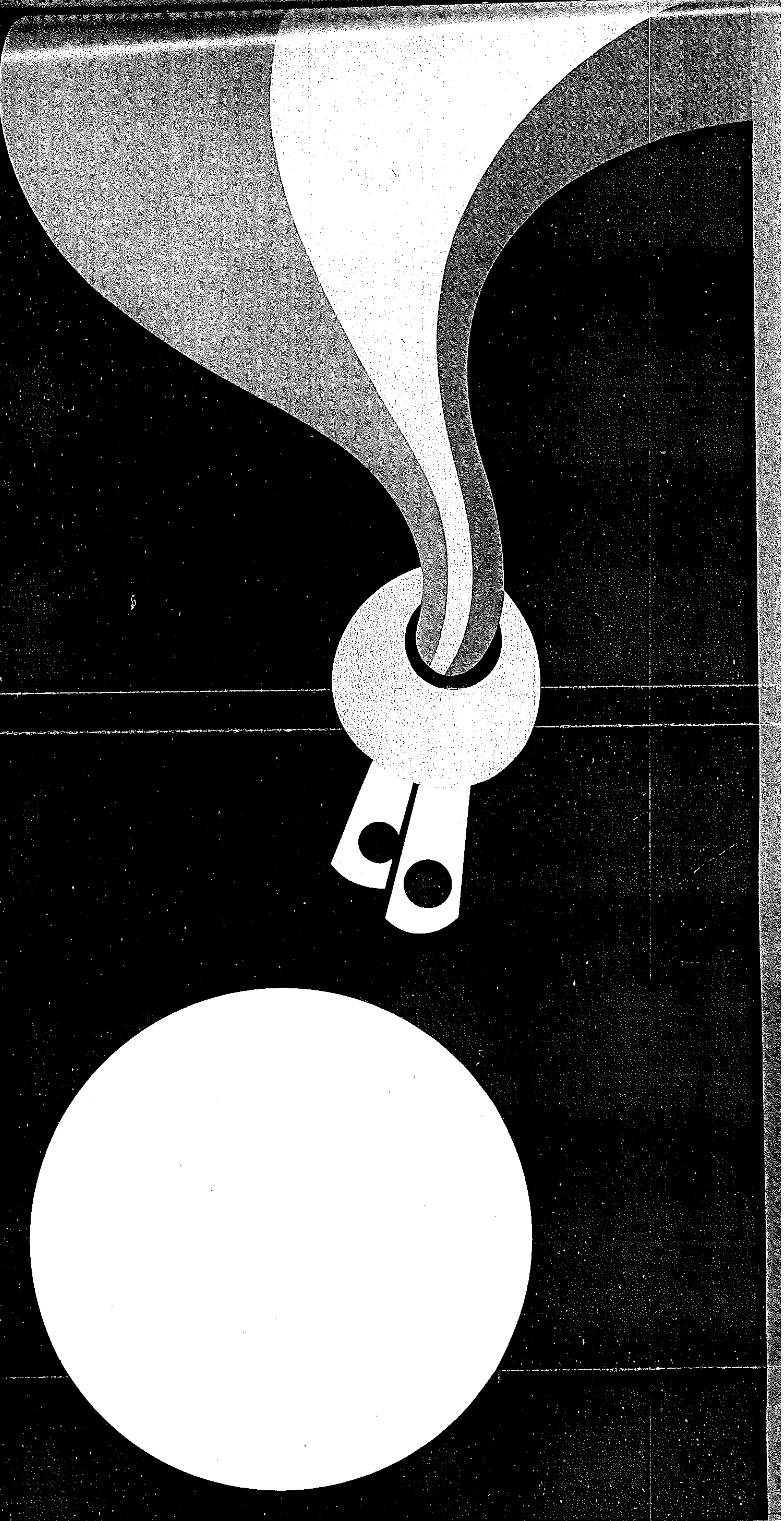
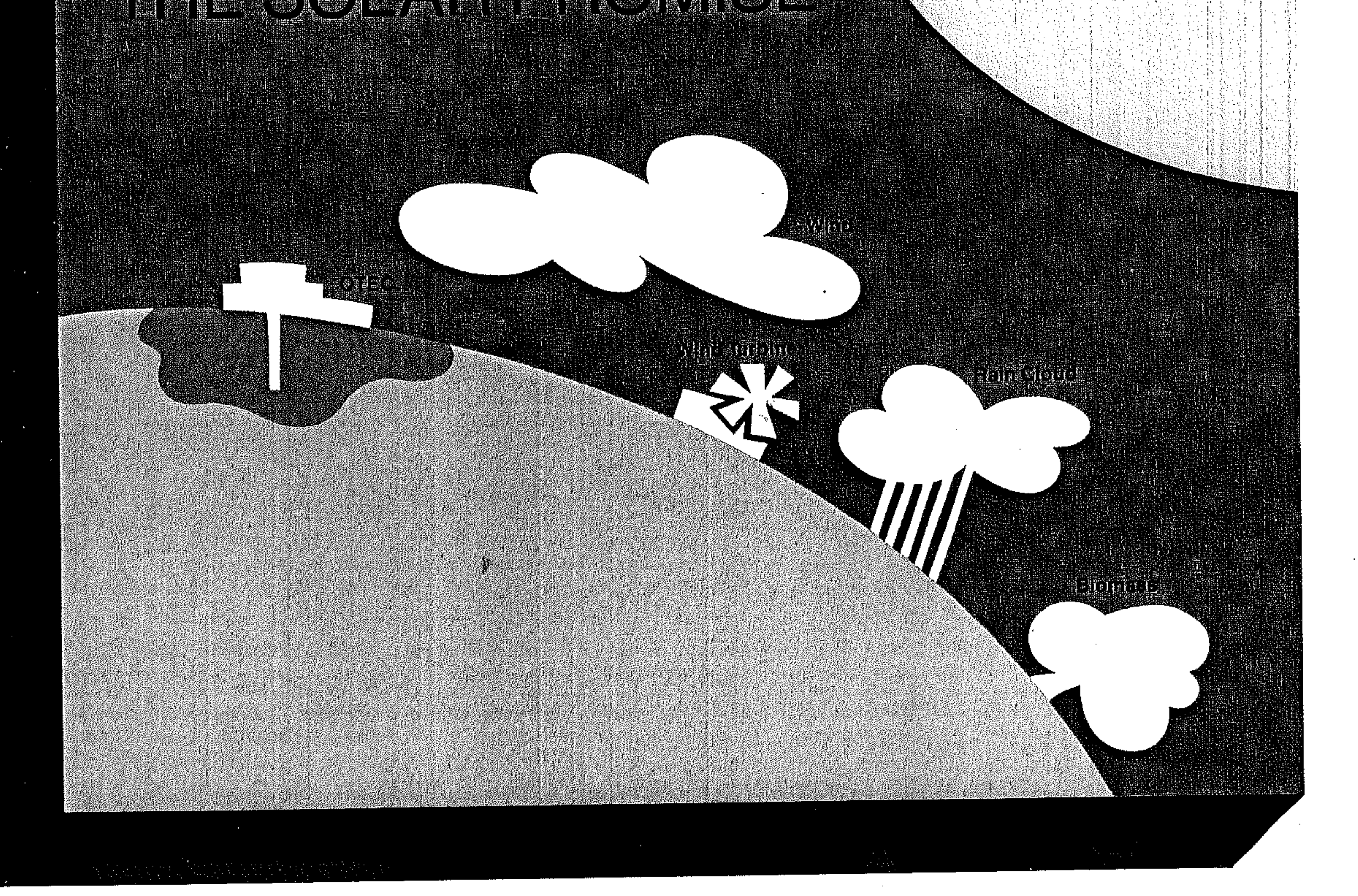


SOLAR PROMISE

THROUGH MOST OF HUMAN HISTORY THE SOLAR CONNECTION WAS TAKEN FOR GRANTED. NOW THERE IS SOMETHING NEW UNDER THE SUN. NAMELY, WHAT WE ARE LEARNING TO DO WITH IT.

Second in a series of three posters designed for an energy-enriched curriculum.

THE SOLAR PROMISE



The primitive groping for energy resources has given way to a managed effort to manufacture energy. Instead of just looking for direct physical sources of energy, we look for new ways of converting the energy from old sources.

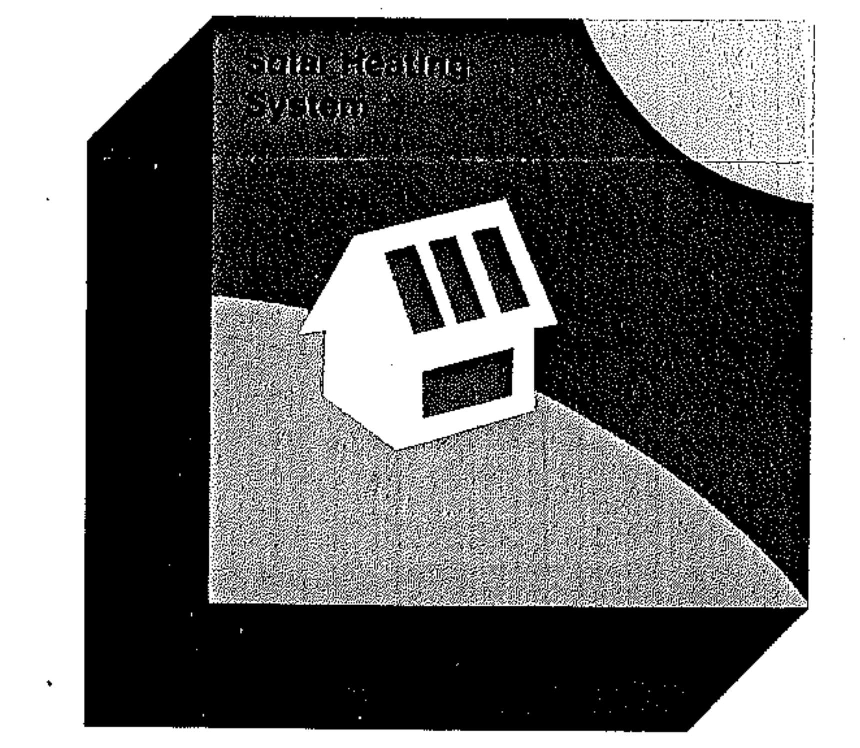
Sunlight is a case in point. Through most of human history, there wasn't much to do about sunlight, except to hope it came down when we wanted it. Solar reliability mattered most to farmers and sunbathers.

Today, as we look to the sun as a future source of electrical energy, the most important thing about the solar connection is that we have to make it. We can do this by collecting solar energy, concentrating it, converting it into heat or electricity, and storing and distributing it.

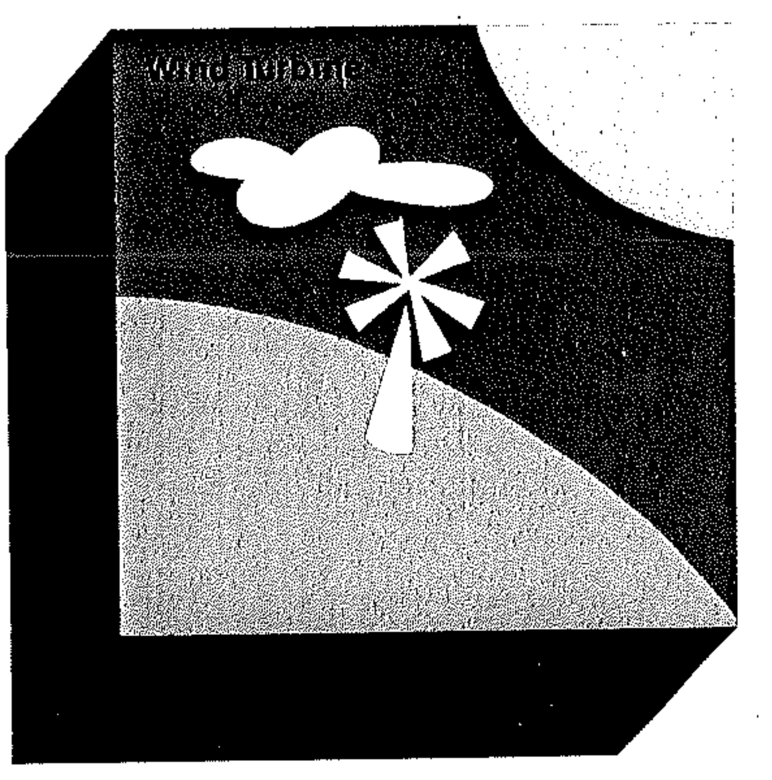
That's easier said than done. Obviously the sun is loaded with energy – so much that the equivalent of ten barrels of oil falls on every acre of the United States on an average day. If only we could collect it in barrels.

We can't. For one thing, the sun's energy is diffuse, spread out rather than concentrated (an acre, after all, is almost the size of a football field). All the solar energy normally falling on a square yard would barely keep a 200-watt bulb lit for a day. For another thing, it is erratic, available to us only by day and then subject to such variables as latitude and cloud formations.

Sunlight has been used to warm houses for centuries, but in the last decade there has been new development of solar heating systems to warm houses and heat water. There are two kinds of systems: *active*, in which moving air or water takes the heat from separate collectors and stores it in water or rock; or *passive*, in which the house itself collects and stores heat.

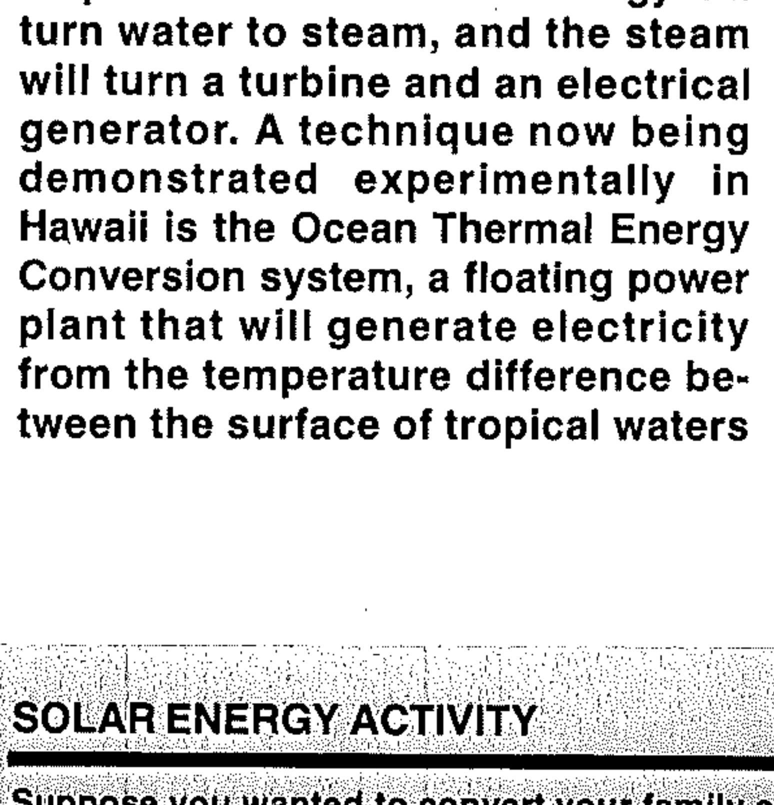


Solar energy for electricity sounds new but isn't. Most of the energy we now use came from solar energy that was stored in plants long ago and is available to us as the fossil fuels coal, oil and natural gas. Most of the electricity we use is produced by burning fossil fuels in power plants. Even hydroelectric plants use energy that is stored in water but that came originally from the sun. The wind is also converted solar energy.



There are a growing number of small windmachines on farms and in isolated communities today, and three huge (300 foot propeller blades) windmachines are being constructed on the Columbia River Gorge in Washington. A 200-foot propeller drives a generator on an experimental windmachine on a mountain near Boone, North Carolina.

The heat of solar energy can be converted to electricity as well. Under construction near Barstow, California is an array of mirrors which focus sunlight on a boiler at the top of a "solar powertower." Focused energy will turn water to steam, and the steam will turn a turbine and an electrical generator. A technique now being demonstrated experimentally in Hawaii is the Ocean Thermal Energy Conversion system, a floating power plant that will generate electricity from the temperature difference between the surface of tropical waters and the cool, deep currents.



Electricity can be produced directly from sunlight by a solar cell, in which sunlight passing through crystalline materials, called semiconductors, frees electrons to flow.

Solar cells are now expensive and not very efficient. But the raw material is readily available. Semiconductors can be made from purified silicon, the major component of sand. Although solar cell-generated electricity would now cost several times as much as electricity from traditional sources, new materials and inexpensive mass production techniques can make it an important energy source for the future.

ACTIVITY. Solar energy could serve many of our energy needs. Below are some exercises which will dramatize the promise and problems of solar energy. Remember, it must be collected over a large area (or by specialized collectors such as green plants) and must be stored for use at night or on cloudy days. Using a price of $10/watt for solar cells you can calculate how much a solar panel for powering an automobile would cost. You can also calculate the cost of a solar collector (at $100/M²) for a hot water system.

The following references provide a more thorough treatment of solar energy:

Hayes, Denis. RAYS OF HOPE: THE TRANSITION TO A POST-PETROLEUM WORLD. A Worldwatch Book. New York: W.W. Norton & Co., Inc., 1977.

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Second in a series of three posters designed for an energy-enriched curriculum. Sponsored by Westinghouse Advanced Power Systems Divisions.
Designed by Peter Bradford, Ralph Caplan, and Lorraine Johnson. Produced by the National Science Teachers Association, John M. Fowler, Director of Special Projects, 1742 Connecticut Ave., N.W., Wash., D.C. 20009

SOLAR ENERGY ACTIVITY

Suppose you wanted to convert your family car from gasoline or diesel to solar power using photovoltaic cells. How much collector surface would you need to drive your car at 55 miles per hour at noon on a bright sunny day?

STEP 1: How many Btu's do you need per hour?

$$\frac{\text{Btu}}{\text{hr}} = 55\,\frac{\text{miles}}{\text{hr}} \div \frac{\text{family car}}{\text{mpg*}} \times 125{,}000\,\frac{\text{Btu}}{\text{gal}} = \underline{\quad\quad}\,\frac{\text{Btu}}{\text{hr}}$$

STEP 2: Convert Btu/hr to kilowatts.

$$\text{Kilowatts} = \frac{\text{Btu}}{\text{hr}} \times 0.293\,\frac{\text{Watt-hr}}{\text{Btu}} \div 1000\,\frac{\text{Watts}}{\text{kilowatt}} = \underline{\quad\quad}\ \text{kilowatts}$$

STEP 3: How much solar cell area will be needed?

$$\text{Area in } M^2 = \underline{\quad\quad}\ \text{kilowatts} \div 1\,\frac{\text{kilowatt**}}{M^2} \div .15^{***} = \underline{\quad\quad}\ M^2$$

Does it seem that solar energy is well suited to powering a car? Why or why not?

*Use the EPA highway rated miles per gallon for your car or a car you would like.
**Power available at noon on sunny day. ***Maximum efficiency of solar cells.

Solar energy may be better suited to other uses, like heating water. Do the following calculations in order to find out the area of collector space you would need to heat the water in your house for a day.

STEP 1: How much hot water is used in your house in a day (5 minute shower = 100 liters (25 gal), bath = 100 liters, washing machine load = 160 liters, dishwasher load = 100 liters, other uses: estimate liters used)?
Total Hot Water Needs = ____ liters

STEP 2: How many kilowatt-hours will be needed to heat the water from 10°C to 60°C (50°F to 140°F)?

$$\text{kWh} = \underline{\quad\quad}\ \text{liters hot water} \times .056\,\frac{\text{kWh}}{\text{liter}} = \underline{\quad\quad}\ \text{kWh}$$

STEP 3: What area of collector would you need to heat the hot water?

$$\text{Area in } M^2 = \underline{\quad\quad}\ \text{kWh} \div .20\,\frac{\text{kW*}}{M^2} \div 24\ \text{hours} \div .40^{**} = \underline{\quad\quad}\ M^2$$

What use for solar appears to be most appropriate – hot water or automobile? What factors contribute to making this the best use of the available solar energy?

*Average solar energy averaged over U.S. for 24 hours. **Efficiency of solar hot water heaters.