's rays, preventing them from warming the house? Does the roof overhang allow the winter sunlight to pass through your windows? Do your evergreen trees break and slow those cold winter winds?

questions

1. How does your model house compare to those of other students in placement of windows, size of doors, and roof arrangement?

2. Which model house in Worksheet A is best designed for winter heating and summer cooling? Why?

3. Now that you have completed the activity, how could you improve your model house and landscaping to increase their effectiveness in winter heating and summer cooling?

4. A passive solar house such as you have constructed is considered one way to conserve energy. Why?

5. How should homes be landscaped to conserve energy?

6. In which direction should the roof overhang so that winter sunlight passes through windows and summer sunlight is blocked out?

7. Define the following terms: deciduous tree, evergreen tree, roof overhang, passive solar house.

looking back

You have now planned the design and landscaping of a passive solar house. In doing this you may have discovered that there are many simple things you can do to use the sun's heat in cold weather and still avoid overheating in summer.

Did you consider which way the house should face? How many windows and doors did you plan, and where did you put them? Did you use roof overhangs for summer shade? What about evergreen windbreaks and deciduous shade trees? A passive solar house uses all these features to save energy by natural heating and cooling.

going further

Make the improvements to the model house that you suggested in your response to Question 3.

Add a sunspace or solar greenhouse to your model house. Indicate an earth berm on the proper side(s).

Obtain additional copies of Worksheets A, B, and C. Redesign and landscape the same house for an active solar energy heating or hot water system. Draw flat plate solar collectors on the south-facing roof. Determine the best roof pitch for the collectors and redraw the sidewalls to obtain this pitch.

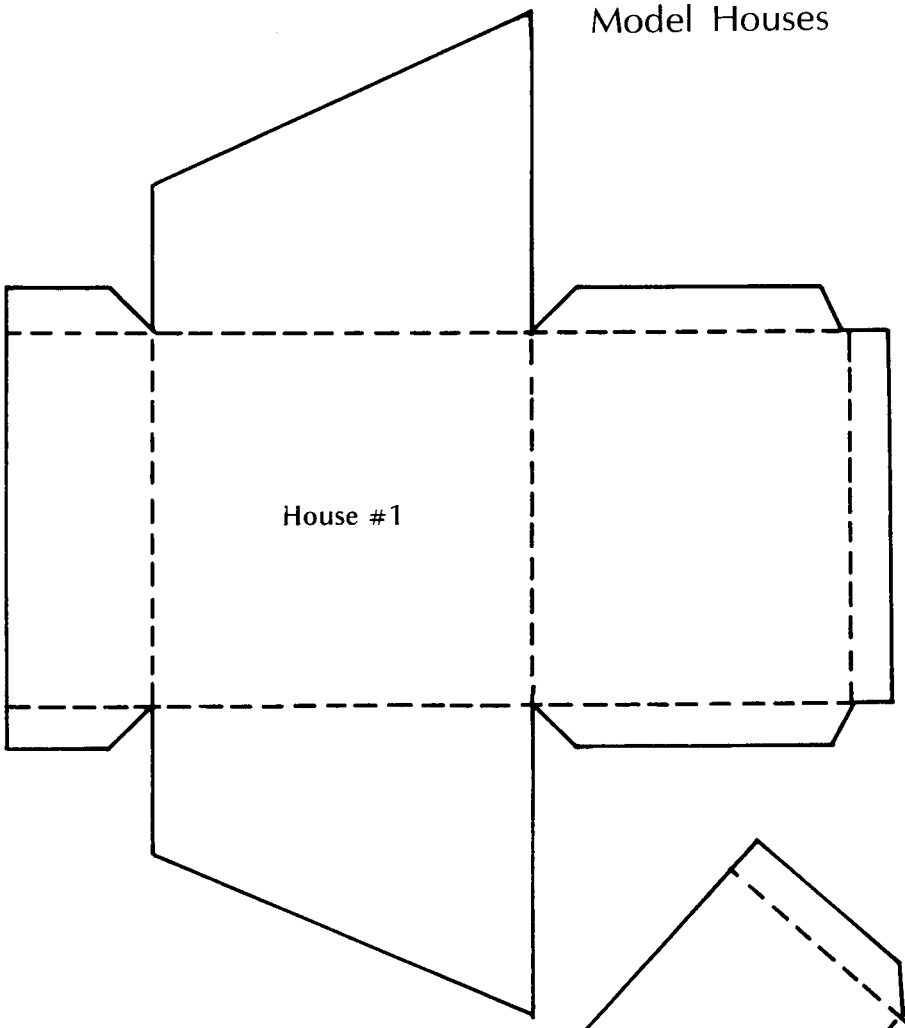
Obtain additional copies of Worksheets A, B, and C. Redesign the same house to include a cooling system, such as an evaporative cooling system. What factors will have to be considered for such a system?

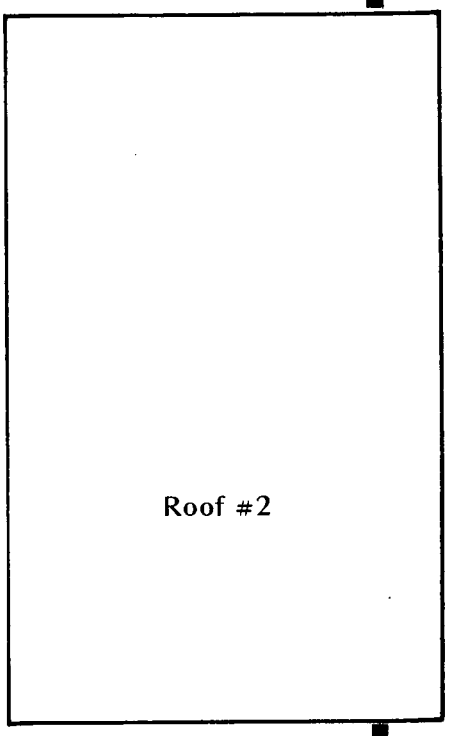
Construct a passive solar model home of your own design from other materials, such as wood or plaster of paris.

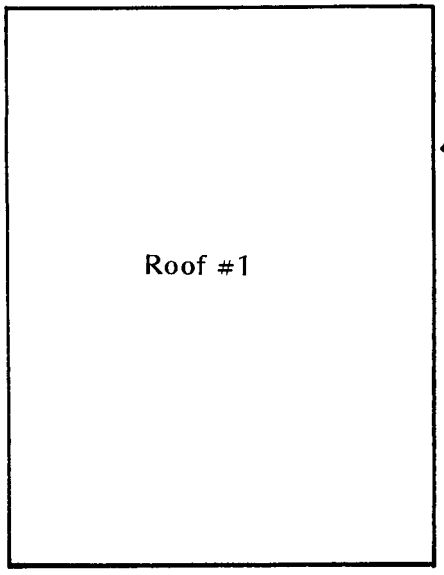
Windows permit passive solar heating due to the greenhouse effect. Explore this principle further by completing Activity 2 in the Earth Science Activities book.

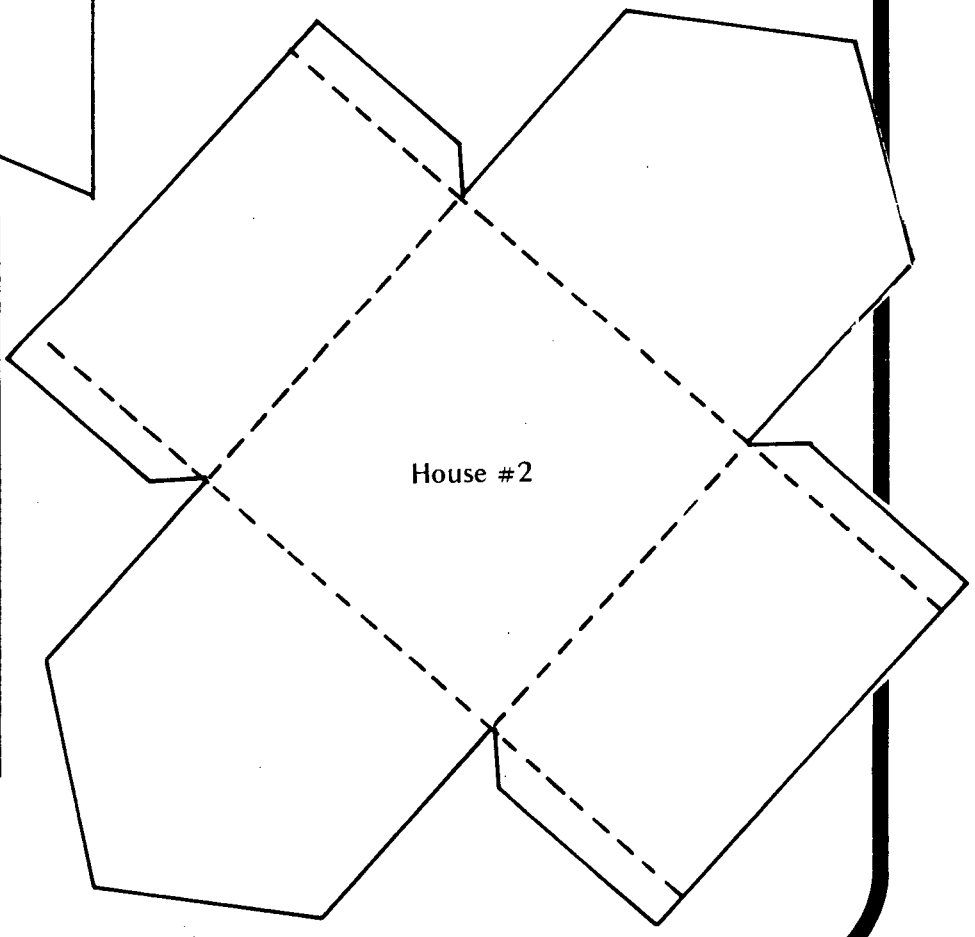
Worksheet A

Model Houses









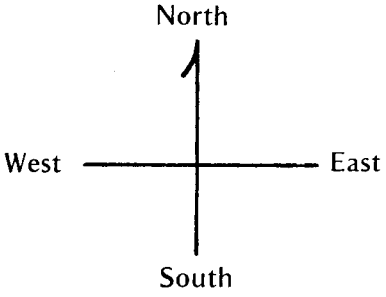
Worksheet B
Plot Plan

Key:

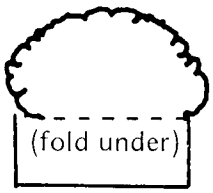
Fence (indicate height)

Driveway

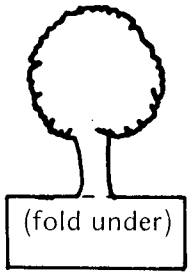
Sidewalk



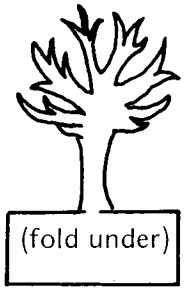
Worksheet C
Model Trees and Shrubs



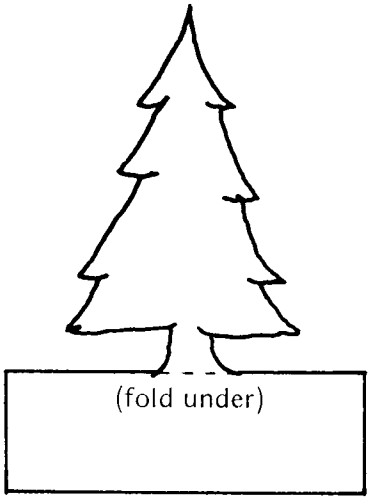
Shrub



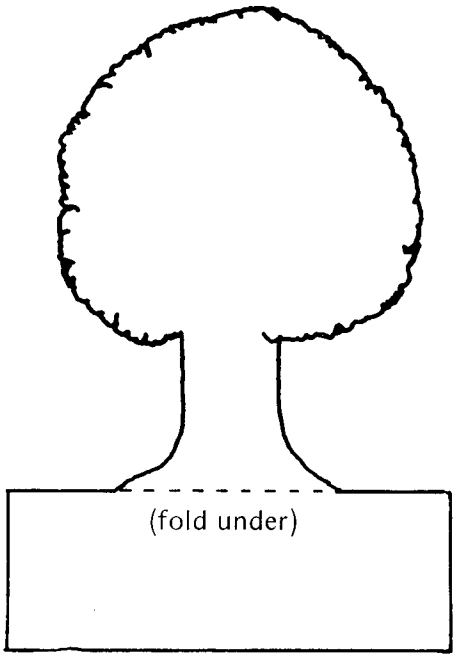
Small Deciduous Tree, Summer



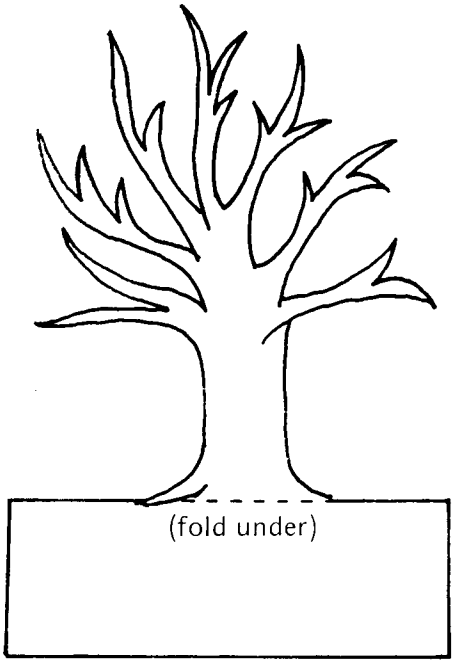
Small Deciduous Tree, Winter



Evergreen



Large Deciduous Tree, Summer



Large Deciduous Tree, Winter

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Teacher Information

A Passive Solar House

Suggested Grade Level and Discipline

Science, grades 7-9
Home Economics
Consumer Education
Art

Skill Objectives

Applying principles of passive solar construction to the structural design and landscaping of buildings

Major Understandings

Buildings may be designed and landscaped, through proper placement of windows, doors, and vegetation, to maximize the greenhouse effect.

A roof overhang should block the more intense solar rays of summer, but should allow winter sunlight to enter windows.

Deciduous trees will provide a building with shading from the intense solar rays of summer but allow those rays to strike the building during fall and winter.

Coniferous trees serve as excellent windbreaks and can be located to reduce infiltration heat losses from a building during winter. Vegetation can also be located to channel summer breezes toward the building.

Background

Homes can be heated by the sun in winter and protected from the sun's heat in summer. If this is done without mechanical equipment, then the house has a passive solar system. But if heat is transferred by pumps and fans, which require an outside source of energy, then the house has an active system. In a passive solar system, heat flows by natural means such as convection, conduction, and radiation.

Passive solar design is really very simple, and can be incorporated easily into a new or existing home. Basically, a passive solar home collects heat in winter through south-facing glass (glazing) and stores the excess in a thermal mass, from which it is distributed slowly when indoor temperatures drop at night or on cloudy days. A passive house will have more windows on the south side and fewer (or none) on the north side. Windows can be double-glazed on the south side and even triple-glazed on the other sides. In winter, all windows should be covered at night with insulating interior treatments to keep heat loss at a minimum. The house should be well insulated and weather-stripped to avoid infiltration and conduction heat losses as much as possible. To provide protection from the heat of the summer sun, a passive solar home should have overhangs to shade windows on the south and west sides. Exterior window treatments should be used to prevent sunlight or heat from entering. Vents and windows should be placed to increase natural ventilation or to exhaust excess heat from the house.

In addition, a passive solar house must be sited properly on its lot. The position of the sun at different seasons of the year can be charted to determine which portion of the site receives the most sun between 9:00 A.M. and 3:00 P.M. Hills, large trees, and other buildings should not obstruct the sun during the heating season.

Proper landscaping of the home contributes to energy conservation. Deciduous trees should be planted on the south and west sides of the house. Their leaves will shade the house in summer; but in autumn, when the leaves fall, the sun's rays will strike the house. Coniferous trees should be planted on the windward side of the building. They provide a windbreak for the prevailing winds. Wind reduction will cut infiltration heat losses. Other vegetation should be planted to channel cooling summer breezes toward the building.

Advance Planning

Determine the direction of the prevailing winds for your area.

Find the sun angles for winter and summer for your latitude. Solar books, solar contractors and dealers, and your local weather station are all sources.

Worksheets A, B, and C can be reproduced by various copying machines on heavy weight paper.

Suggested Time Allotment

Two class periods for model construction

One class period for class discussion

Suggested Approach

Have the students work individually or in pairs. They should compare results after completing their designs.

Leaving some of the work on display will encourage further discussion and investigation.

An alternative would be to assign the activity for homework and to follow up with a full period of display and discussion directed by the teacher.

You might follow up this activity with a field trip to a local passive solar home.

Points for Discussion

What factors would you consider in designing and building a passive solar home?

How might you modify an existing home in order to increase its passive solar heating or cooling effects?

What facts could you present to a homeowner in order to convince him that proper landscaping can promote energy conservation?

Typical Results

Well-designed model homes should have most windows on the south side, a roof overhang on the south, a coniferous windbreak in the direction of the winter winds, and deciduous trees to the south.

Evaluation

Construction of the dwellings and various landscapes will vary a great deal in quality. This should not receive much emphasis as it is not directly related to the objectives.

Inspect each passive home design and discuss its features with its designer.

Ask students to evaluate a model house and site drawing in terms of passive solar design.

Modifications

Model house drawings can be traced onto tagboard, then cut out. This will provide sturdier models. You might want to provide larger scale cut-outs for students to trace, as they might find it easier to work with larger models.

Modify the activity for higher ability students by encouraging precise measurement of sun angle, roof pitch, and overhang length.

Students can research thermal storage units and then build them into their model homes. Suggestions include thermal storage walls, roof ponds, storage tanks, and Trombe walls.

References

Landscape Design That Saves Energy, Anne Simon Moffat and Marc Schiler.
(William Morrow and Co., Inc., Wilmor Warehouse, 6 Henderson Dr., West Caldwell, NJ 07006, 1981, $17.95.)

Natural Solar Architecture: A Passive Approach, David Wright.
(Van Nostrand Reinhold Co., Lepi Order Processing, 7625 Empire Dr., Florence, KY 41042, 1978, $8.95/paper.)

1979 NYSERDA Passive Solar Design Awards, NYS Energy Research and Development Authority.
(Technology Transfer, Rockefeller Plaza, Albany, NY 12223, 1980, $7.00/paper.)

The Passive Solar Energy Book, Edward Mazria.
(Rodale Press, Inc., 33 E. Minor St., Emmaus, PA 18049, 1979, $12.95/paper.)

Solar Site Planning: A Guide to Residential Landscaping for Energy Efficiency, David Marlatt et al.
(Southern Solar Energy Center, 61 Perimeter Park, Atlanta, GA 30341, contact SSEC for price.)

Southern Solar Homes: A Planbook of Energy Efficient Designs for the Southern U.S.
(Southern Solar Energy Center, 61 Perimeter Park, Atlanta, GA 30341, 1980, contact SSEC for price.)

"Passive Solar Heating," Solar Factsheet 121.
(Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS), P.O. Box 8900, Silver Spring, MD 20907, 1980, single copies free.)

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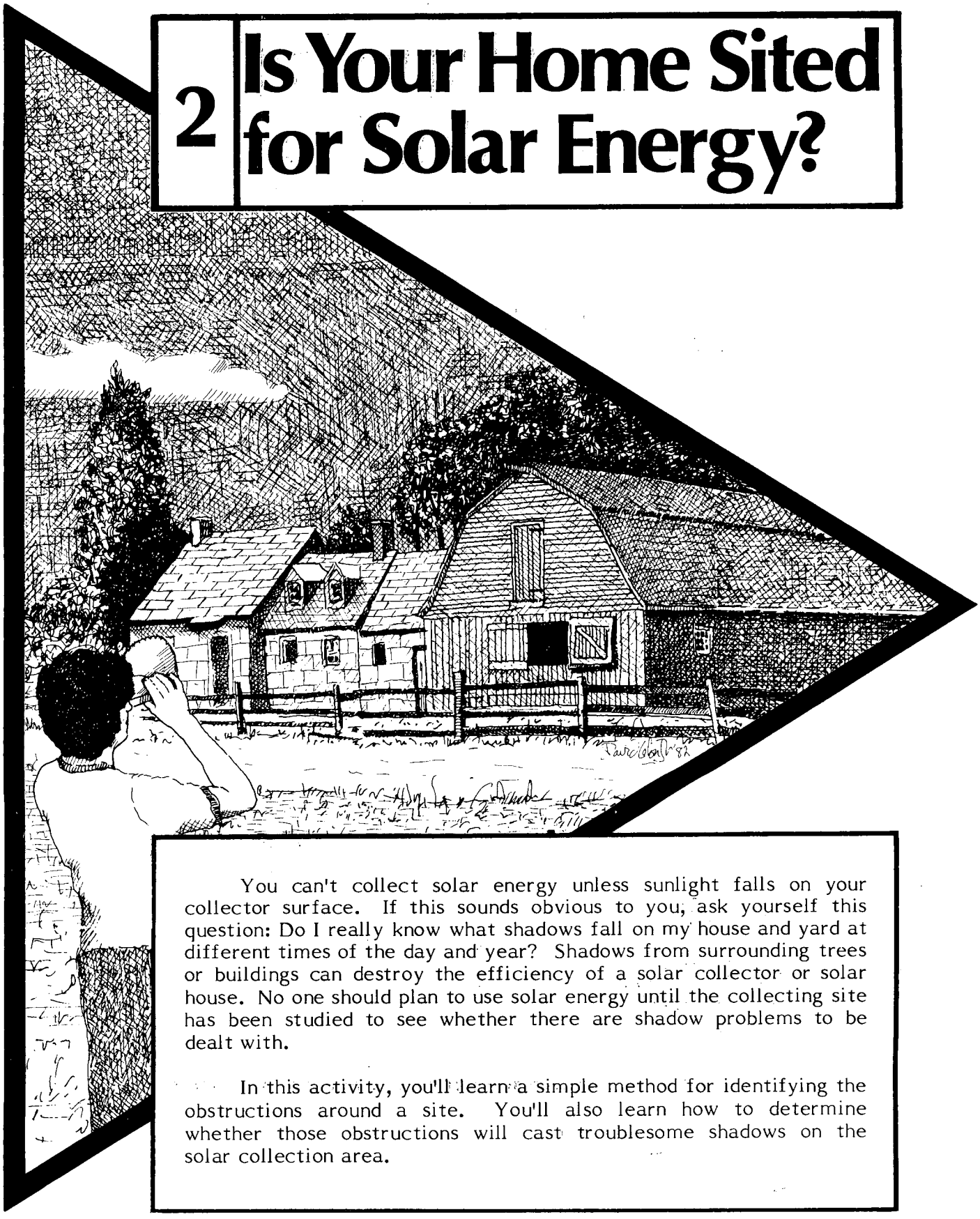
2 Is Your Home Sited for Solar Energy?



You can't collect solar energy unless sunlight falls on your collector surface. If this sounds obvious to you, ask yourself this question: Do I really know what shadows fall on my house and yard at different times of the day and year? Shadows from surrounding trees or buildings can destroy the efficiency of a solar collector or solar house. No one should plan to use solar energy until the collecting site has been studied to see whether there are shadow problems to be dealt with.

In this activity, you'll learn a simple method for identifying the obstructions around a site. You'll also learn how to determine whether those obstructions will cast troublesome shadows on the solar collection area.

objectives

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

- o construct a device to locate the winter path of the sun in the sky,
- o explain how the device functions,
- o use the device to discover obstructions that will shade a house or site, and
- o evaluate whether a house or site is properly located for collection of solar energy.

skills and knowledge you need

The ability to use a magnetic compass

The ability to draw simple outlines

The knowledge of your latitude

The knowledge of the seasons of the year when different kinds of solar collectors are used

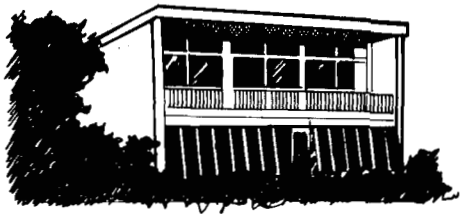
materials

thin cardboard

glue

tape

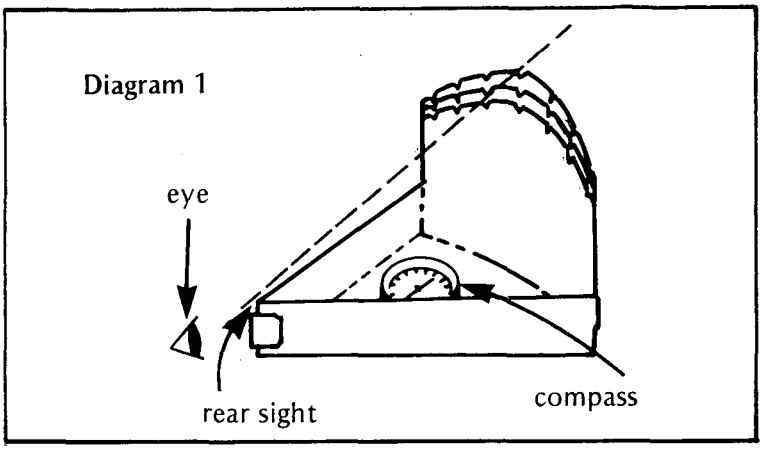
a small magnetic compass



procedure

1. Glue the sun locator (Worksheet A) onto a thin sheet of cardboard.

2. After the glue has dried, cut out the two sections of the sun locator along the solid lines.



3. Cut the top section of the sun locator along the line which most closely represents your latitude.

4. Assemble the sun locator as shown in Diagram 1. Bend the edges of the bottom section upward along the dotted lines. Bend all tabs upward or over along the dotted lines.

5. Fit the top section along the curved edge of the bottom section. Tape all tabs in place.

6. Center the compass on the mark on the base of your sun locator. Use the following chart to decide which area of the country you live in, then choose the correct direction line. Align the compass needle with the correct direction line by turning the sun locator.

Area of United States	Direction Line
New England	15° West
Mid-Atlantic States Midwest South, including eastern Texas	True North
Northwest (100th meridian Southwest and West)	15°East

7. Take your sun locator to the site you want to evaluate for solar collection. This may be a window, the side of a building, a potential house site, or a solar collector site. Stand as close as is safely possible to the surface that would be collecting the solar energy.

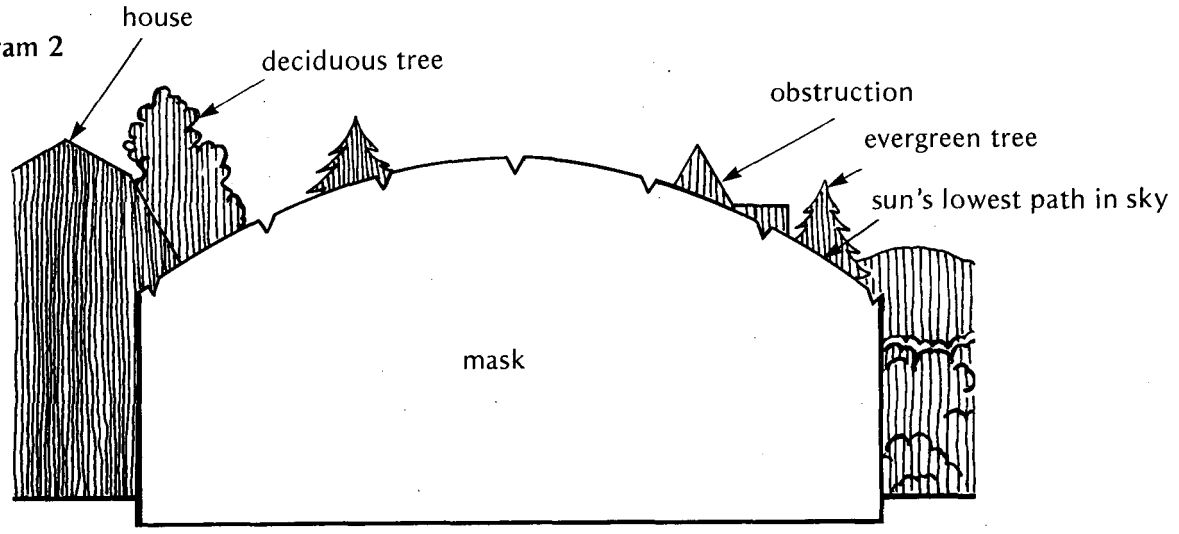
Caution: Be sure to obtain the landowner's permission to use a site on private land.

8. Hold the locator level. Realign the compass with the correct direction line.

9. Your sun locator is now aimed toward true south. Keeping the locator level and aligned in this direction, lift it to your eye so that you are looking through the rear sight.

Caution: Never use your sun locator to look directly at the sun. Permanent eye damage can result.

Diagram 2



10. The curved top of the sun locator represents the sun's lowest path in the sky in your area (winter, December 22nd). The sun will never drop lower in the sky than this line, so objects masked by your locator will never shade your site.

11. However, objects in front of you which appear above the curved top will create shading problems at your site. Starting at 9:00 A.M. on your locator, observe the objects that will shade your site during winter. On Worksheet B, sketch these objects in their correct positions and proportions. Continue sketching until you reach 3:00 P.M. Your sketch may look something like Diagram 2.

12. Repeat steps 7-11 for two other potential solar sites.

questions

1. How does the sun locator work?

2. Which of your three potential sites had the most shading problems? Why?

3. Are shading problems that occur at 9:00 A.M. or 3:00 P.M. as serious as those that occur at noon? Why or why not?

4. Which site or sites would you recommend for the installation of solar energy devices? Why?

5. The sun's highest path in the sky (summer, June 22nd) is 47° higher than its lowest path. For each site you sketched, what shading would occur in summer?

6. What kinds of solar devices would you operate all year? Only in winter? Only in summer? For which would winter shading be a problem? Summer shading? Are there times when summer shading is an advantage? Explain.

7. Which of the sites you evaluated would be best for year-round operation of solar devices? For summer operation? For winter operation? Why?

looking back

The sun locator is a simple device for identifying the sun's lowest path through the sky during the year. Using it you are able to see whether the objects around a site shadow that site from the sun during December. The hours from 9:00 A.M. to 3:00 P.M. are the most important time for solar collection. If you have a site that is generally unshadowed from 9:00 A.M. to 3:00 P.M. you have a good solar site.

going further

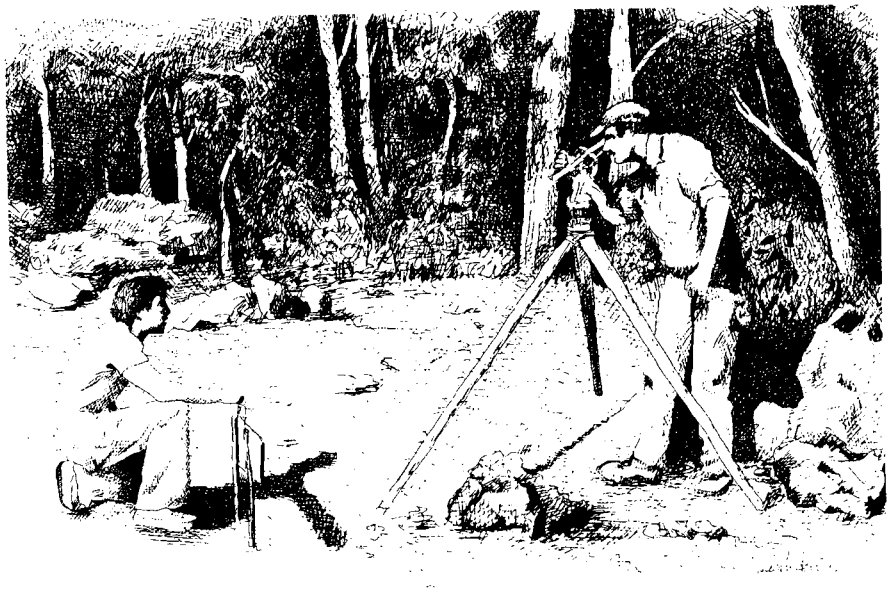
If you haven't already done so, try Activity 1 in this book, "A Passive Solar House." This activity will give you additional information on siting a solar house.

The magnetic declination corrections for your sun locator were very general (but will not usually affect solar system performance as long as the system is still located within 15° of true south). To obtain a more accurate declination correction, consult an isogonic chart (available from a surveyor or the U.S. Department of Commerce). Repeat the activity using this new correction, and compare the results to those of the original activity. Were there significant differences?

The sun locator design was obtained by charting the altitude and azimuth of the sun on December 22nd at different latitudes. Investigate "solar altitude" and "solar azimuth" and find out how they are used to develop "sun charts." Learn how to read a sun chart. Use a compass and transit to plot on a sun chart for your latitude the obstructions at one of your sites. How does the sun chart compare to your original sketch?

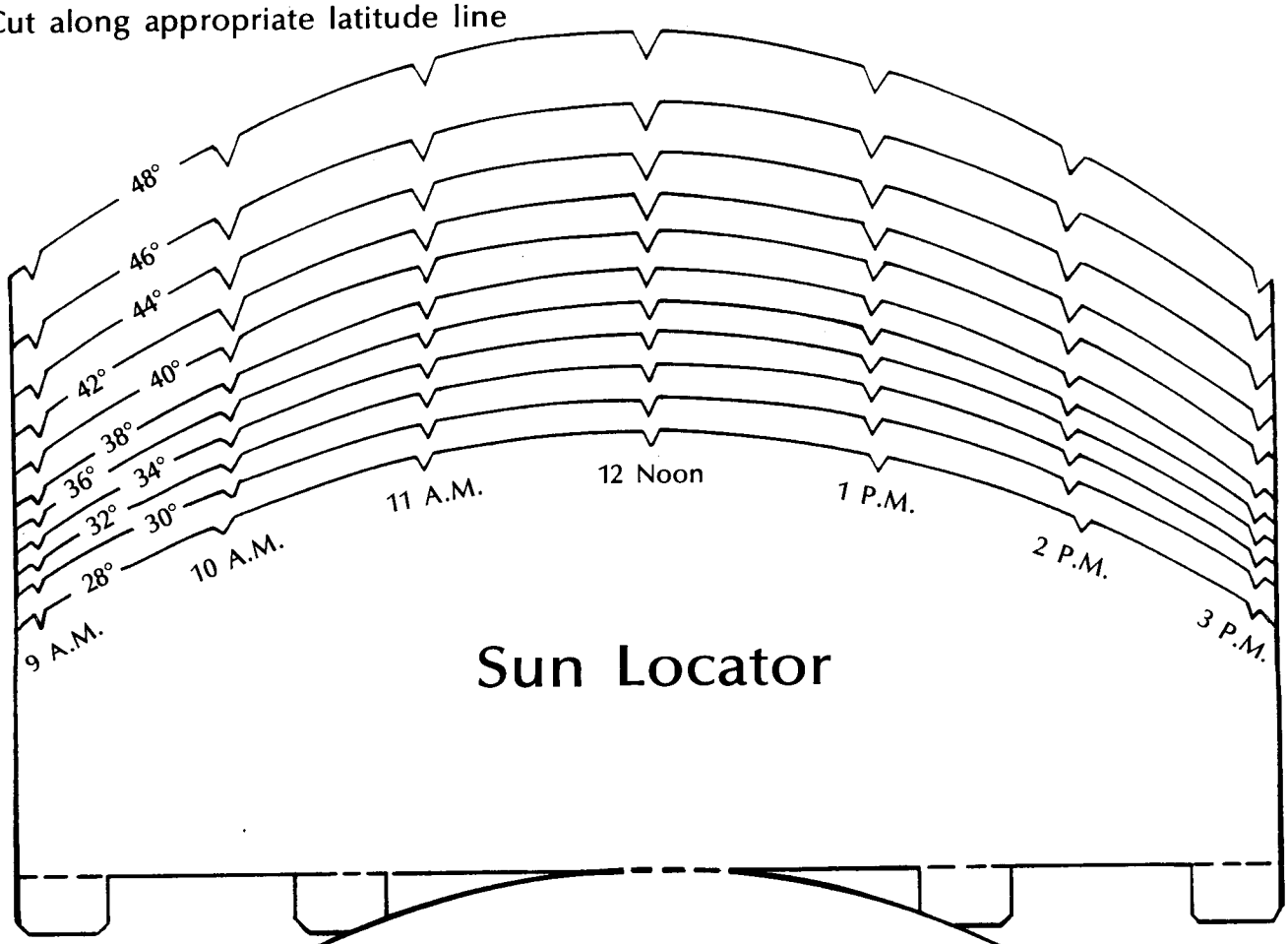
Investigate what is meant by the term "solar window" as it applies to a solar site.

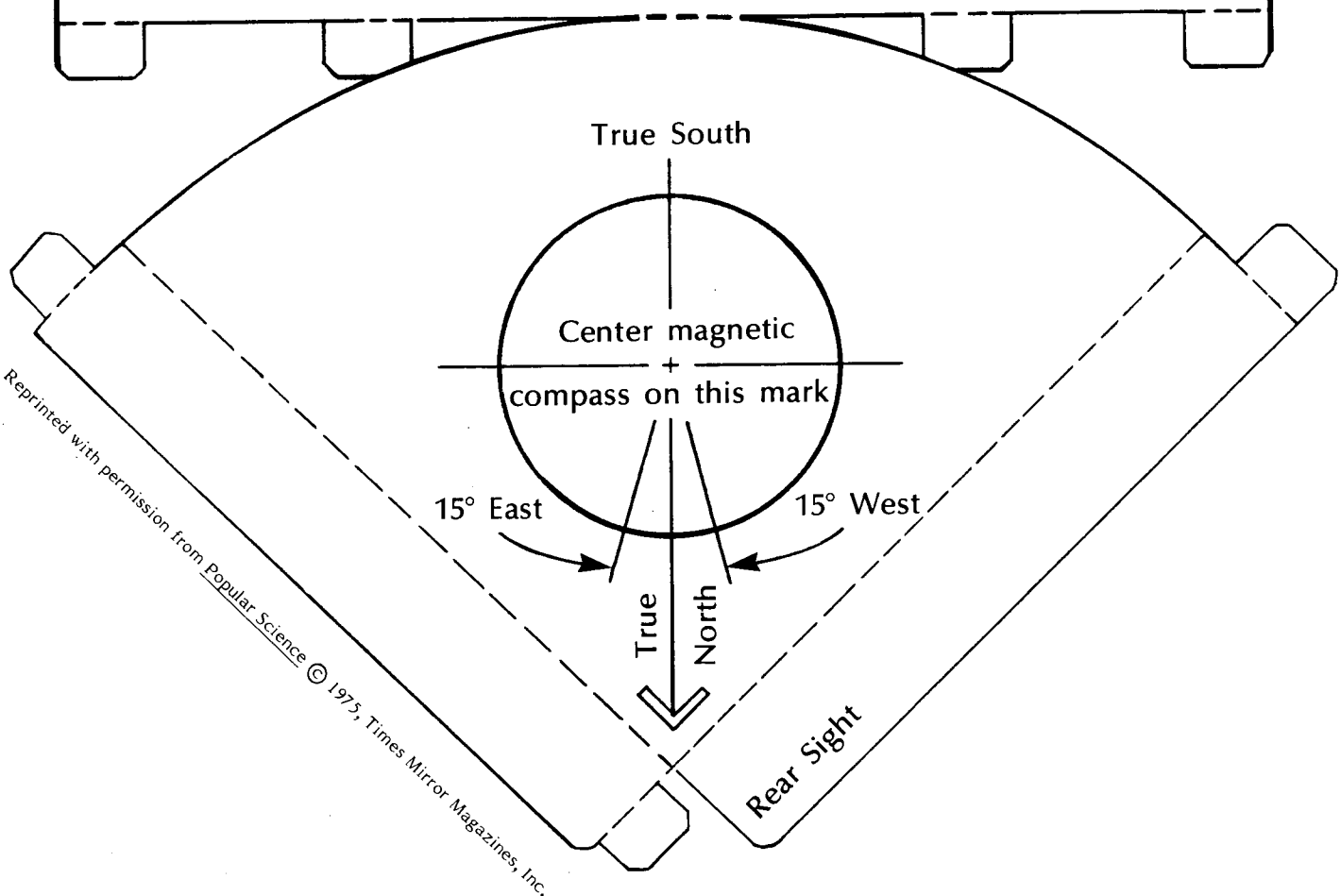
Invite a solar architect or builder to speak to your class about the problems involved in siting a solar home correctly.



Worksheet A

Cut along appropriate latitude line





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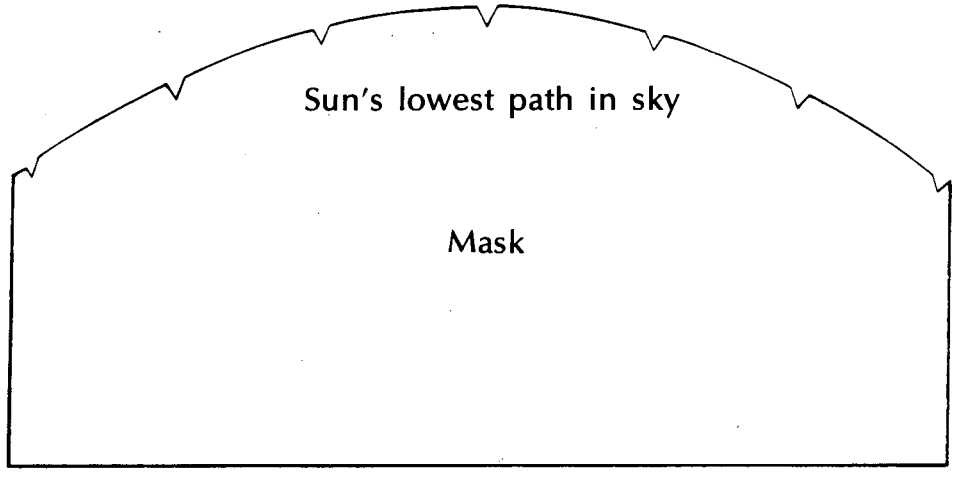
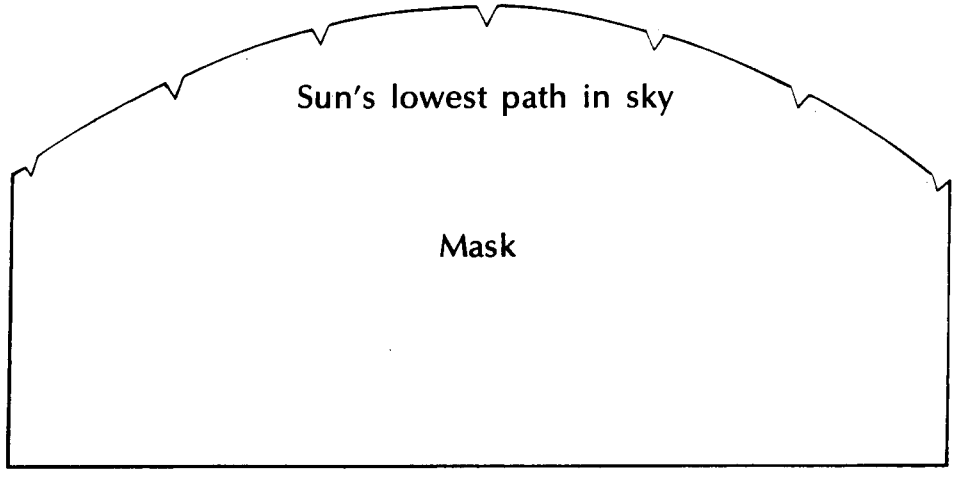
Worksheet B

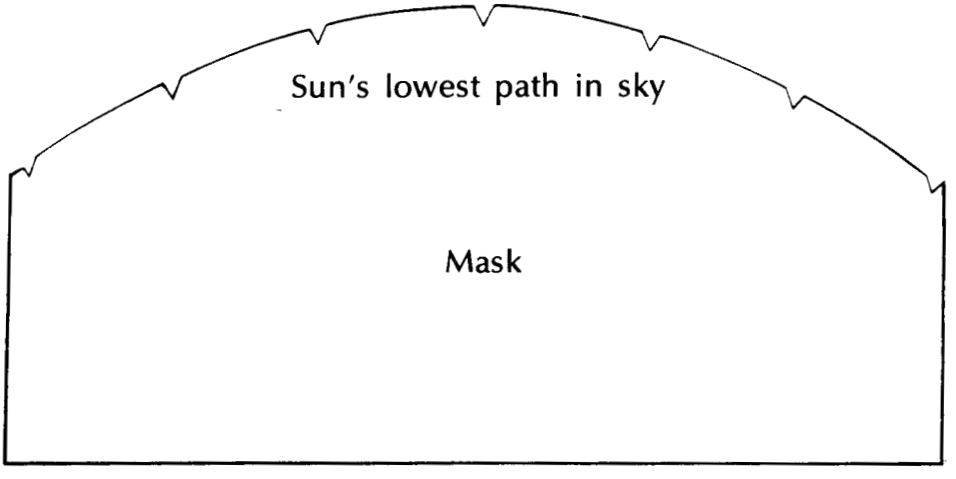
Latitude = _____ °



Latitude = _____ °



Latitude = _____ °



Teacher Information

Is Your Home Sited for Solar Energy?

Suggested Grade Level and Discipline

Science, grades 6-9
Earth Science
Physical Science
Industrial Arts
Home Economics

Skill Objectives

Constructing a device to locate the sun's winter path in the sky

Using a magnetic compass

Using the sun locator to determine solar shading problems

Sketching observations

Assessing the potential of a site for solar energy collection

Major Understandings

The sun locator is a simple device which projects onto the skyline the path of the sun at the winter solstice.

This device can be used to assess a site for solar energy collection. Objects which are masked by the locator will not shade the site. Objects which appear above the mask will cast shadows on the site at particular times of day in winter.

Summer shading of a site will occur through an arc 47° higher than the position of the winter sun at noon.

A sketch drawn from observations made with the locator can be used to pinpoint objects obstructing the sun and the length of time they will obstruct the sun.

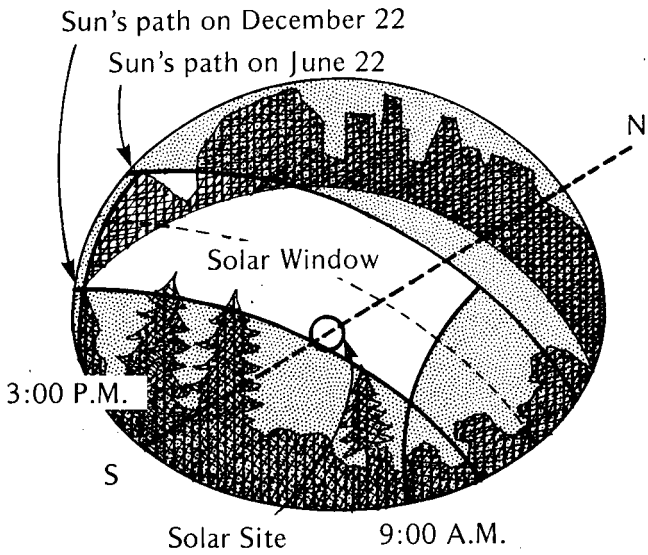
Different sites have different potential for use of solar energy collection devices. Some sites will be better for some uses than for others.

Background

Solar collectors cannot collect the sun's energy unless the sun shines on them. This may seem an obvious point, but it is one that can be overlooked when a site for a solar system is being chosen. The altitude of the sun is the angle between the position of the sun in the sky and a point directly below on the horizon. This altitude varies by 47° during the course of a year, and unless solar system owners can observe the altitude of the sun on December 22nd at their sites, they may be unaware of potential shading problems.

The sun's greatest heating effect occurs between the hours of 9:00 A.M. and 3:00 P.M. Standard Time. No more than 5% of solar collector area should be shaded during this time. There are many obstructions which may shade collectors: hills, other buildings, fences, chimneys, dormers, evergreen trees, and deciduous trees (remember these lose their leaves in winter but large limbs may still cause significant shading). Use of the sun locator allows you to accurately plot the times of day that direct sun is blocked by these kinds of obstructions.

If you imagine the sky as a transparent dome whose center is your site, you can project the sun's path during the year onto this dome. The area enclosed by the sun's position at 9:00 A.M. and 3:00 P.M. throughout the year, and its path on June 22nd and December 22nd comprise the "solar window" for your site. All direct radiation must come through this window. Any obstructions projected onto the dome in "front" of this window will block sunlight and shade your site. The sun locator gives the winter edge of this solar window and allows one to see obstructions projecting into it.



There are many kinds of solar collectors, each designed for different purposes: domestic hot water systems, active space heating systems, swimming pool heaters, windowbox units, breadbox collectors, even whole houses used as passive solar collectors. Each collector will be located in a different place on a site and may require solar radiation at a different time during the year, depending on purpose and latitude. In northern climates, for example, a swimming pool heater is operated only during the summer months. It will need access to sunlight only through the upper portion of the solar window and, as a result, may often be placed lower to the ground.

Advance Planning

Duplicate sufficient quantities of Worksheets A and B. If desired, duplicate the teacher background section for student use.

Inexpensive (and small) magnetic compasses are available from many science supply companies. You may also be able to borrow them from middle school science teachers.

Obtain thin sheets of cardboard. Boxes of paper often have cardboard filler. Oak tag will also work well.

Determine the latitude of your location.

Select a practice solar site where students can learn how to use their locators.

Suggested Time Allotment

1 class period to construct the locator

1 class period (or an overnight homework assignment) to perform the activity

1 class period to answer questions and compare and discuss results

Suggested Approach

Introduce the activity by explaining the importance of siting solar houses and solar collectors so that they are not shaded, especially during the winter, when the sun is at its lowest position in the sky. Discuss the concept of a "solar window" and the need to keep this window free of obstructions.

Select a site in or near the school where students can practice using their locators and seek teacher help if necessary. A south-facing classroom window makes a good site.

Ask students to assess the potential of their own homes, or one of their favorite places, for solar collection. This may be assigned as homework.

Explain why there are magnetic declination correction lines on the sun locator.

If necessary, explain which kinds of collectors are used at different times during the year, or help students to answer Question 6.

After students have performed the activity and answered the questions, discuss the possibility of using different portions of the "solar window" for different kinds of collectors. Discuss when shading may be an advantage (as when a passive solar house is shaded from summer sun by a deciduous tree).

Precautions

Remind students that they should never look directly at the sun.

If students are working on this activity on the school grounds, make sure they are closely supervised.

Remind students to ask permission to evaluate a site on private property.

Caution students that they should not attempt to simulate the exact location of a potential solar collector, for example, on a roof top.

Points for Discussion

Why did you line up the compass needle with one of the three north positions?

Why do you think your locator is designed to collect information from 9:00 A.M. to 3:00 P.M. only?

Should you automatically cut down a deciduous tree blocking your site? Why or why not?

If a site is a poor location for using solar energy devices, can it be improved? How? What effect would the improvements have on other aspects of the site?

Should summer shading obstructions always be removed? Why or why not?

Typical Results

Results will be highly variable, depending on the sites students select for evaluation. In general, open sites will have few shading problems, while sites with trees and closely-spaced houses and buildings will produce obstructions.

Evaluation

Check students' sketches and answers to questions to make sure they understood the concepts introduced by the activity.

Ask students to explain how a sun locator works.

Show students a sketch from an unfamiliar site and ask them to evaluate the site for shading problems and solar collection potential.

Modifications

Convert the sun locator into a "solar window" locator. On paper, draw a locator with the sun's lowest path and highest path traced out, then make a transparency of the top section and attach the transparency to the paper bottom section. Your locator will show the solar window at your site.

References

Installation Guidelines for Solar DHW Systems in One- and Two-Family Dwellings, Second Edition, U.S. Department of Housing and Urban Development.
(Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, 1980, contact GPO for price.)

The Passive Solar Energy Book, Edward Mazria.
(Rodale Press, Inc., 33 E. Minor St., Emmaus, PA 18049, 1979, $12.95/paper.)

"Build a Low-Cost Shade Plotter," John Free.
(Popular Science, Boulder, CO 80302, February 1982.)

"How to Trap Solar Heat with Your Windows," Edward Allen.
(Popular Science, Boulder, CO 80302, February 1975.)

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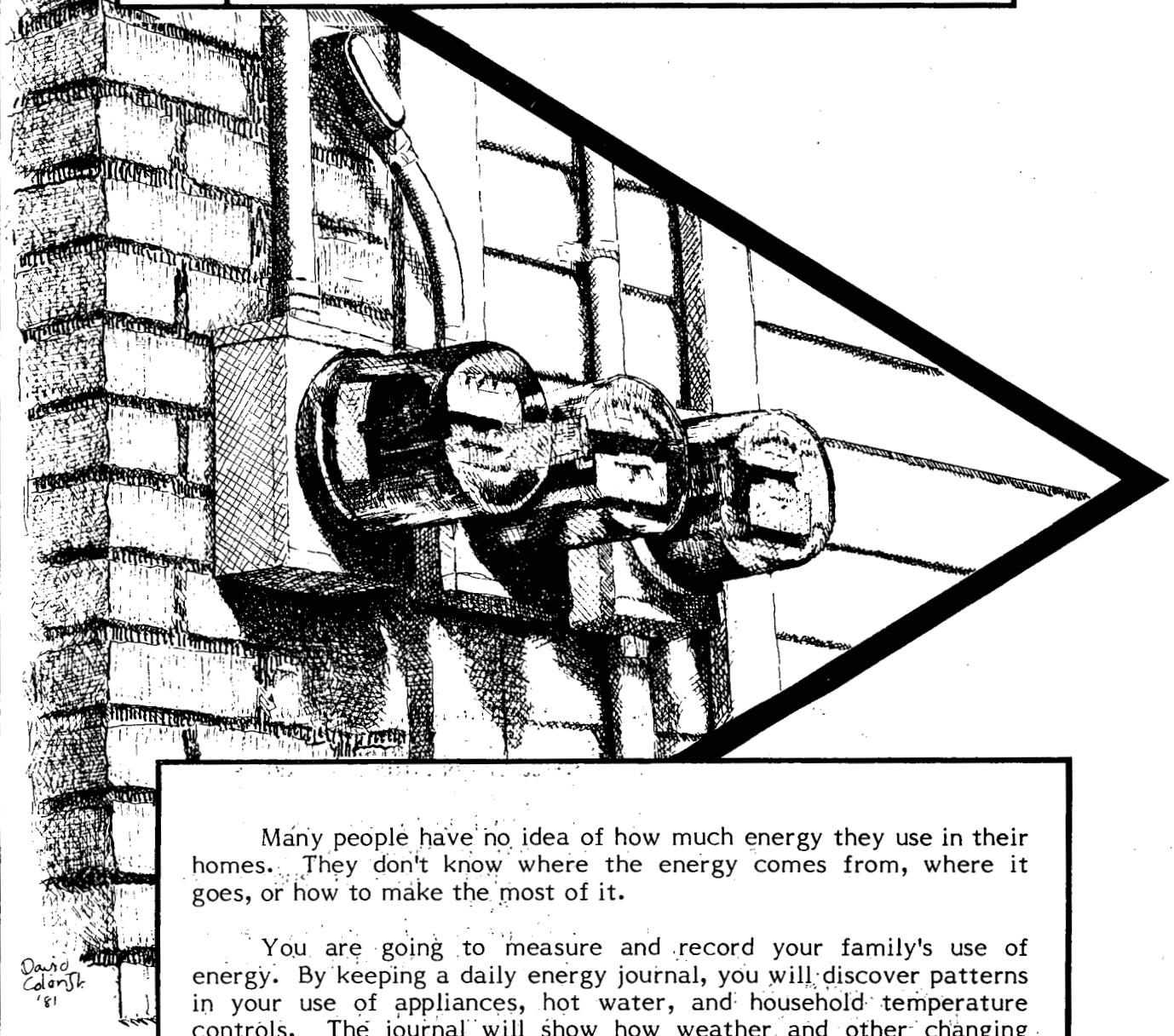
3 Home Energy Use



Many people have no idea of how much energy they use in their homes. They don't know where the energy comes from, where it goes, or how to make the most of it.

You are going to measure and record your family's use of energy. By keeping a daily energy journal, you will discover patterns in your use of appliances, hot water, and household temperature controls. The journal will show how weather and other changing factors affect those patterns. You'll also take weekly readings on household fuel consumption. Your data will tell you when the energy is being used, and how.

With this collection of data in hand, you'll then be ready to ask the questions: What is my family doing to save energy and money? and: What else can we do to save more?

objectives

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

- o recognize the sources of the energy used in your home and the units in which fuels are measured,
- o read electric and/or gas utility meters,
- o determine how much energy your family uses in a one month period, and
- o identify factors which affect the rate of your home's energy use.

skills and knowledge you need

Using basic arithmetic skills

Organizing information and graphing data

Keeping a daily journal

materials

a notebook

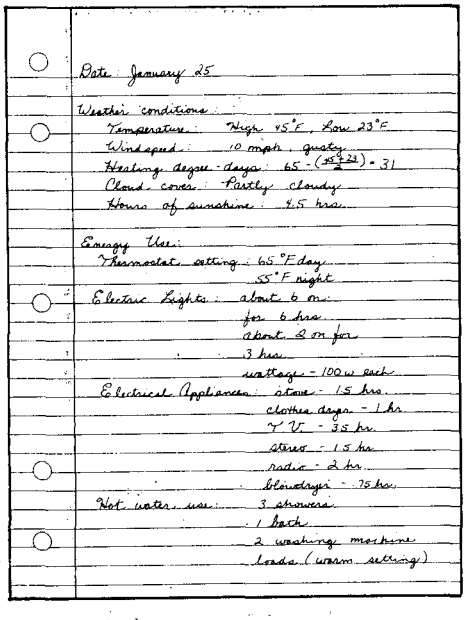
access to utility meters in your home or apartment

daily newspapers, a television, or a radio to obtain weather reports

a calculator (optional)

procedure

Sample Journal Page


Date: January 25

Weather conditions:
Temperature: High 45°F, Low 23°F
Windspeed: 10 mph, gusty
Heating degree-days: 65 - (45+23)/2 = 31
Cloud cover: Partly cloudy
Hours of sunshine: 4.5 hrs.

Energy Use:
Thermostat setting: 65°F day
55°F night
Electric Lights: about 6 on
for 6 hrs.
about 2 on for
3 hrs.
wattage - 100w each
Electrical Appliances: stove - 1.5 hrs.
clothes dryer - 1 hr.
TV - 3.5 hr.
stereo - 1.5 hr.
radio - 2 hr.
blowdryer - 75 hr.
Hot water use: 3 showers
1 bath
2 washing machine
loads (warm setting)

1. For the next month keep a <u>daily</u> record of the following information in your notebook/journal.

   a. Weather conditions, including

      - high and low temperatures
      - wind speed
      - cloud cover or approximate hours of sunshine
      - heating or cooling degree-days (your teacher will tell you how to do this)

   b. The pattern of energy use in your home, such as

      - thermostat setting for heating and/or air conditioning
      - number of electric lights on, length of time they are on, and their wattage
      - length of time electric appliances are run and their wattage
      - number of showers and baths taken

c. Any change in the pattern of home energy use, such as a new stove

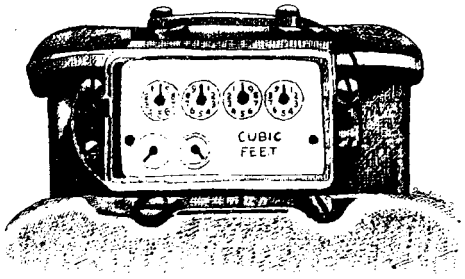
2. At the same time, keep a weekly record of the following information for your home.

   - electrical consumption
   - natural gas consumption
   - fuel oil consumption
   - bottled gas (liquid propane) consumption
   - wood consumption

   (See the practice worksheet for help in reading electric and gas meters.)

3. Place your home's weekly energy data in the appropriate columns on the Data Table. The unit of measurement for each fuel is as follows.

Fuel	Unit of Measurement
electricity	kilowatt hours (kWh)
natural gas	cubic feet (CF)
fuel oil	gallons
bottled gas (LP)	pounds or gallons
wood	cords (face or full)



4. To complete the Data Table, you must convert the amount of each kind of energy used to Btu. The British Thermal Unit (Btu) is defined as the amount of heat necessary to raise the temperature of one pound of water one degree Fahrenheit. The following chart provides the energy equivalents.

Amount	Btu Equivalent
1 kWh electricity	3,413 Btu
1 cubic foot natural gas	750 Btu
1 gallon #2 fuel oil	89,700 Btu
1 gallon bottled gas	73,200 Btu
1 pound bottled gas	17,264 Btu
1 full cord of hardwood	11,500,000 Btu
1 full cord of softwood	6,500,000 Btu

Multiply the Btu equivalent by the number of units of each kind of energy used. Record in the appropriate columns of the Data Table.

5. To find the total number of Btu used in your home each week, add the Btu calculated for each kind of energy. Place in the "total" column of the Data Table.

6. Plot the weekly totals of energy used on Graph 1. Compare your results to those of other students in the class.

7. Plot weekly energy use in Btu for each energy source on the appropriate graphs. Compare these graphs to one another and to those of other students in the class.

8. From your daily record, total the number of heating or cooling degree-days for each week. Plot on Graph 7. Compare this graph to the others you have constructed.

questions

1. Compare your graph of total energy use (Graph 1) to your graph of heating or cooling degree-days (Graph 7). Are there any similarities? If so, can you explain them?

2. What fuels do you use for energy in your home? For what purpose is each fuel used?

3. In terms of total Btu, which fuel supplies most of the energy needs in your home? What is this fuel used for?

4. Which fuel supplies the least energy in your home? What is this fuel used for?

5. According to Graph 1, during which week was your home's energy use the greatest? Use your daily journal to explain the reasons for this.

6. According to Graph 1, during which week was your home's energy use the least? Again, use your daily journal to explain the reasons for this.

7. What conclusions can you draw about your home's total energy use over time?

8. What are some changes your family could make to reduce the amount of energy it uses?

looking back

Every household has different needs and different energy use patterns. Only you and your family can decide what those patterns should be. But to make good decisions you need good information.

When you have finished this activity, you will probably know a lot more about your family's use of energy than you did before. You'll know

which fuels you use most,

what your present energy use patterns are, and

how weather affects energy use.

Perhaps you'll want to collect more information, from other sources, about appliances, household heating and hot water, and energy conservation.

When you put all this information together, you'll probably discover that saving energy doesn't mean lowering your standard of living. On the contrary, saving energy means saving money and having a more comfortable home.

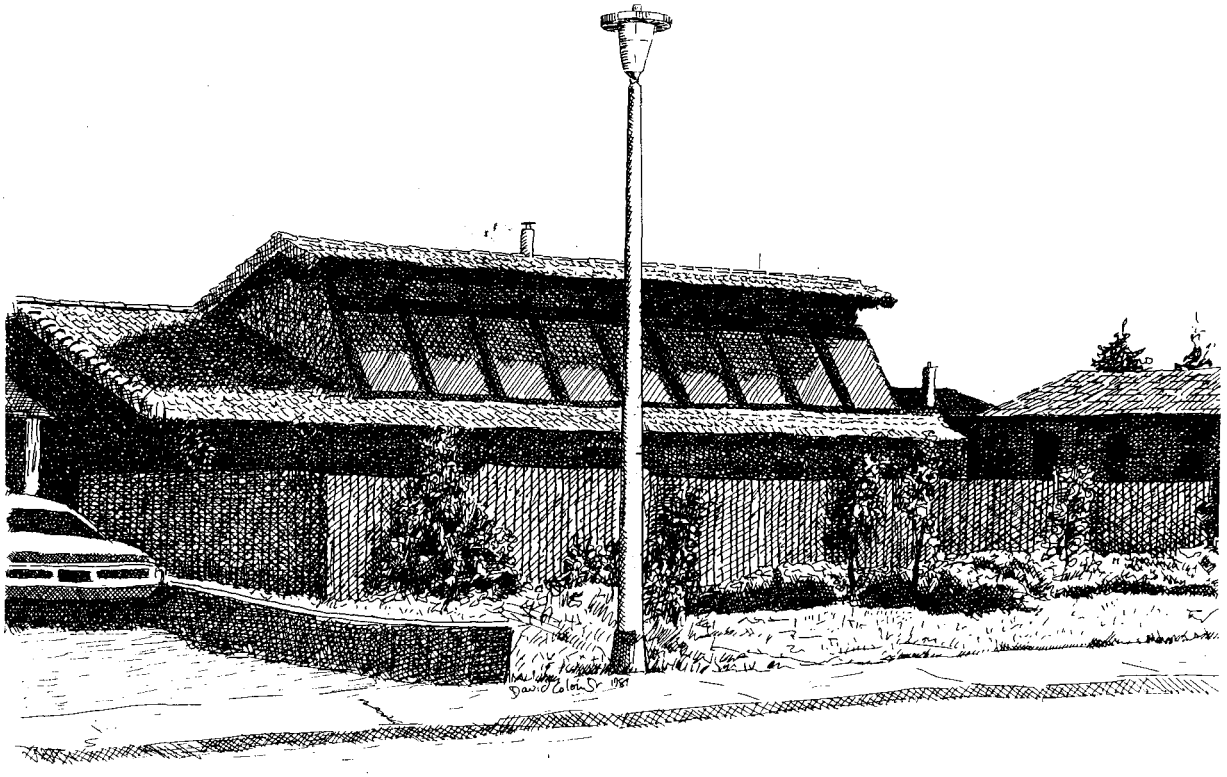
going further

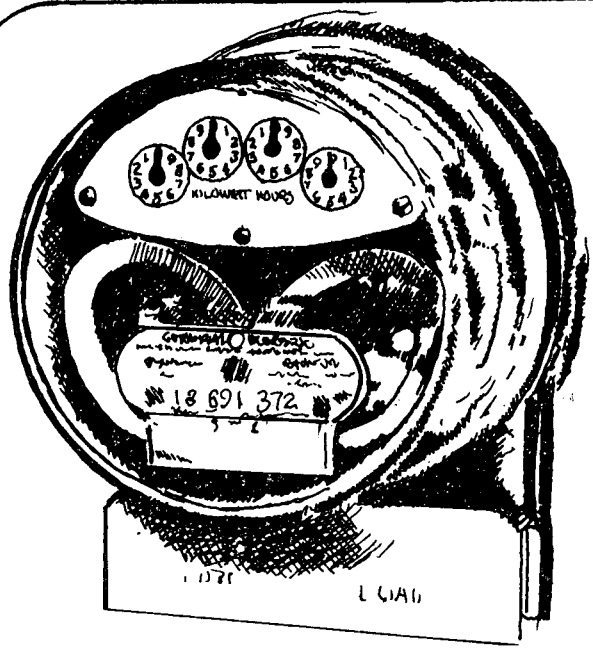
With your parents' permission, keep a monthly record of the amount of money spent on each kind of energy used in your home. If you have data for several months, construct a graph of amount spent versus month.

With your family's agreement, implement a plan to reduce your home's energy use. Continue your journal. After several weeks, compare these new data with your original data to see if your plan reduced energy use.

Expand your energy journal to include gasoline use. Keep track of all trips made by car, motorcycle, snowmobile, etc. Record the destination, miles travelled, and the number of gallons of gasoline used. Determine the number of miles per gallon for each of your family's vehicles. Plan some gasoline conservation measures.

Do an energy survey of your school. Follow the same steps as you used when surveying your home.

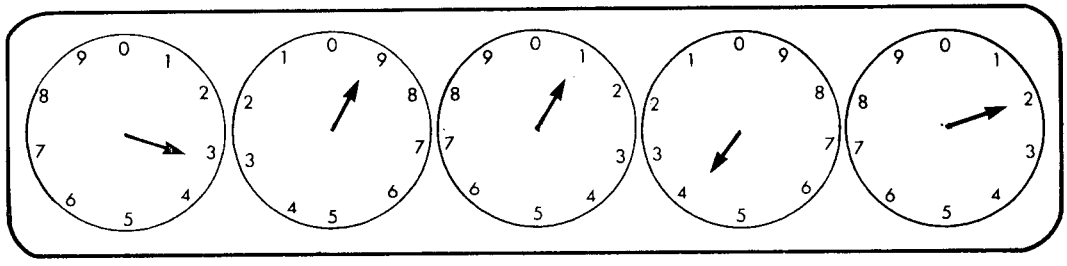




Practice Worksheet
Reading an Electric Meter

Electric meters measure electricity in kilowatt-hours (kWh). The meters are usually read monthly (or bimonthly) by a representative from your local electric company so that the company knows how much to bill you for your electric use.

To learn how to read an electric meter yourself, look at the sample meter shown below.



Notice that some of the dials read clockwise and some read counter-clockwise. Start at the left and read the number to which the needle points. If the needle is between two numbers, read the lower number.

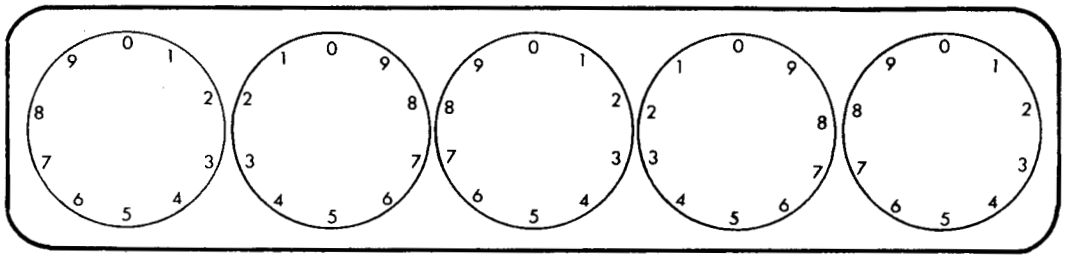
What is the number of kilowatt-hours shown on the dial above?

_____ _____ _____ _____ _____ kWh

Now take the next page home with you and fill in the blank dials with the reading from your own electric meter. If your meter is different from the one shown, carefully copy the dials from your meter exactly as they appear, and then draw each needle on the dial as it appears on your meter. (Do this on a separate sheet of paper.)

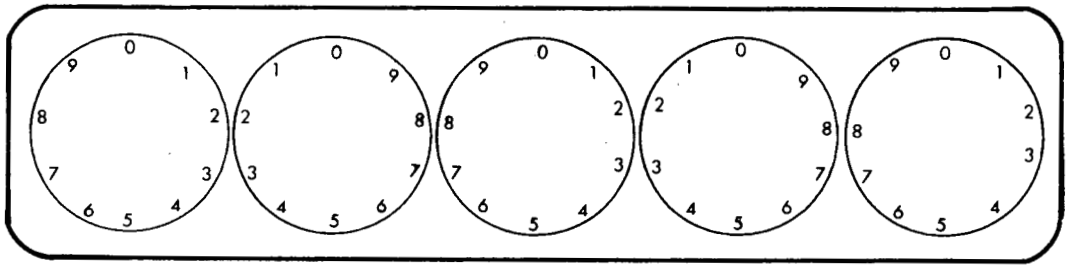
Read your meter again one day later. Try to read the meter at the same time as the day before. Fill in the second set of blank dials to record your reading.

Worksheet



Date: _____ Time: _____

Meter Reading #1: _____ kWh



Date: _____ Time: _____

Meter Reading #2: _____ kWh

If you subtract meter reading #1 from meter reading #2, you will know how much electricity your home used in one day.

Meter Reading #2 _____ kWh

Meter Reading #1 _____ kWh

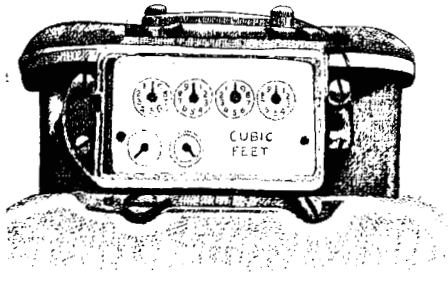
_____ kWh = your electric use for one day

To help you understand what this answer means, 1 kilowatt = 1000 watts. Therefore, 1 kilowatt-hour is equal to ten 100-watt bulbs burning for 1 hour.

NOTE:

Look for a meter-multiplier number on all meters. Some electric meters may have only 4 dials and should have a meter-multiplier factor of 10 stated on them as (x 10). On these meters the number read from the dials must be multiplied by 10 to arrive at kilowatt-hours.

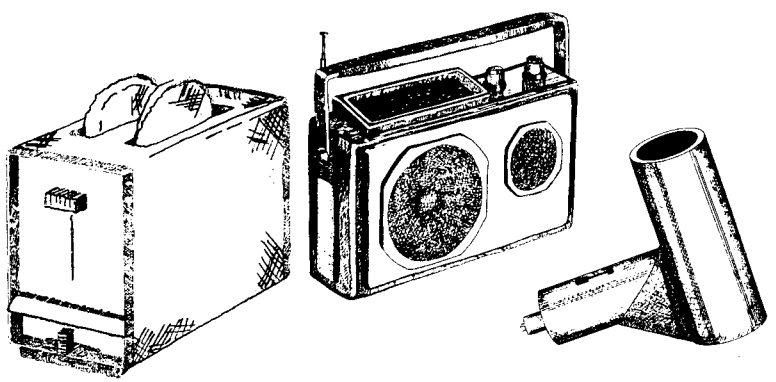
If you also have a gas meter, it is read in the same way, except that each unit measured by most gas meters is equal to 100 cubic feet. Therefore, gas meter readings must be multiplied by 100 to arrive at cubic feet.



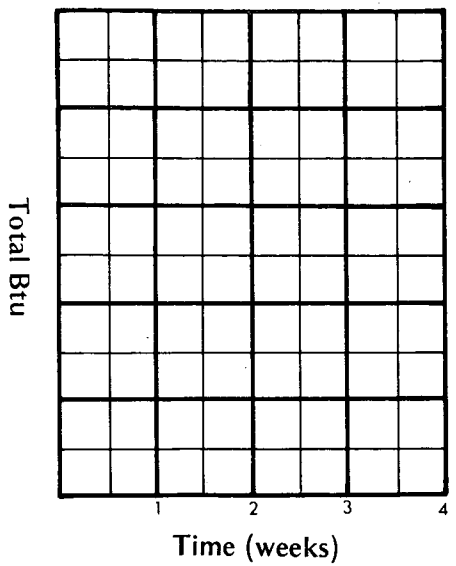
Data Table

Weekly Home Energy Use

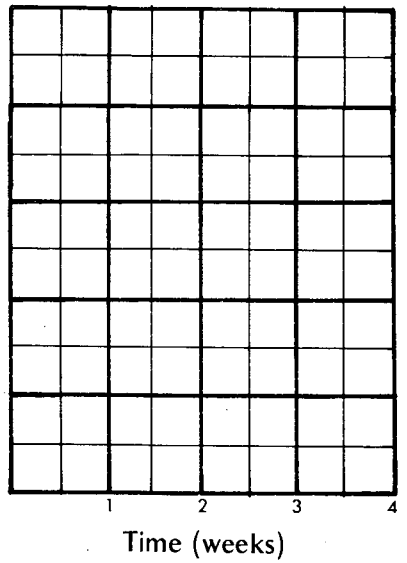
		Electricity		Natural Gas		Fuel Oil		Bottled Gas (LP)		Wood		
Week	Dates	kWh	Btu	CF	Btu	gallons	Btu	gallons or pounds	Btu	cords	Btu	Total Btu
1												
2												
3												
4												



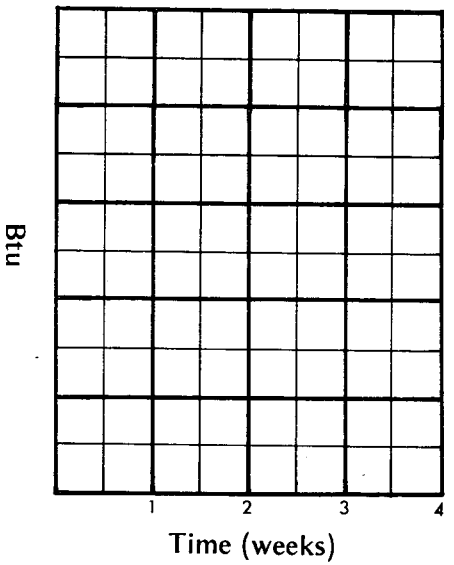
Graph 1 Total Energy Use



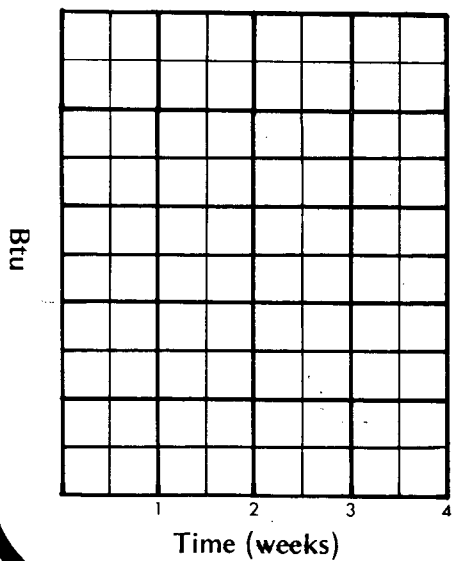
Graph 2 Electricity



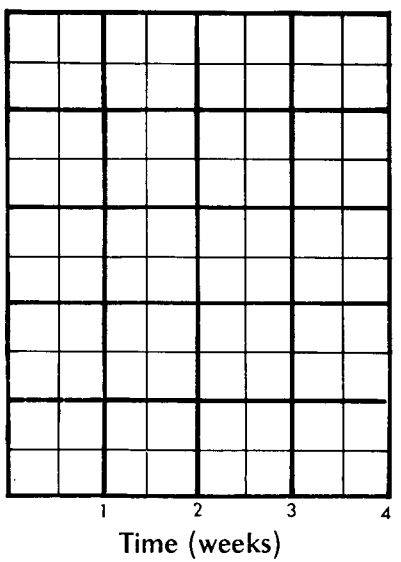
Graph 3 Natural Gas



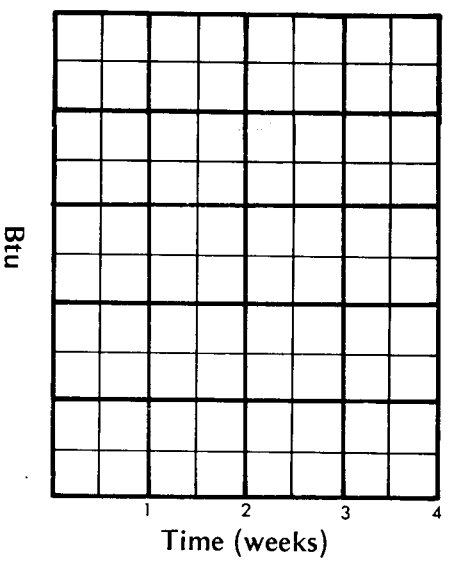
Graph 4 Fuel Oil



Graph 5 Bottled Gas

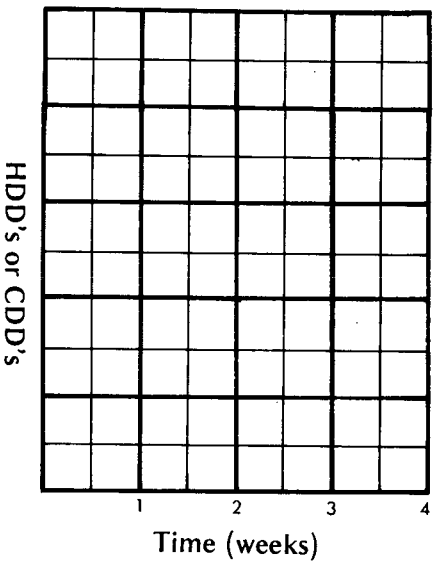


Graph 6 Wood



Graph 7

Total Heating or Cooling Degree-Days



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Teacher Information

Home Energy Use

Suggested Grade Level and Discipline

Physical Science, grades 9-12
Earth Science
Consumer Education
Human Ecology
Math
Adult Education

Skill Objectives

Reading electric and/or gas meters

Logging daily and weekly energy data

Converting various energy units to a standard unit

Interpreting graphs displaying energy use over time and comparing these to a graph of total heating or cooling degree-days over time

Major Understandings

Total energy consumption in a home will vary according to changing weather conditions and changing use of space heating or cooling, lighting, and appliances.

Identifying the particular purposes for which specific fuels are used enables one to plan measures to conserve energy in the home.

Background

Most families use more than one fuel to meet their home energy needs. Although some newer homes may be all-electric, usual combinations include natural gas and electricity, fuel oil and electricity, or some combination with bottled gas. In addition, wood is being used increasingly as an auxiliary fuel. Since these kinds of energy are commonly measured in different units, it is difficult to compare the proportion of home energy derived from each source. This problem can be solved by converting each energy unit to a single common unit, the British Thermal Unit (Btu). Most engineering work is done in Btu and most heating and cooling systems are rated in Btu.

The values of the Btu equivalents for the various fuels given in the student section are corrected for the burning efficiencies of the furnaces. For the purpose of this activity, fuel oil burner efficiency was assumed to be 65%, natural gas burner efficiency 75%, bottled gas burner efficiency 80%, and wood stove efficiency 50%. In the home, electrical efficiency in resistance heaters is 100%, although conversion efficiency from the fuel burned in the power plant through transmission to the home is only 33%.

If you prefer to have students use a metric unit for heat energy, then the standard unit is the calorie. A calorie is defined as the amount of heat necessary to raise the temperature of one gram of water one degree Celsius, from 14.5° to 15.5°C. A kilocalorie is 1000 calories. The kilocalorie equivalents for each fuel are given in the following table.

Fuel	Kilocalorie Equivalent
1 kilowatt-hour	860.1
1 gallon #2 fuel oil	22,604.4
1 cubic foot natural gas	189
1 gallon bottled gas	18,446.4
1 pound bottled gas	4,350.5
1 cord hardwood	2,898,000
1 cord softwood	1,638,000

(For all woods taken together, average Btu per pound = 2895; kilocalories per pound = 729.5)

Since space heating or cooling is a major use of energy in the home, the concept of heating or cooling degree-days is helpful in a survey of home energy use. Comparison of

heating or cooling degree-days from week to week or month to month can help to determine the proportion of energy used for space heating or cooling.

In general, heat is not required when the mean temperature is 65°F (19°C) or above. To determine heating degree-days for a given day, subtract the mean outdoor temperature from 65. For example, if on a given day the high = 40°F and the low = 20°F, then

$$\begin{aligned} HDD &= 65 - \left(\frac{40+20}{2}\right) \\ &= 65 - 30 \\ &= 35 \end{aligned}$$

In a similar manner, cooling is required whenever the mean outdoor temperature exceeds 75°F (24°C). To determine cooling degree-days, use the formula

$$CDD = \left(\frac{\text{high} + \text{low}}{2}\right) - 75$$

Total degree-days over a period of time can be found by adding the results for each day. Degree-day information can also be obtained from a local weather station, oil dealer, or utility company.

Advance Planning

Announce in advance of the activity that a notebook will be needed for keeping a daily journal.

If possible, obtain a gas or electric meter to use as a classroom demonstrator. Contact your local utility companies.

The data table, graphs, and practice worksheet can be duplicated and handed out to students as the activity progresses.

Suggested Time Allotment

Introduction of the activity, including short lessons on journal keeping, fuel units, and heating or cooling degree-days should require 1 to 2 class periods.

Use of the practice worksheet on reading meters should require part of 2 class periods separated by 1 day.

Part of one class per week will be needed to work on the journal, to record data, and to work on converting energy units.

One to two class periods will be needed to prepare graphs. (Some of these graphs could be done as homework assignments.)

One to two class periods will be needed to describe and compare differences among student results, and to discuss energy conservation methods and their possible effects.

Suggested Approach

Vary the length of time devoted to journal-keeping according to the interest level of the students.

Thoroughly introduce the concept of journal-keeping if students have not been exposed to it before.

Demonstrate making energy conversions to Btu and allow for practice time in making conversions.

Give students help in plotting data on graphs. Since some Btu values may be reported in millions, students may have difficulty selecting an appropriate scale for the Y axis. You may want them to develop a scale in tenths of millions; for example, 1.1 million, 1.2 million.

For career and consumer education infusion, representatives from the energy field may be invited into the classroom.

Precautions

Some students may not have access to utility meters, especially if they live in apartment houses.

Parents may regard this activity as an invasion of privacy. A statement of purpose, along with permission slips to be signed by parents, is suggested.

Not all utility meters are alike. Contact your utility company for the kind of meters used in your locality.

Caution students against tampering with any electrical control which might be located near utility meters. If students are inspecting appliances to determine their wattages, caution them to unplug the appliances first.

Student interest may lag during a long-term investigation such as this; therefore, a weekly update session may be important.

Points for Discussion

Predict the seasonal changes in the relative amounts of the different fuels used in your home.

What measures should you apply in your home to reduce energy consumption? When would each measure be most effective?

How important will home energy conservation be in addressing the crisis in energy supply and demand occurring in the United States?

Typical Results

Results will vary depending on geographic location and time of year. In different geographic locations either electricity, fuel oil, or natural gas will be used for space heating, while electricity will be used for cooling.

Evaluation

Observe your students' ability to keep daily journals as the activity progresses. Check journals weekly.

Collect and review the data gathered by each student. Was the data table carefully and correctly filled in? Were the graphs well organized and usable for data analysis?

Are the answers to the questions requiring analysis of the graphs well thought out?

Are the suggested measures for home energy conservation appropriate and significant?

Modifications

Parts of this activity may be used separately depending on the ability and interest levels of the students.

To simplify the weather reports and journal keeping requirements, degree-days can be obtained and written on the chalkboard each day by the teacher or by a selected group of students as a project.

References

Energy Conservation: Experiments You Can Do . . .from Edison.
(Thomas Alva Edison Foundation, Cambridge Office Plaza, Suite 143, 18280 W. Ten Mile Rd., Southfield, MI 48075, 1974.)

Energy Conservation in the Home: An Energy Education/Conservation Guide for Home Economics Teachers, Lil Clinard.
(U.S. Department of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830, 1977, free.)

547 Ways to Save Energy in Your Home, Roger Albright.
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The Home Energy Guide: How to Cut Your Utility Bills, John Rothchild and Frank Tenney, Jr.
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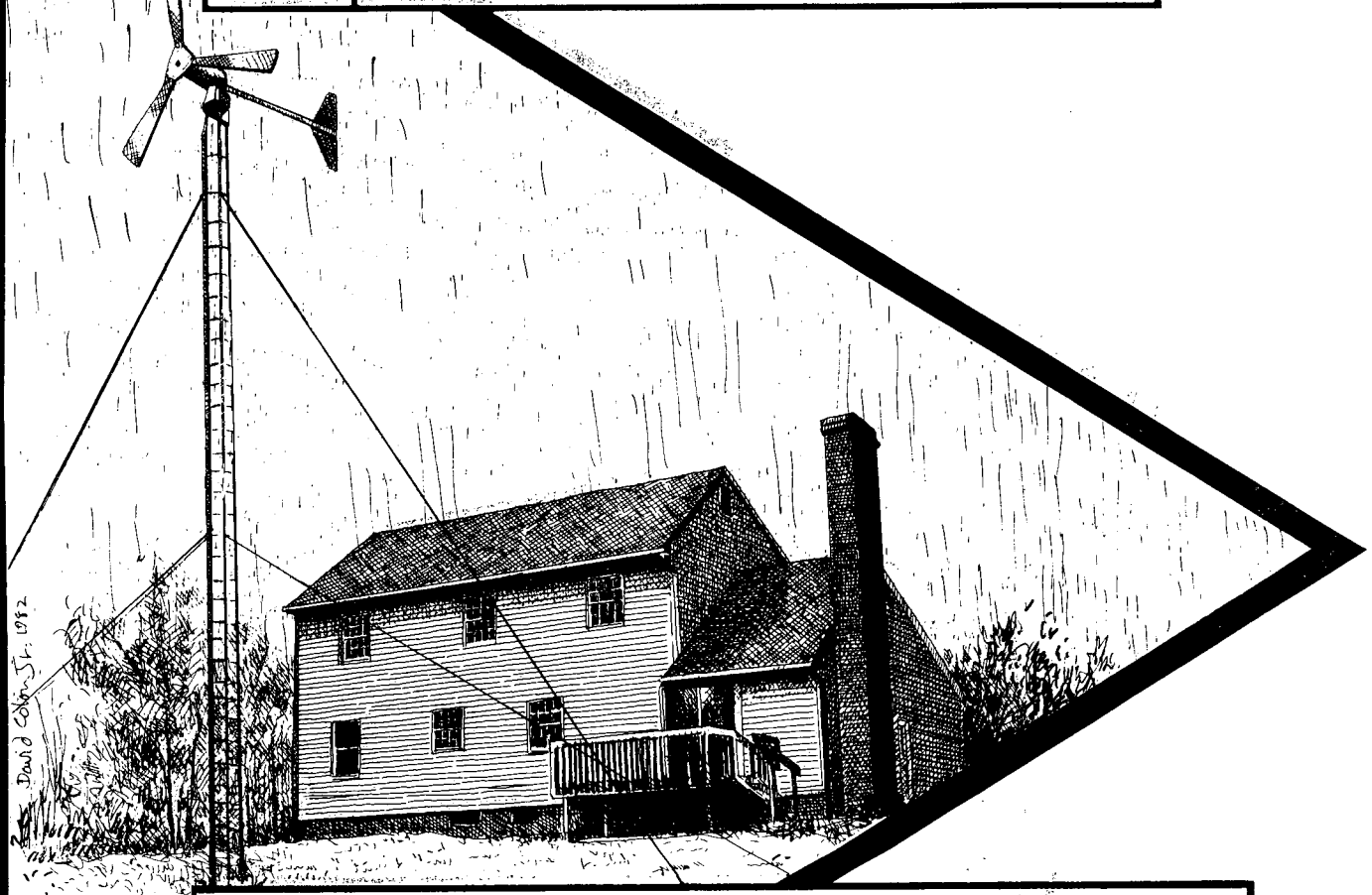
PAGE

4 Wind Power for Your Home?



Winds are caused by the movement of air masses of different temperatures and densities. The sun heats different parts of the earth's surface differently. Those surfaces, in turn, heat the air above them to different temperatures. Warmer air expands, becomes less dense, and is buoyed up by surrounding cooler, denser air which rushes in to replace it. This creates wind, which is thus considered to be a form of solar energy.

For centuries, wind power was used to run machinery. In the last hundred years windmills were even adapted to produce electricity. But soon power companies with large, central plants burning fossil fuels put the wind generators out of business.

Now, because of the rising price of fossil fuels, people are again considering wind as a source of power for homes, factories, and entire communities. In this activity you'll determine whether your home could get its electricity from the wind.

objectives

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

- o construct a simple instrument for measuring wind speed,
- o successfully use the instrument to measure wind speed,
- o determine the electrical requirements of your home in watts, and
- o choose a size and number of wind generators needed to meet the electrical needs of your home.

skills and knowledge you need

The skill of reading and interpreting tables of data

The skill of performing simple arithmetic operations

The knowledge of average annual wind speed in your area

materials

ping-pong ball

30 cm long piece of monofilament fishing line

protractor

bubble level

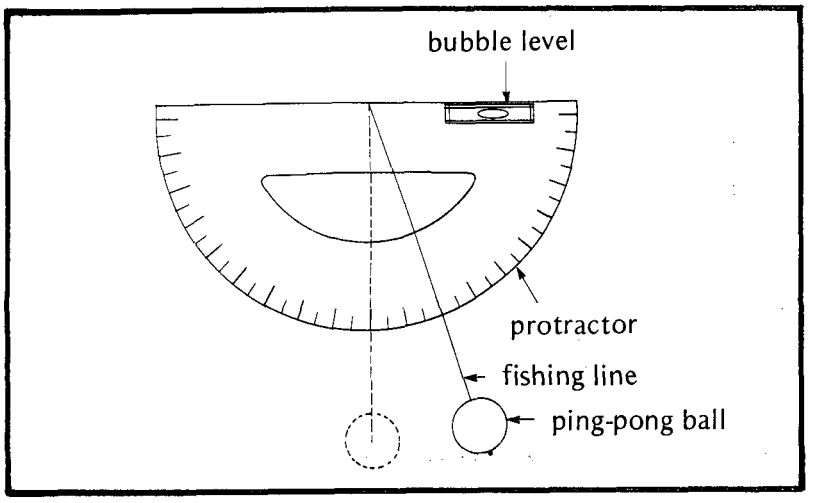
needle (longer than the diameter of the ping-pong ball)

red magic marker

glue

procedure

1. Construct the wind-speed indicator as shown in the diagram.



a. Color the fishing line with the magic marker.
b. Glue the bubble level on the protractor as shown.
c. Thread the needle with the colored fishing line and push it through the ping-pong ball.
d. Remove the needle from the fishing line. Knot the end of the fishing line and glue it to the ping-pong ball.
e. Glue the other end of the fishing line to the center of the protractor as shown.

2. Choose an open site near your home. Holding your indicator so that the bubble of the level is centered, face into the wind and record the angle that the fishing line makes with the horizontal plane of the protractor. Take measurements of this angle at four different times: 8:00 A.M., 12:00 Noon, 4:00 P.M., and 8:00 P.M. Record each measurement in Data Table 1. Add these values and divide by four to determine the average angle of the fishing line. Record this value.

3. From Data Table 2, choose the angle closest to your average angle. Record the wind speed determined by this angle on Data Table 1.

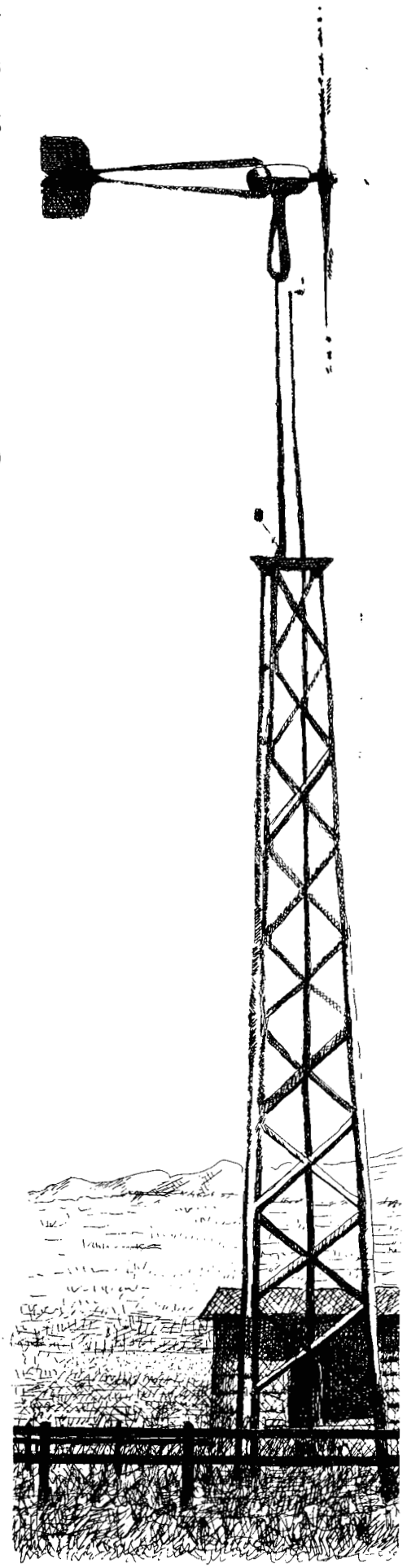
4. In Data Table 3, the average wattages of common home electrical appliances are given in Column 1. Determine which of these appliances are in use in your home at a time when the fewest number of appliances are in operation. Copy their wattages in Column 2. This is known as your home's base load. Then determine the appliances in use at a time when the greatest number of appliances are in operation and record their wattages in Column 3. This condition is known as your home's peak load.

   (If more than one of any appliance is in use at either time, multiply the wattage by the number in use before entering it in Columns 2 or 3.)

   Add each column to determine the total wattage for each condition of use.

5. Data Table 4 indicates the wattages provided by propeller-type wind generators of varying diameters for several wind speeds. Select the wind speed which is at or just below the value found for your home site. From the wattages given under that wind speed, determine the number and diameter of wind generators which would supply first the base and then the peak load requirement of your home.

   For example, if your wind speed were 16 km/hr. and your home's base load requirement were 325 watts, then you would need one 5.5 m diameter



wind generator, two 3.6 m diameter wind generators, or three 3 m diameter wind generators to meet your home's requirement.

Record your choices in Data Table 5.

6. Find out the average annual wind speed for your area. Try your local weather station or university science department. Repeat Step 5 for this wind speed.

questions

1. For the wind speed you determined, how did the number and size of wind generators needed compare under peak and base load requirements?

2. How did the average annual wind speed differ from the value you determined? Explain.

3. How did the number and size of wind generators needed compare for the average annual wind speed and for the value you determined?

4. You found the wind speed on your home site for only one particular day. How could you carry out a more valid wind site analysis?

5. Would the average annual wind speed for your area necessarily be a valid measurement for your home site? Why or why not?

6. In general, experts agree that unless the average annual wind speed is at least 16-19 km/hr. wind generators are not economical. According to the data you collected, are the winds strong enough to merit serious consideration of wind generators as an alternative source of electricity?

7. Wind generators capable of producing 6000 watts of power at windspeeds above 13 km/hr. cost approximately $10,000 to install. Would such a system meet your home's electrical needs? At which level of use? Would it save your family money over time? Explain.

8. How could you reduce the peak load requirement for your home? Would leveling this peak demand make the economics of installing a wind generator any more reasonable? Why or why not?

looking back

While wind power offers a solution to our growing energy crisis, it should now be clear to you that wind generators cannot be expected to perform economically and efficiently at every location. Even in regions with high average wind velocities, the unforeseen changes in wind speed make systems less than reliable. In the near future, it is likely that wind generators will serve to supplement rather than fully replace electricity from other energy sources.

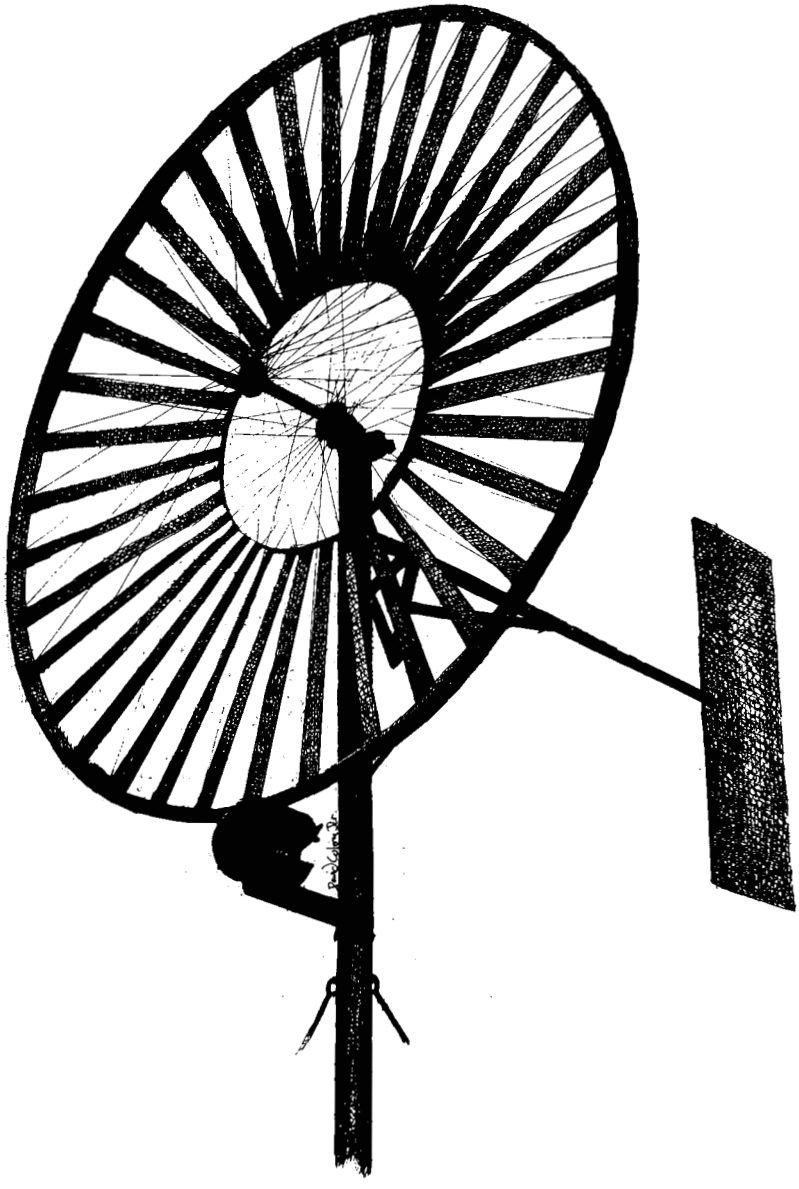
going further

Carry out the wind site analysis you proposed in answer to Question 4.

You have probably noticed that most wind machines are attached to tall towers. Research the purpose of these towers and prepare a report for the class.

Newer designs in wind generators are being tested. Investigate the progress being made on the Savonius and Darrieus rotors and compare their efficiencies to one another and to the propeller-type generators.

Storage of energy generated from the wind may be accomplished in several ways: battery storage, hydrogen storage, flywheel storage, compressed air storage, or heat storage. Determine the differences and similarities between these methods of storage.



Data Table 1

Time	Angle of Fishing Line
8:00 A.M.	
12:00 Noon	
4:00 P.M.	
8:00 P.M.	
Average angle of fishing line:	
Wind speed indicated by average angle:	km/hr.

Data Table 2

Angle Fishing Line Makes with Protractor	Wind Speed (km/hr.)
90°	0
85°	9.3
80°	13.2
75°	16.3
70°	19.0
65°	21.6
60°	24.0
55°	26.4
50°	30.0
45°	31.5
40°	34.4
35°	37.7
30°	41.5
25°	46.2
20°	52.3

Data Table 3

Average Wattages of Electrical Household Appliances

Appliance	Column 1 Average Wattage	Column 2 Base Load	Column 3 Peak Load
Air conditioner	860		
Electric blanket	177		
Clock	2		
Clothes dryer	4,856		
Coffee maker	1,200		
Dishwasher	1,201		
Fan (attic)	370		
Food freezer	341		
Food mixer	127		
Food waste disposer	445		
Frying pan	1,196		
Hair dryer	600		
Heater (portable)	1,322		
Hot plate	1,200		
Iron	1,100		
Light bulbs	as labeled		
Microwave oven	1,450		
Radio	71		
Radio/Record player	109		
Range	12,200		
Refrigerator (12 cu. ft.)	321		
Sewing machine	75		
Shaver	15		
Television (black/white)	45		
Television (color)	145		
Toaster	1,146		
Vacuum cleaner	630		
Washer (automatic)	512		
Water pump	460		
Total Wattage Required			

Reprinted with permission of Edison Electric Institute from "Annual Energy Requirements of Electric Household Appliances."

Data Table 4

Available Power from the Wind in Watts
(System efficiency of 30%)

Propeller Diameter (m)	Wind Speed (km/hr.)				
	8	16	24	32	40
1.2	2	19	64	152	296
1.8	5	43	144	341	665
2.4	10	76	256	605	1183
3.0	15	119	399	947	1848
3.6	21	170	575	1363	2661
4.2	30	232	782	1855	3623
4.8	38	307	1022	2423	4731
5.5	48	383	1293	3066	5988
6.0	59	473	1597	3785	7393

Reprinted from Electric Power from the Wind, by Henry M. Clews, Solar Wind Publications, 1972.

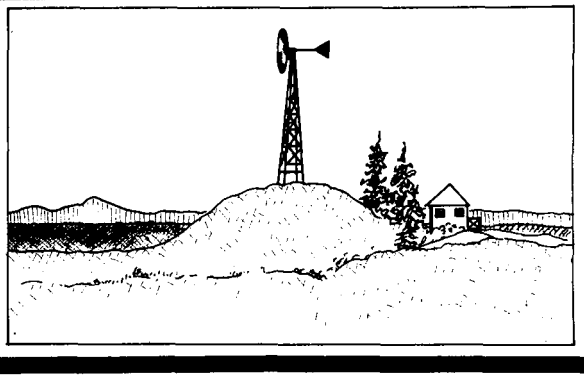
Data Table 5

Propeller-Type Wind Generators Needed to Supply Base Load Requirement

	Number	Diameter (m)
For the Wind Speed You Determined		
For the Average Annual Wind Speed		

Propeller-Type Wind Generators Needed to Supply Peak Load Requirement

	Number	Diameter (m)
For the Wind Speed You Determined		
For the Average Annual Wind Speed		



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Teacher Information

Wind Power for Your Home?

Suggested Grade Level and Discipline

Science, grades 8-9
General Science
Physical Science

Skill Objectives

Constructing a simple pendulum-type device for measuring wind velocity

Using the device in taking reasonably accurate measurements of wind velocity

Calculating the peak and base loads of power required by a home's electrical appliances

Determining, by consulting a prepared table, the appropriate sizes and numbers of wind generators to meet the peak and base load requirements of a home

Evaluating the economic feasibility of installing wind generators at the student's home site

Major Understandings

As wind speed increases, the power available from the wind increases also. (Power is proportional to the cube of the wind speed.)

As the diameter of a wind generator's propeller increases, the power available from the wind increases also. (Power is proportional to the square of the propeller diameter.)

The number and adequate size of wind generators for a given home will be determined by the home's peak power requirement.

A home's peak power requirement can be reduced by leveling the electrical load, thus making wind power a more economical alternative.

Wind power is recommended as an alternative source of electrical energy only where the average wind speed is at least 16-19 km/hr.

Background

Human beings have long captured the kinetic energy of the winds to irrigate crops, propel sailing ships, and grind flour from grain. Originating in seventh century Persia, the windmill was widely adopted throughout the world, perhaps reaching its greatest level of importance in seventeenth century Holland. In the United States, wind power became an important rural source of electricity by the 1920's, but the establishment of the Rural Electrification Administration in 1930 brought federally-supported, centrally-generated power to most farms in the subsequent two decades. By 1950, few small-scale windmills were left in operation.

Today, as the supplies of fossil fuels dwindle and energy costs rapidly increase, people are once again returning to the clean, renewable, and proven technology of wind energy. Modern wind turbines, or wind machines, possess the higher rotational speeds necessary for electrical generation. These machines may be scaled to provide sufficient power for individual homes, factories, or even entire communities.

While a wind generator should theoretically be able to capture about 59% of the kinetic energy of the wind which passes through its propellers, in practice blade inefficiencies and mechanical losses reduce this value to about 35%. The power output of a given wind turbine depends upon both wind velocity and the diameter of its propellers. Wind power increases as the cube of the wind speed; double the wind's velocity and an eightfold increase in power is obtained. Wind power increases as the square of the propeller's diameter; double the diameter of the blades and a fourfold increase in power is obtained. Both these relationships are limited by a third, known as Betz's Law, which states that a wind machine extracts maximum power when the wind is slowed to one third of its initial velocity.

In this activity, students become aware of these general relationships as they determine the size and number of wind generators appropriate to meeting their homes' power requirements. They should be reminded that a major difficulty in adopting wind energy technology is the high cost per unit of power output, caused by both the variable nature of the winds and the need for electrical storage.

Advance Planning

Obtain supplies for the pendulum-type anemometer well ahead of time. Bubble levels can be obtained from hardware stores.

If desired, longer lists of appliance wattages can be obtained from local electric utilities.

Duplicate class quantities of the needed data tables.

Suggested Time Allotment

One-half to one class period for construction of pendulum-type device

A two day interval for the out-of-class determination of average wind velocity and home appliances' peak and base load requirements

One-half to one class period for calculation of appropriate size and number of wind generators and for follow-up class discussion

Suggested Approach

Students should construct their pendulum-type anemometers during class time so that the teacher can check quality and give instructions concerning their use. Give students the opportunity to test their instruments on school grounds.

The collection of wind velocity and power requirement data could best be obtained at home over a weekend.

In class, help students to complete Data Table 5. Provide an opportunity for students to compare and discuss their selections of wind generators, as well as their responses to the questions.

This activity might be followed up by a guest speaker from a company involved in the manufacture of wind electric generators.

Precautions

If students are going to inspect appliances for their power ratings, they should be reminded to first unplug them.

Stress that collection of wind data over only one day does not yield valid information on average annual wind speed or the suitability of wind power for a particular site.

Points for Discussion

How is an increase in wind velocity related to the ability of a wind generator to produce electrical power?

How is an increase in the size of a wind generator's propeller related to its ability to produce electrical power?

What characteristics should a wind generator system possess to provide electrical power to a small community?

What changes might you make in your household's power requirements to make the use of wind generators more realistic in terms of cost and comfort?

How important a source of energy will wind power become in the remainder of this century? Explain.

Typical Results

Student data and calculations will vary. However, except for students living in regions of persistent, high-speed winds, pupils will discover that many large, propeller-driven wind generators would be required in order to meet the peak power demands of their households.

Evaluation

Observe the construction and use of the pendulum-type anemometers. Did the students closely follow the directions of the activity?

Inspect students' data sheets for reasonableness and accuracy. Would the size and number of wind generators selected actually provide sufficient power to meet the needs determined?

Review students' answers to questions. Do their responses indicate an understanding of the economic and technical limitations associated with wind electric generation?

In the summary class discussion, ask students to use Data Table 4 in determining the quantitative effects that the doubling of wind velocity and propeller size have on the power output of a wind generator.

Modifications

A more valid wind speed analysis, although more time consuming, would consist of measuring and recording wind velocities two times a day for two or three weeks.

The use of the Beaufort Scale of Wind Speeds could, if necessary or desired, be substituted for the pendulum-type anemometer in determining wind velocities. The scale can be found in most earth science texts.

Some students may wish to construct and calibrate more sophisticated anemometers.

Students might be encouraged to determine the peak power requirement of their school and to devise a plan to meet this requirement through the use of wind machines.

References

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Wind Power: A Turning Point, Worldwatch Paper 45, Christopher Flavin.
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"How to Make a Wind Site Analysis," Jeanne McDermott.
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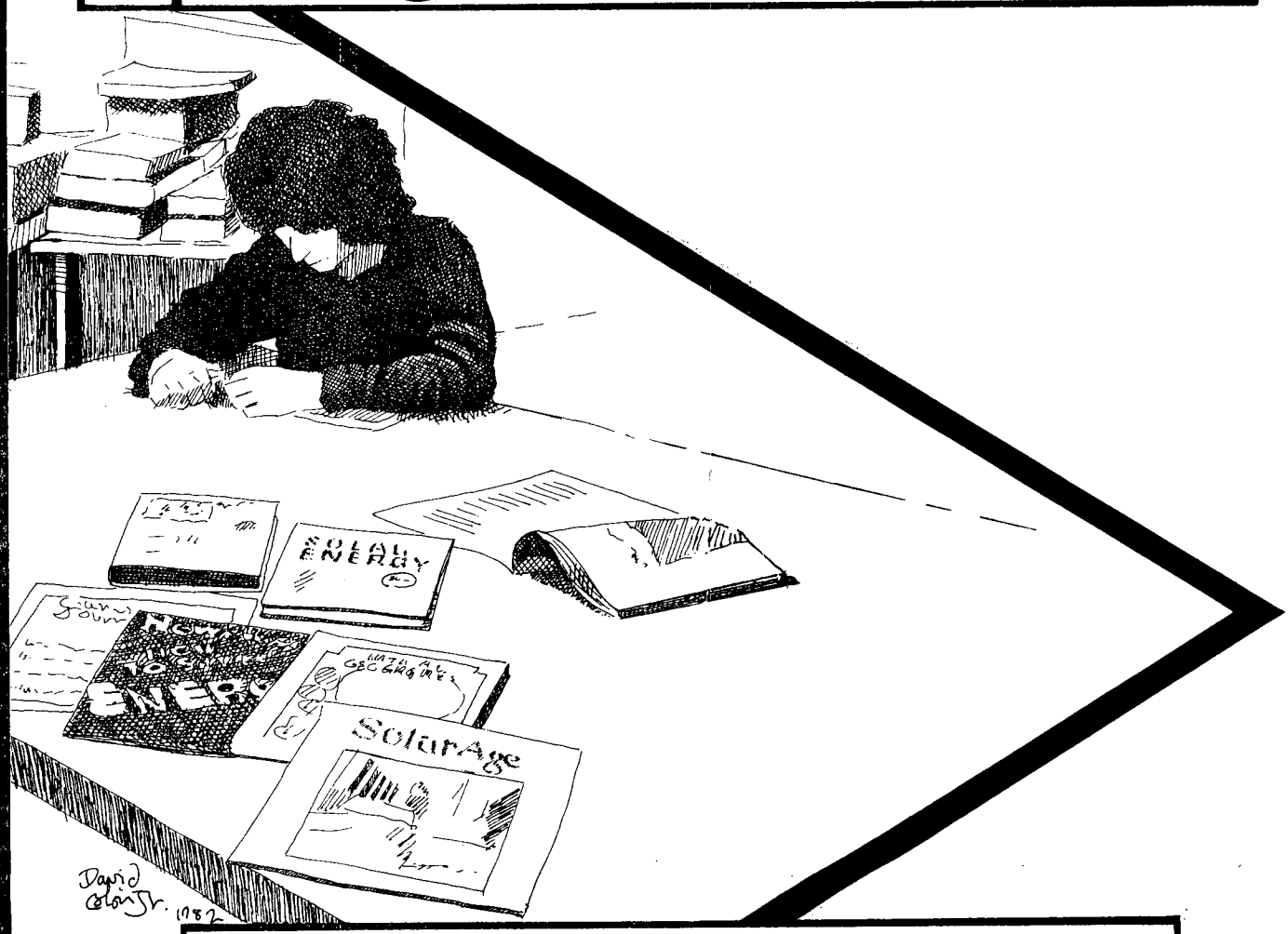
5 Researching Renewable Energy Topics



Becoming well informed can be exciting and fun, but it also means work. Every time a new topic becomes important, we see a flood of new books and magazine articles about that topic. Lately you have probably noticed a large number of recent books and articles about renewable energy. For someone new to the subject, the big question is, "Where do I begin?"

Some of the searching and sifting is already done for you. The card catalog in the library lists books by topic. The Reader's Guide to Periodical Literature lists magazine articles by topic. You will use these library references to find articles and books on renewable energy. With each student reading and reviewing a few items, the class will soon have a large reference file on renewable energy.

objectives

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

- list some books and magazine articles about renewable energy available from your school or public library,
- summarize the main ideas of these books and articles,
- contribute to a renewable energy reference file that will be used by your class and teacher, and
- describe one method that researchers often use to organize and store the results of their research.

skills and knowledge you need

Using library reference materials

Locating library books and magazine articles

Summarizing information which you've read

materials

library references, especially the Reader's Guide to Periodical Literature and the card catalog

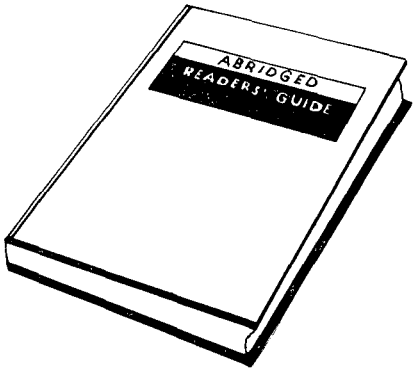
index cards, 7.6 x 12.8 cm (3 x 5 inches)

scissors

paste or glue

procedure

Completing Data Table 1



1. Use the Reader's Guide, the card catalog, and other library references to find articles and books on renewable energy. List these source materials under the appropriate section (books or articles) of Data Table 1, along with the other information requested.

2. Use Data Table 1 to help you find as many of these books and articles as possible. If any sources are not available, note this under the last column.

Completing Data Table 2

3. Skim the books and articles to see what interests you, then read at least five of them. For each one that you read, complete Data Tables 2 and 3 as follows.

   a) Select the main topic of your article or book from the headings at the top of Data Table 2. Darken in the square directly above the appropriate heading with pencil. In some cases you may need to darken more than one square.

   b) Place the title, source (for articles), author(s), and date of publication in the appropriate spaces. In some cases source or author spaces will be blank.

Completing Data Table 3

   c) On Data Table 3, circle what you think are the appropriate descriptions of the reading and interest levels of the book or article. Since this is your opinion, don't worry about what other students may think these levels are.

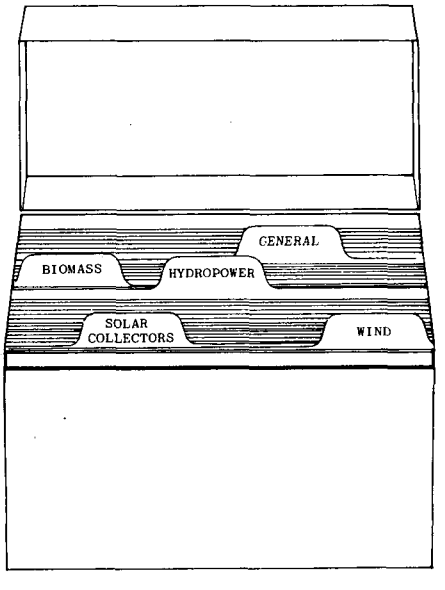
   d) Write a brief but accurate summary of the main ideas of the book or article. Keep in mind that other students will decide whether the book or article fits their needs based on your summary.

   e) Note any facts presented by the book or article which you found particularly interesting or helpful.

   f) Finally, write your name in the reviewer's space.

4. When you have completed both Data Tables 2 and 3 for each book or article, cut the Data Tables out one set at a time. Paste Data Table 2 on one side of an index card and Data Table 3 on the other.

5. Collect all completed file cards and group them according to the darkened squares above the cards' headings. Store the cards in a file box in the classroom, where they are readily available for future reference.



questions

1. Which book or article did you think was most interesting? Why?
2. Which books or articles were too difficult for you to read?
3. Which renewable energy topics appear to be most popular with magazine writers?
4. Which magazines seem to have the most articles on renewable energy?
5. Where else might you look for books or articles you couldn't find?
6. Describe the method you used in this activity to organize and store the results of your research.
7. Based on what you have read, how important do you think renewable energy will be as a future energy source? Why?

looking back

With the completion of this activity your class will have a file of perhaps one hundred or more references on renewable energy. The information in this file can be used in many ways: for term papers and reports, discussions and debates, reading assignments and bibliographies. It will remain useful for several years, and can be added to monthly or annually.

Today's libraries may file information electronically, on microfilm or microfiche. Libraries often use computers to search files located far away, in other states or even other countries. But all these files start the same way: someone finds the books and articles, reads and reviews them, and files the information about them for later use. This is the basic process of all library research.

going further

Expand your literature search to audio-visual materials such as filmstrips, audio cassettes, films, and multi-media kits.

If possible, expand your literature search to include computer searches of data bases. Visit a library with computerized services to learn what it has available.

Consult the class reference file to find additional readings on a renewable energy topic that interests you.

Start a vertical file (a reference file of short-term information) of newspaper clippings, pamphlets, booklets, and brochures on renewable energy. Write to government agencies, your state energy office, utilities, industries, businesses, and consumer groups requesting free information.

Use your class reference file to develop a renewable energy bibliography.

Data Table 1

Books

Title	Author	Publisher	Date	Number of Pages	Library where Available

Articles

Title	Author	Magazine or Journal (including volume and issue)	Date	Pages	Library where Available

Data Table 2

General	Passive Space Heating	Active Space Heating	Solar Water Heating	Solar Collectors	Solar Greenhouses	Solar Siting	Solar Cooling	Photovoltaics	Ocean Thermal Energy	Wind Energy	Hydropower	Biomass Energy	Geothermal Energy	Energy Conservation	Other (specify) ____

Title

Source

Author(s)

Date

Data Table 3

Reading Level	Easy	Average	Difficult
Interest Level	Low	Average	High
Summary			
Interesting Facts Presented			
Reviewer			

Teacher Information

Researching Renewable Energy Topics

Suggested Grade Level and Discipline

Science, grades 7-12
Industrial Arts
English
Social Studies
Reading

Skill Objectives

Using the Reader's Guide to Periodical Literature and library card catalogs to locate sources of renewable energy information

Selecting books and articles and evaluating their interest and reading levels

Critiquing books and articles by writing brief summaries of their main ideas

Major Understandings

There exist systematic techniques for locating books and periodical literature on specific topics.

Renewable energy is becoming an increasingly popular topic for books and magazine articles.

A classroom reference file allows students to pool their efforts and provides a wealth of information to individuals who are beginning research on a particular topic.

Literature searches are commonly done by scientists and researchers. The reference file used here is one method for organizing the results. The file can be continually updated.

Background

The ability to obtain accurate and up-to-date information is an important skill. Scientists and researchers commonly search books and journals (the literature) before starting a new experiment or opening a new area of investigation. These individuals also keep up with new information in their fields as it is reported.

With the current explosion of journals and print materials, staying abreast of new information has become increasingly difficult. An organized system for keeping track of sources of information is imperative. This activity illustrates one simple method for organizing searched data.

Computer data bases are the search modes of the future. But unless a researcher has unlimited access to these new data bases and is able to program his/her own data base for sources of specific interest, a simple and handy reference file is still needed. Increasingly, this need is being met by microfiche files, but they still must be keyed and organized.

A classroom reference file is useful to both students and teachers. In this activity, students gather and organize information for you and for themselves.

Advance Planning

Check on the availability of books and articles on renewable energy in the school library. If availability seems limited, consider having the librarian subscribe to some of the magazines listed in the references, or borrow back issues from friends and colleagues interested in alternative energy.

Coordinate use of the library facilities with the librarian. If students seem unfamiliar with library procedures, ask the librarian to give a short orientation lesson.

Obtain a 3 x 5 card file.

Duplicate several copies of Data Tables 2 and 3 for each student. If possible, duplicate the tables directly onto the fronts and backs of the index cards.

Suggested Time Allotment

Variable, depending on the time you can devote to the activity

Suggested Approach

This activity can be used to introduce or end a unit on renewable energy, as an individual student project, as an introduction to writing a research paper, or as enrichment for gifted students.

Make sure students know how to use the Reader's Guide and the card catalog. Remind students of library rules and procedures. Arrange for the librarian to work with students deficient in library skills.

Help students to select books and articles appropriate to their reading and interest levels.

Help students to identify the main topics of books and articles. Critique summaries and assist students in keeping summaries brief and accurate.

Discuss the importance of literature searches to scientific activity. Explain the terminology: literature search, journal, abstract.

Precautions

Make sure there is an adequate number of Reader's Guides available.

Remind students of library rules.

Points for Discussion

Which magazines present renewable energy articles which are both interesting and easy to read?

Why are some articles on renewable energy difficult to understand?

To what other uses could you put this method for developing a reference file?

Why is it important to have a reference file?

Typical Results

An extensive reference file will be developed by students. This file will serve as a useful resource for future students, who can also update it regularly.

Evaluation

Check students' data tables and their answers to the questions for completeness and degree of understanding.

Ask students to describe how they would do a literature search.

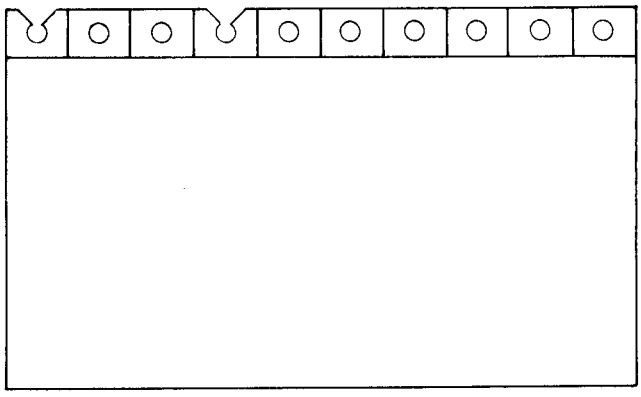
Ask students to describe how they would organize and store the results of a literature search.

Monitor the level of use given to the reference file once this activity is completed.

Modifications

Ask students to use their index cards to present oral reports on their readings.

Punch all headings at the top of Data Table 2. Then, rather than darkening the space, notch the punched hole. When a long, thin tool, such as a knitting needle, is inserted through a heading of interest, all cards on this topic will drop. This technique eliminates the need for grouping by topic. If desired, you can then organize the file alphabetically or by some other useful system.



References

Solar Energy Bibliographies.
(Solar Lobby, 1001 Connecticut Ave., N.W., Suite 510, Washington, DC 20036, single copies free.)

Current Energy and Ecology.
(Publications and Subscription Office, Curriculum Innovations, Inc., 3500 Western Ave., Highland Park, IL 60035, for student reading.)

Popular Mechanics.
(P.O. Box 10064, Des Moines, IA 50350.)

Popular Science.
(P.O. Box 2881, Boulder, CO 80302.)

Rain: Journal of Appropriate Technology.
(Rain Umbrella, Inc., 2270 N.W. Irving, Portland, OR 97210.)

Rodale's New Shelter.
(33 E. Minor St., Emmaus, PA 18049.)

Solar Age.
(P.O. Box 4934, Manchester, NH 03108.)

Solar Energy Bibliographies.
(Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS), P.O. Box 8900, Silver Spring, MD 20907, 1980, single copies free.)

Solar Energy Bibliography.
(Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.)

Solar Energy Bibliography.
(U. S. Dept. of Energy, Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830.)

Your local Cooperative Extension and your state Energy Office.

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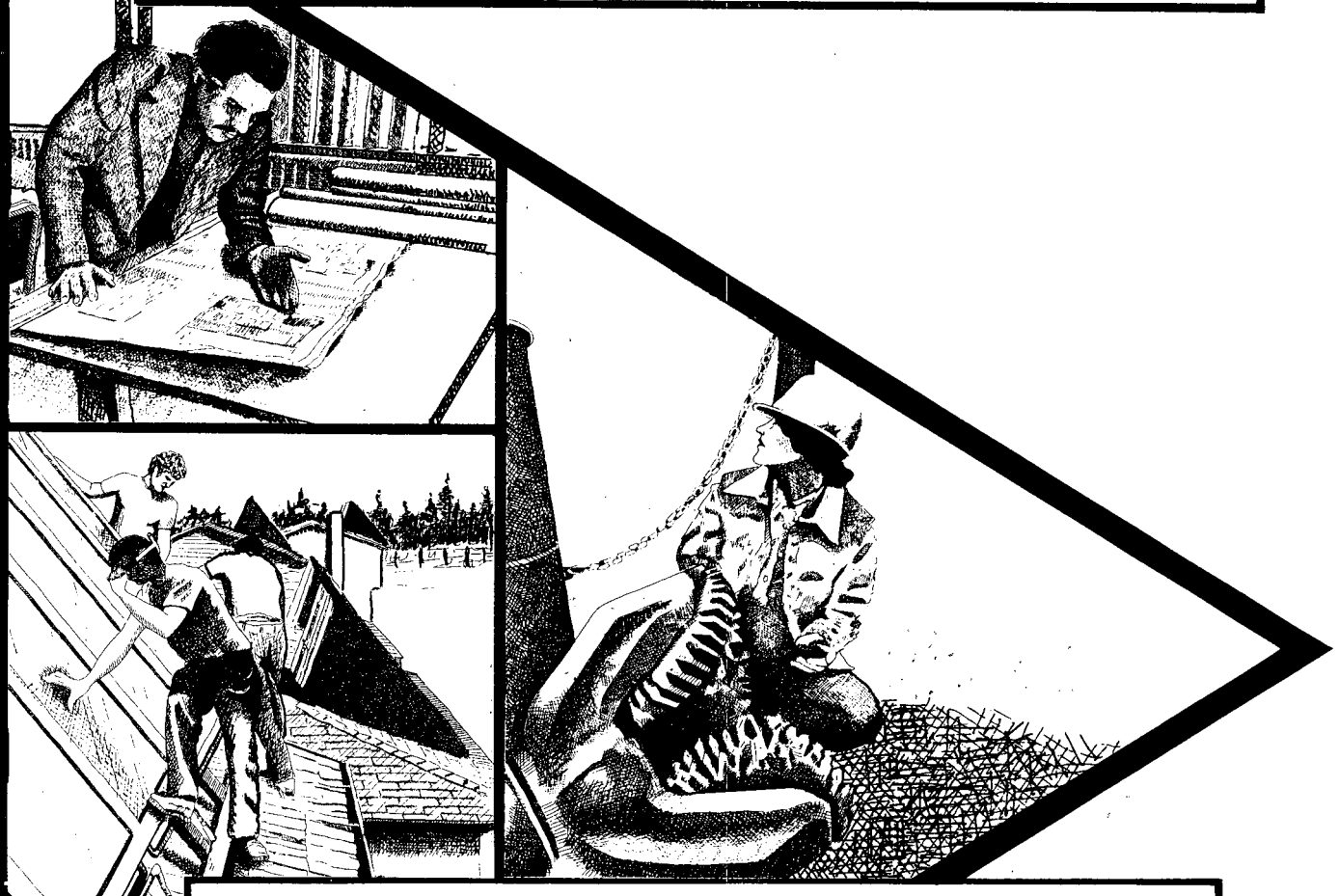
6 Careers in Renewable Energy



Renewable energy may well be a major part of our energy supply in the 21st century. Even now much experimental research in renewable energy is being conducted, and construction and pilot projects are springing up worldwide. All are testing renewable energy as a future replacement for today's fossil fuel industries. Renewable energy technology could revolutionize the energy field.

But what does this mean for future careers in the field of energy? What kinds of careers are available now, and what kinds might be in demand twenty years from now?

In this activity you will examine careers in renewable energy and the effect they could have on your own career choices.

PRACTICAL, "HANDS-ON" JOB-RELATED

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This 160-hour (4 weeks, day) program covers all phases of solar equipment installation — from preliminary siting to installation techniques and followup procedures. The use of tools, equipment and methods that are essential to the solar industry are emphasized on the maintenance level.

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- Special emphasis on solar heating equipment as an adjunct to existing systems, *especially oil-fired.*
- Low tuition fee includes working tools, texts, and training aids.
- Living accommodations available within walking distance of classrooms for out-of-town enrollees.

This course provides excellent training for owner-managers of solar installation companies and their service personnel. Highly recommended for those planning to enter the solar field.

Inquire to:

NEW ENGLAND FUEL INSTITUTE
Solar Education Division

20 Summer St.
Watertown, Mass. 02172
Phone: (617) 924-1000
Telex: 922-401

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objectives

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

- o identify the different areas of renewable energy in which people work,
- o list several jobs and careers in the renewable energy field,
- o record the results of a literature, computer, or newspaper employment section search on careers in renewable energy, and
- o determine the skills and education required for a particular renewable energy job.

skills and knowledge you need

Using library reference materials

Analyzing words and terms for meaning

Matching job skills to educational skills

materials

a notebook

library reference materials, especially the Reader's Guide to Periodical Literature

the employment sections of large circulation newspapers

magazines

a dictionary

a glossary of solar terms

a glossary of career terms

career reference books and pamphlets

procedure

1. Listed below are some renewable energy technologies and applications. People with jobs in renewable energy will most often work in one of these areas.

solar space heating and cooling
solar water heating
industrial process heat
hydropower
ocean thermal energy
photovoltaics
wind energy
biomass conversion
geothermal energy

Caution: The ads displayed here are not current offers. Do not send applications or resumes to the agencies or organizations mentioned.

Working with a small group of two or three class members, look up these terms in a dictionary or solar glossary and then define them in your notebook. Discuss each term as a group to make sure each member understands it.

2. Listed below are some of the kinds of work done by people in the renewable energy field. These kinds of work can be done in any of the areas listed in Step 1.

   research and development
   manufacturing
   marketing and distribution
   construction
   installation and maintenance
   design and analysis
   engineering and consulting services

   Look up these terms in a career glossary and then define them in your notebook. Again discuss each term as a group to make sure each member understands it.

3. Using the terms you defined in Steps 1 and 2 as a guide, conduct a literature search for books, articles, and information on renewable energy jobs and careers. Consult any or all of these sources:

   the Reader's Guide to Periodical Literature,

   career center materials, and

   guidance office materials.

   List in your notebook all books, articles, and pamphlets you find and read.

4. If your school subscribes to a computerized career guidance system, conduct a search of the system for renewable energy careers information. Place the results in your notebook.

5. Search the employment sections of several different newspapers for open positions in the renewable energy field. Also search specialized magazines and journals, such as Solar Age, for job openings. If permissible, cut these out and place them in your notebook.

TVA SOLAR

The Solar Applications Branch, Tennessee Valley Authority, has managerial and technical employment opportunities in Chattanooga, Tennessee.

Experience in managing business or governmental solar, wind, or biomass projects is required.

For further information contact:

Solar Applications Branch (SA0182)

TVA TENNESSEE VALLEY AUTHORITY TVA
Chattanooga, Tennessee 37401

TVA may consider for appointments only U.S. citizens and others eligible for payments under section 602, Pub. L. 94-363, and section 750, Pub. L. 94-419.

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POSITIONS AVAILABLE

Solar Marketing Manager: Energy Design Corporation is a small, technologically oriented solar equipment firm which manufactures and markets high performance, premium quality solar collectors. We are seeking a proficient person to manage marketing in the U.S. and abroad. Experience in engineering, HVAC and solar preferred. This is a key position with good salary and benefits, with a sound, growing company. **Energy Design Corporation, P.O. Box 34294, Memphis, TN 38134 (901)382-3000.**

Expanding distribution requires addition of salesman in the New York-New England area. Applicants should have sales experience and good knowlede of solar, building, and energy conservation field. Send resume to **Warehouse 7, 1863 Central Ave., Albany, NY 12205.**

Mechanical/Solar Engineers Permanent positions available in our New York City and Hartford, CT, offices for engineers and designers with experience in the design of HVAC, plumbing, piping, electrical and energy conservation systems for commercial and institutional projects. Engineers with experience in solar design also required. Send complete resume, availability, salary requirements to: **Dubin-Bloome Associates, P.C. Consulting Engineers, 42 W. 39th St., New York, NY 10018.**

Architectural Draftspersons Licensed Architect: Experience in Passive Solar Construction essential. Residential and light commercial work in vicinity of Allentown and Reading Pennsylvania. Thirty plus hours per week, allowing time for second pursuit. $12,000 per year projected. Raises commensurate with growth of business. Send sample working drawing and perspective rendering with resume to: **Shelter Design Group, Stony Run, PA 19557.**

Associate Editor, Solar Engineering. *Solar Age* is looking for a writer/editor to solicit, prepare, edit, and coordinate, under the direction of the editor-in-chief, feature and news coverage of solar engineering and solar energy systems design. Preference will be given to applicants who have three to five years experience in solar engineering and who have demonstrated magazine writing abilities. Knowledge of magazine composition and production is an asset. The position requires the ability to initiate ideas and to produce accurate copy, to work under deadline pressure, and to analyze planned or built solar residential and commercial structures. Working familiarity with solar design tools is also required. Qualified candidates should provide a detailed resume, including salary requirements, representative samples of published material, and materials describing solar projects worked on within the last three years. Apply to: **Bill D'Alessandro, Editor, *Solar Age*, Church Hill, Harrisville, NH 03450.** No phone inquiries will be accepted.

6. Using the results of your searches, develop in your notebook a list of jobs and careers in the renewable energy field. For each job or career, determine

   the required level of education,

   the required skills and abilities, and

   the working conditions and location.

   Your employment ads and career library materials will be especially helpful in determining these items.

7. Work with your group to develop a list of jobs and careers which will be affected as the field of renewable energy develops. Enter this list in your notebook.

8. Brainstorm with your group a list of renewable energy jobs and careers which may be in demand ten to twenty years from now. (This may require some creative thinking.) Enter this list in your notebook also.

questions

1. How many current jobs and careers did you list in the renewable energy field?

2. Make a list of renewable energy jobs and careers which require each of the following educational levels.

   a) no high school diploma
   b) high school diploma
   c) two years of college or vocational training
   d) four years of college
   e) advanced degree (Master's or Ph.D.)

3. Where are the best places to look for renewable energy job and career information?

4. Are there any new, unusual, or interesting job opportunities in renewable energy? If so, what are they?

5. In which areas of renewable energy (Step 1) and in what kinds of work (Step 2) do most of the renewable energy jobs seem to be? The fewest?

looking back

Were you surprised to discover how many opportunities exist for working in the renewable energy field? You probably found that many people with different levels of education and different skills are needed for various types of energy jobs or careers.

Most needed are engineers, scientists, systems analysts, and instructors, but people who can manufacture and install solar equipment will also find positions. We should also not forget the opportunities available for salespeople, especially as solar applications become more affordable and widespread.

For a person truly interested in the field of renewable energy, there is an excellent chance of finding a challenging job or career in one of its related work areas.

going further

Interview someone working in the field of renewable energy. This may be a businessman, a salesman, an engineer, a construction worker, or a representative from a state, federal, or local agency. Prepare your questions ahead of time. Find out especially about the possibilities for employment in this person's area of specialization.

Invite your guidance counselor or a specialist in career guidance to speak to the class about career selection. Ask this person to bring information on renewable energy careers.

Write to solar manufacturers and state and federal agencies involved in energy for information about solar careers.

List satellite (indirect) jobs and careers which will be affected by a growing renewable energy industry.

Update your career list periodically. Add information on careers in other areas which interest you.

Choose one renewable energy career which particularly interests you. Find out as much about this career as you can and enter it in your notebook.

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Teacher Information

Careers in Renewable Energy

Suggested Grade Level and Discipline

Science, grades 6-12
Social Studies
Industrial Arts
Home Economics

Skill Objectives

Using library reference materials

Conducting a literature or computer search

Organizing and recording information gathered

Identifying career areas and specific jobs in renewable energy

Brainstorming potential renewable energy careers

Major Understandings

There are numerous career opportunities in the field of renewable energy.

A search of newspaper employment sections, career data bases, magazine articles and employment ads, books, and career materials will turn up a large number of career opportunities.

Renewable energy jobs and careers include all possible combinations of educational levels, job skills, and working conditions.

As the renewable energy field develops, new and unexpected jobs and careers will open up.

Background

Career education strives to provide an active relationship between the world of education and the world of work. Most students have only a minimal knowledge of the career opportunities open to them. Two major reasons are the sheer number of job titles (tens of thousands) and the rate at which this number increases. Another reason is the rate at which career opportunities change. An excellent example is the manner in which the energy crisis is expected to contribute to major and rapid change in occupations.

Solar development, especially, has experienced many peaks and valleys over the last 100 years. No doubt this pattern will continue as federal funds allocated to research and development fluctuate, but overall the trend is upward. The total financial outlay in solar research and development now tops one billion dollars per year. Sales of solar devices will soon reach billions per year. Right now over 2,000 establishments, with approximately 25,000 workers, are engaged in solar activities. Solar employment is expected to be triple this number in 1983.

Seventy-five percent of all solar workers are engaged in some aspect of space and water heating. A breakdown of solar jobs by work area is given in the chart below.

Manufacturing (collectors and other products)	31%
Research and development	23%
Architectural and energy services	18%
Installation	12%
Other	16%

Solar opportunities are most prevalent in the states of California, New York, Massachusetts, Texas, and Colorado. Engineers are engaged primarily in research and development, skilled labor in installation, and unskilled labor in commercial areas. Engineers are the largest occupational group. Most-

needed personnel include atmospheric scientists, engineers, systems researchers, and college instructors. Personnel least difficult to hire include clerical staff and skilled and unskilled labor. Individuals with special design, analysis, or installation skills are especially sought after.

Colleges and universities, technical and vocational schools, and companies and unions provide training programs in renewable energy with an emphasis on solar. One major concern of renewable energy professionals is that rapid development and implementation of new technologies could result in a lack of trained manpower, which in turn would constrain renewable energy development and acceptance.

Advance Planning

Find out what resources your school has available for career planning. If your district has a career center, visit it and talk to a career specialist. Check on the availability of computerized career guidance systems.

Include your guidance counselor, librarian, and vocational adviser in the planning of this activity.

Look over the references listed at the end of the teacher section for additional information on careers in general and renewable energy careers in particular.

Contact solar organizations and firms for information on solar careers.

Announce that a notebook will be needed for this activity.

Obtain glossaries. Renewable energy glossaries are available from many sources, including the text that accompanies this book. Obtain career glossaries from your career center or career reference books.

Obtain back issues of large circulation newspapers and of alternative energy magazines.

Suggested Time Allotment

Variable, depending on the time you have available for the activity

At least one period for defining terms

At least one period for the search

At least one period for developing lists and discussing results

Suggested Approach

If students are unfamiliar with the concept of career education, discuss the importance of career exploration and planning.

Discuss the renewable energy technologies, applications, and work areas mentioned in Steps 1 and 2. Help students to define terms. We suggest that this activity be used near the end of a unit on renewable energy, so that students are already familiar with renewable energy concepts.

Explain what a literature or computer search involves.

Specific articles on renewable energy careers may be difficult to locate. Don't forget that general articles on renewable energy may often offer good clues to possible careers and jobs.

If some students need review of library procedures, have the librarian present a short review lesson for them.

Invite a speaker from a local college, vocational program, or institute to give a presentation to the class.

If students have not already taken a career interest inventory or vocational preference test, plan for them to take one.

Once students have started listing possible careers, introduce the career clusters developed by the former U.S. Office of Education.

Construction	Consumer and Homemaking
Manufacturing	Marketing and Distribution
Agribusiness and Natural Resources	Communication and Media
Marine Science	Hospitality and Recreation
Environment	Personal Service
Business and Office	Public Service
Transportation	Health
	Fine Arts and Humanities

Ask students to assign the careers on their list to the career clusters.

Introduce the concept of brainstorming if students have not brainstormed ideas before.

Consider using this activity as enrichment for gifted and talented students, vocationally-oriented students, or students with a particular interest in renewable energy.

Precautions

If students are using the library or career center, make sure they know the rules.

Keep career exploration open-ended. Do not require students to make possible career selections.

Make sure sufficient copies of needed materials are on hand.

Points for Discussion

What factors will influence how many jobs and careers become available in renewable energy in the future?

What effect has the energy crisis had on renewable energy career opportunities?

How important a source of energy will solar and other renewable energies become? How will this affect career opportunities in the energy field?

How will educational requirements, skill requirements, and working conditions affect your choice of a career or job?

Typical Results

A computer search of one career guidance data base turned up the following careers. The descriptors used were limited to solar engineer, solar components installer, and solar components assembler.

civil engineer
architect
mechanical engineer
heat transfer technician
plumber/pipefitter
sheet metal worker
roofer
urban/regional planner
refrigeration/air-conditioning mechanic
electrician
furnace installer
production assembler
bench assembler
electronics assembler

Other careers and jobs students may list will include:

insulation installer
auxiliary system installer
fabrication worker
prefabrication worker
lawyer
salesperson
real estate broker
appraiser
assessor
zoning agent
consumer protection agent
home construction laborer
standards developer
scientist
insurance agent
investor
solar dealer
solar builder
trainer - educator
licenser
construction worker
maintenance person
repair person
bill collector
inspector
inventor
carpenter
mason
glazier
factory worker
crane operator
contractor
legislator
consultant
engineer
designer
developer
banker
estimator
researcher
landscaper

Evaluation

Ask students to list some of the different areas of renewable energy in which people work.

Ask students to list renewable energy jobs and careers which interest them and to give the skill and education requirements for each.

Check notebooks for neatness, accuracy, and extent of research.

Evaluate student lists for understanding of career opportunities.

Evaluate each student's participation in the small group discussions.

Modifications

If you do not have much class time available for this activity, consider using only sections of it. Some sections can easily be dropped or assigned for homework.

References

Career Education: A Handbook for Implementation.
(Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, 1972, contact GPO for price.)

Careers in the Energy Industry, B. H. Kraft.
(Franklin Watts Publishers, 845 Third Ave., New York, NY 10022, contact publisher for price.)

Careers in Energy-Related Occupations.
(PEM Press, Pathescope Educational Media, Department 883, Wayman Ave., New Rochelle, NY 10802, $3.50/paper.)

Meeting Energy Workforce Needs: Determining Education and Training Requirements.
(Information Dynamics, Inc., 111 Claybrook Drive, Silver Spring, MD 20902, 1980, contact publisher for price.)

National Solar Energy Education Directory, George Corcoleotes et al.
(Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, 1980, contact GPO for price.)

Occupational Outlook Handbook, U.S. Bureau of Labor Statistics.
(Superintendent of Documents, U.S Government Printing Office, Washington, D.C. 20402, 1980, contact GPO for price.)

Solar Energy Employment and Requirements, 1979-1983, Girard W. Levy and Jennifer Field.
(National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161, 1980, print copy or microfiche, contact NTIS for prices.)

The Solar Jobs Book, Kay Ericson.
(Brick House Publishing Co., 34 Essex St., Andover, MA 01810, 1980, $7.95.)

Your Career in Energy-Related Occupations, George Davis.
(Arco Publishing, Inc., Division of Prentice-Hall, Inc., 219 Park Ave. S., New York, NY 10003, 1980, $3.50/paper, for student reading.)

"Careers in Energy, Ecology, and the Environment," Current Energy and Ecology, December 1979.
(Curriculum Innovations, Inc., 3500 Western Ave., Highland Park, IL 60035, for student reading.)

Career World Magazine.
(Curriculum Innovations, Inc., 3500 Western Ave., Highland Park, IL 60035, for student reading.)

Metric Conversion Table

Unit of Measure	English Unit	Multiply By ► ◄ Divide By	Metric Unit	Symbol
Length	inches	2.54	centimeters	cm
	feet	30.0	centimeters	cm
	feet	0.3	meters	m
	yards	0.91	meters	m
	miles	1.61	kilometers	km
Area	square inches	6.5	square centimeters	cm^2
	square feet	0.09	square meters	m^2
	square yards	0.8	square meters	m^2
Mass (Weight)	ounces	28	grams	g
	pounds	0.45	kilograms	kg
Volume	gallons	3.8	liters	l
	cubic feet	0.03	cubic meters	m^3
Temperature	degrees Fahrenheit	5/9 (after subtracting 32) 5/9 plus 32	degrees Celsius	^oC
Heat	Btu	252	calories	c
Speed	miles per hour	1.61	kilometers/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, 5.8×10^9 joules or 5.5×10^6 Btu or 1.39×10^6 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 determined by multiplying required volts by required amperes. One horsepower = 746 watts.