DOCUMENT RESUME

ED 258 837 SE 045 834

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TITLE Solar Renewable Energy. Teaching Unit.
INSTITUTION Department of Energy, Washington, D.C.
SPONS AGENCY Tennessee State Univ., Nashville. Div. of Continuing Education.
PUB DATE Jul 81
NOTE 12p.; Presented at an Energy Workshop held at Tennessee State University. Handouts referred to in the unit are not included and are not available.
PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Alternative Energy Sources; Energy; *Energy Conservation; *Energy Education; Photosynthesis; *Science Activities; Science Curriculum; Science Education; Science Instruction; Secondary Education; *Secondary School Science; *Solar Energy; Units of Study
IDENTIFIERS *Renewable Resources

ABSTRACT

This unit develops the concept of solar energy as a renewable resource. It includes: (1) an introductory section (developing understandings of photosynthesis and impact of solar energy); (2) information on solar energy use (including applications and geographic limitations of solar energy use); and (3) future considerations of solar energy (discussing current methods of use and projected uses). Student activities are listed; a few contain descriptions of related concepts and materials needed for the investigations. Also included are evaluation questions and recommended films on solar energy (with source indicated). (ML)

ENERGY WORKSHOP

Dr. Arie Halachmi, Director

SOLAR

RENEWABLE ENERGY

by

Marion Buchanan

Mary Jo Mangum

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Loretta Roland

Teaching Unit

Energy Workshop

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The Energy Workshop was co-sponsored by TSU and a grant from the U.S. Department of Energy. However, the opinions and positions expressed in this document are those of the authors and do not represent the official opinions, positions or policies of the sponsors.

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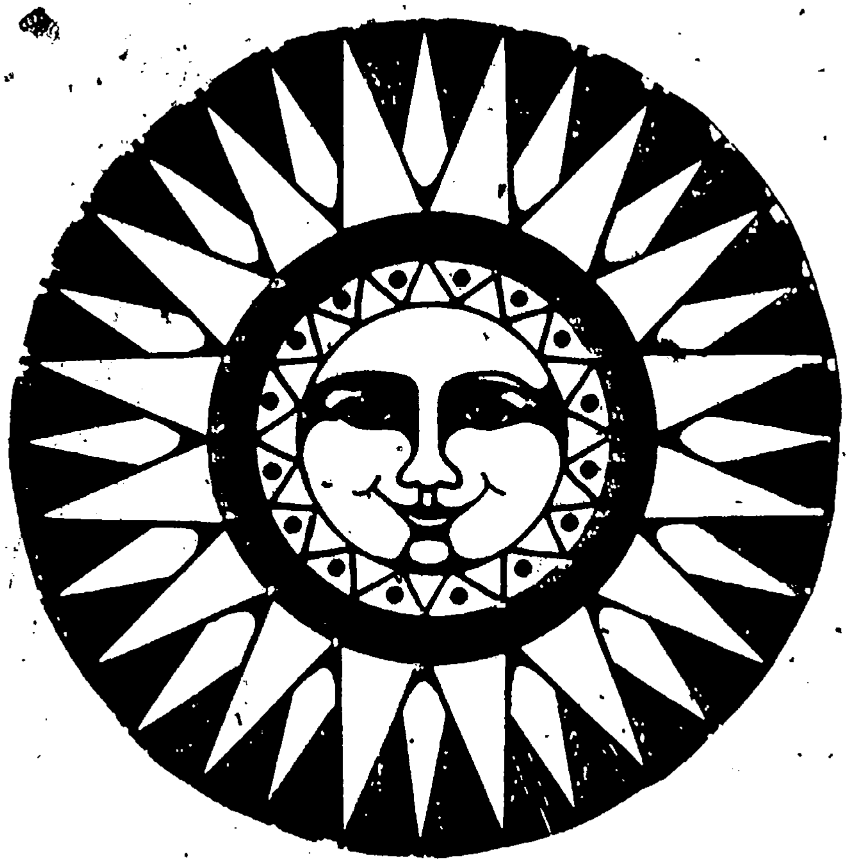

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I. INTRODUCTION

Overview

For hundreds of years, man has regarded the sun as a possible source of power. In 214 B.C. Archimedes defeated the Roman Armada by designing a system of mirrors that concentrated the sun's rays to set enemy ships on fire. In 1615, Salomon de Caux, a French engineer, conducted simple experiments in solar energy. Antoine Lavoisier, a French chemist, used solar energy to melt iron in 1774. John Erickson, an American engineer and inventor, built the first solar steam engine in 1870. Before WW I English scientists built a solar powered pumping station for an irrigation system on the Nile River.

Modern research on the use of solar energy started in the 1930s with the invention of a solar boiler by Charles G. Abbot, the initiation of the Godfrey Cabot solar programs at Harvard University and the Massachusetts Institute of Technology, and the establishment of the Heliotechnic Institute in Russia. The Bell Telephone Laboratories developed a solar battery in 1954. In the same year, the National Physical Laboratory of India devised an aluminum solar cooker, or stove, that will be valuable in areas with little fuel of any kind. The solar stove boils a kettle containing three quarts of water in less than an hour.

** HAND OUT BOOK "ABOUT SOLAR ENERGY"

The sun send out a never-ending stream of radiant energy. Most of this energy we call sunlight. The amount of solar energy streaming toward the earth in only one day equals the energy that could be produced by burning 550 billion tons of coal. This is as much coal as would be dug in the United States in 1,000 years. Enough solar energy falls on the U.S. every 20 minutes to fill the country's entire power needs for one year.

In order to be used as an effective source of power, solar energy will have to be collected and, depending on its use, perhaps concentrated and stored. Scientists have conducted experiments with solar energy to heat and air-condition homes. They also have used it to cook food, to purify water, to irrigate land, and to furnish power for telephone lines. Huge solar furnaces have provided heat for testing metals. But further research is needed before these uses of the sun can become important practically, or before the sun can be used directly as a major source of power.

OBJECTIVES:

1. The student will understand photosynthesis
2. The student will describe the meaning of solar energy
3. The student will discuss the development of solar energy
4. The student will list advantages and disadvantages of solar energy

ACTIVITIES

1. Collect cartoons related to the energy crises and make a bulletin board display.

2. Use a prism to break sunlight into separate colors--the spectrum. Paint a chart reproducing the spectrum. What causes a rainbow?

3. Have students discuss what the earth would be like without the sun in the sky.

4. Let three students representing the sun, the Earth, and the moon demonstrate celestial movements within our solar system. The moon should keep facing the Earth as it circles around it; the Earth should spin counterclockwise while it revolves around the Sun; the sun should twirl counterclockwise as it moves diagonally across the room (Practice to avoid collision).

5. Watch "Great is the House of the Sun", 21 min.

6. Discussion of why energy from the sun is so important to this planet.

7. How much warmer do things get in the sun than in the shade?--30 min.

The student will compare the temperatures of shaded and sunny areas.

CONCEPT: To take the best advantage of solar energy, it is necessary to collect the sun's direct rays.

Materials: 2 styrofoam cups, 2 thermometers, watch.

Pour equal amounts of cold water into 2 styrofoam cups. (The colder the better) Place a thermometer in each cup. Measure the water temperature in each cup. Set one cup in the sun and the other in the shade. What is the temperature of each after 5, 10, and 15 min? Make a graph and use it to record the temperatures for 15 minutes. Use different colors for each cup. Would the water in the cup get warm on a cloudy day? On a cold, sunny day?

FOLLOW UP QUESTIONS:

1. Can a house be heated by solar energy if it is shaded by a big tree?

2. What happens to the water in a hose if it lays in the sun all day?

II. HOW CAN WE USE SOLAR ENERGY?

HAND OUT HOW TO SPEAK "SOLAR."

OBJECTIVES

1. The students will identify ways solar energy can be applied, i.e., water heater, heating and cooling, cells, wind, etc.

2. The students will determine which of the above applications are practical for their geographical locations.

Standby power. It's not just for the other guy.

ACTIVITIES

1. To be done on a bright sunny day: In groups of three let students carry out this procedure.

   a. Assemble the following:

      3 tin cans, one painted black inside
      tap water
      1/2 strip of bacon broken into three pieces
      3 thermometers

   b. Place equal amounts of water in each tin can. Place the thermometers in each can. Using the biconvex lens, concentrate the sun's rays on the water's surface in one unpainted tin can. Check the temperature change every five minutes over a twenty-minute period. Record your observations. Empty the tin cans.

   c. Place a small portion of bacon in each of the three tin cans. Using the biconvex lens, concentrate the sun's rays on the bacon that is in one of the unpainted tin cans: Which piece of bacon cooked the quickest? Why?

2. How much hotter does a house get when the windows face south instead of north.--1 hour.

   The student will compare the amount of solar heat collected in south and north windows.

   CONCEPT: If a home is positioned correctly, it can be used as a passive solar collector.

   MATERIALS: 2 cardboard boxes (same size), white paint or paper, 2 thermometers, plastic wrap, knife(using teacher's discretion) masking tape.

   Cut a large hole in 1 side of both boxes, cover holes with plastic wrap, tape the wrap tightly over the holes. Paint both boxes white, or cover them both with white paper. Place one plastic front facing the sun, the other away from the sun. Place a thermometer in each box, and put them in the sun. Record the temperatures after 10 minutes, and 20 minutes, and 30 minutes. What do you find?

QUESTIONS: If you were designing a house in Alaska, on which side would you have the most windows? What about a house in Arizona?

DISPLAY THE SOLAR HOME

Some students might want to construct their own solar house (small)

3. Present film "Energy from the Sun"--available from NES

4. Have Mr. William Bennett, NES meet with the students to discuss active and passive solar energy, converting solar energy to electricity, heating and cooling with solar energy, and solar cells.

5. On a sunny day put a straight stick into the ground. Mark the position and length of its shadow every hour. When is the shadow longest? When is it shortest? Do you think the results would be the same one month from now?

6. In collecting solar energy, is bigger better?

The student will compare the effectiveness of different sizes of solar collectors.

CONCEPT: More solar energy can be collected by increasing the size of the collector.

MATERIALS: large disposable pie plate, small disposable pie plate, black paint (not water soluble--spray paint is easiest) thermometer, metric measuring cup, clear plastic food wrap, newspapers, styrofoam cups, masking tape, water, candle

Paint both pie plates black, When the paint dires, add 100 ml of water to each pie plate, wrap plastic wrap tightly around them, tape the plastic securely, record the temperature of the water in each plate. Place each on a stack of newspapers in the sun for 10 minutes. (Newspapers serve as insulation. Why is this important? Now pour the water into styrofoam cups and measure the temperatures.

QUESTION: Which plate had the hotter water? How can this information help you design a solar collector?

Refill the large pan. Using a candle, heat to the same temperature you recorded using the sun. How much did the candle cost? How much did the solar energy cost? What are the advantages of each?

Is solar energy free?

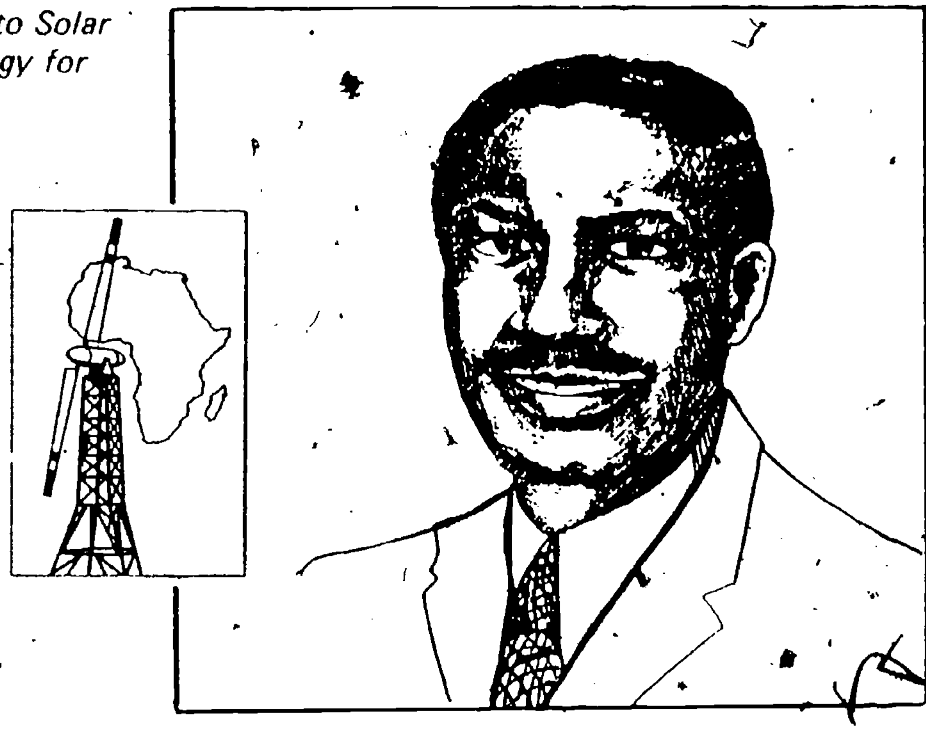
HAND OUT SHEETS ON "SOLAR ANGLES" AND WHERE POWER IS USED IN AN AVERAGE HOME.

Discuss different contributors of solar energy knowledge,
O. S. (Ozzie Williams, 1921-) First Black aeronautical engineer to be hired by Republic Aviation, Inc., He is in charge of trade and industrial relations with emerging African nations, here his work includes the application of solar and wind energy to African needs.

III. FUTURE OF SOLAR ENERGY

By the year, 2000, it is projected that almost 20% of the U.S. energy consumption will be used for heating and cooling of 75 million commercial and residential buildings. Solar energy, by its very nature, is particularly suited for low temperature heating and cooling applications.

From Rockets to Solar And Wind Energy for Africa



O.S. (Ozzie) Williams, 1921-

O.S. (Ozzie) Williams was the first Black aeronautical engineer to be hired by Republic Aviation, Inc., during World War II. Subsequently, he joined Greer Hydraulics, Inc., where he became a group project engineer and helped develop the first airborne radar beacon for locating crashed aircraft. A specialist in small rocket engine design, Williams also was associated with the Reaction Motors Division of Thiokol Chemical Corporation.

In 1961, he joined Grumman International, where he was in charge of developing and producing the control rocket systems that guided lunar modules during moon landings. This responsibility included administering nearly forty million dollars in subcontracts. Williams now is vice president of the firm, in charge of trade and industrial relations with emerging African nations; here his work includes the application of solar and wind energy to African needs.

Different methods of using solar energy in use today.

1. Photovoltaic (power generation) (electric)

   This is very expensive due to high cost and low efficiency of solar cells. But, this form of solar energy has been used extensively by NASA for many years (the Vanguard). One school in Niger, West Africa where the cheapest route for a school to take was to use solar cells and batteries.

2. Heat Generation

   Most common application of solar energy. Heating of hot water for domestic purposes and space heating, space cooling and steam production, and the heating of other materials for industrial utilization. The National Science Foundation recently funded two successful experiments, providing solar heat for a grade school in Timonium, Maryland and a high school in Dorchester, Massachusetts.

How does one justify whether a solar installation is "economically" feasible?

1. The usual technique is by the "life cycle" cost method.

2. The method requires forecasting into the future. One must predict such things as:

   energy escalation rate, inflation rate, maintenance increase rate, market discount rate, insurance and tax increase rate, mortgage rate, depreciation rate.

Cost of Solar Systems

1. collector costs are presently between \$11.00 and \$28.00/ft^2.

HAND OUT SHEET ON "SOLAR FACTSHEET"

EVALUATION

1. Why is energy from the sun so important to this planet?

2. Do you think there would be any way for life on Earth to survive without the sun?

3. Ancient peoples thought of the sun as a god. Most dictionary definitions of God include some words which could be used to describe the sun. Which of these words would you apply to the sun, and why?

4. Why do many plants turn yellow and die if kept from direct sunlight?

5. Why do dark-colored fabrics feel warmer to the touch on a sunny day than light-colored ones?

Films:

Great is the House of the Sun--21 minutes, 16mm, color
order film No. HQ 144
NASA Public Affairs Office (free rental)
Call or write: Marshall Space Flight Center, Alabama 35812

Our Mr. Sun--60 min. Southwestern Soundfilms
1709 South Lamar Street
Dallas, TX 75215

or call local business office of the Southwestern Bell Telephone Co,

"Sunbuilders--16mm, 20 minutes (free loan)
Regional Solar Energy Centers and Department of Energy
Film Library, Technical Information Center
P.O. Box 62, Oak Ridge, TN 37830

New Mexico Passive Solar Buildings, 16mm--13½ min. (free loan)
Deaprtment of Energy Film Library,
Technical Information Center,
P.O. Box 62, Oak Ridge, TN 37830

Design With the Sun: Passive Solar Architecture, 16mm, 27 min. (Rent)
Danamar Film Productions,
275 Kilby
Los Alamos, NM 87544

The Solar Promise, 16mm, 28½ min. (Rent)
Henry Mayer, M.D.
945 Middlefield Rd.
Redwood City, CA 94063

PUBLICATIONS

A Survey of Passive Solar Homes
Superintendent of Documents, Government Printing Office

Solar I
Oak Ridge Associated Universities
U.S. Department of Energy
Education Division
Office of Consumer Affairs
Washington, D.C. 20585
No. DE-AC05-760R00033