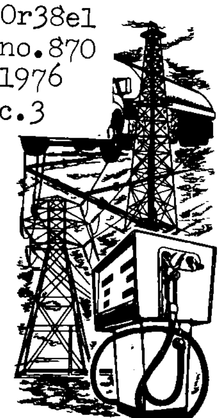


SOLAR ENERGY?

POSSIBLY . . . BUT NOT YET

Diminishing fossil fuel supplies, few remaining sites for additional dams, and increased concern over environmental pollution have caused solar heating and cooling to receive increasing attention.

Small solar heating units have been used, primarily to heat water, in Japan, Europe, India, Australia, and southern parts of the United States; but significant research on heating structures with solar energy was not conducted in the United States until about 1940.

At a national energy seminar sponsored by Oregon State University in 1975, it was estimated that home heating by some form of solar energy will increase and that one in every hundred United States homes may use this heating system by 1985.

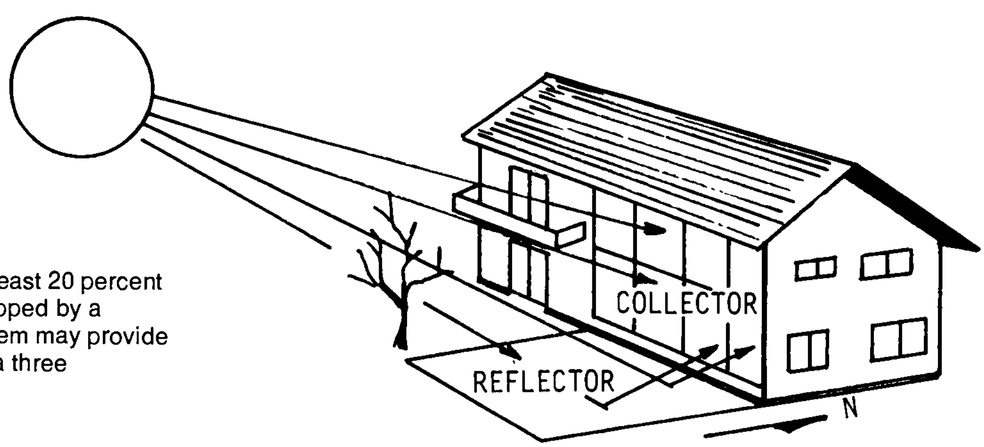
This leaflet discusses the potential for solar energy for home heating and lists suggested references for further study.

Solar Energy Received on Earth

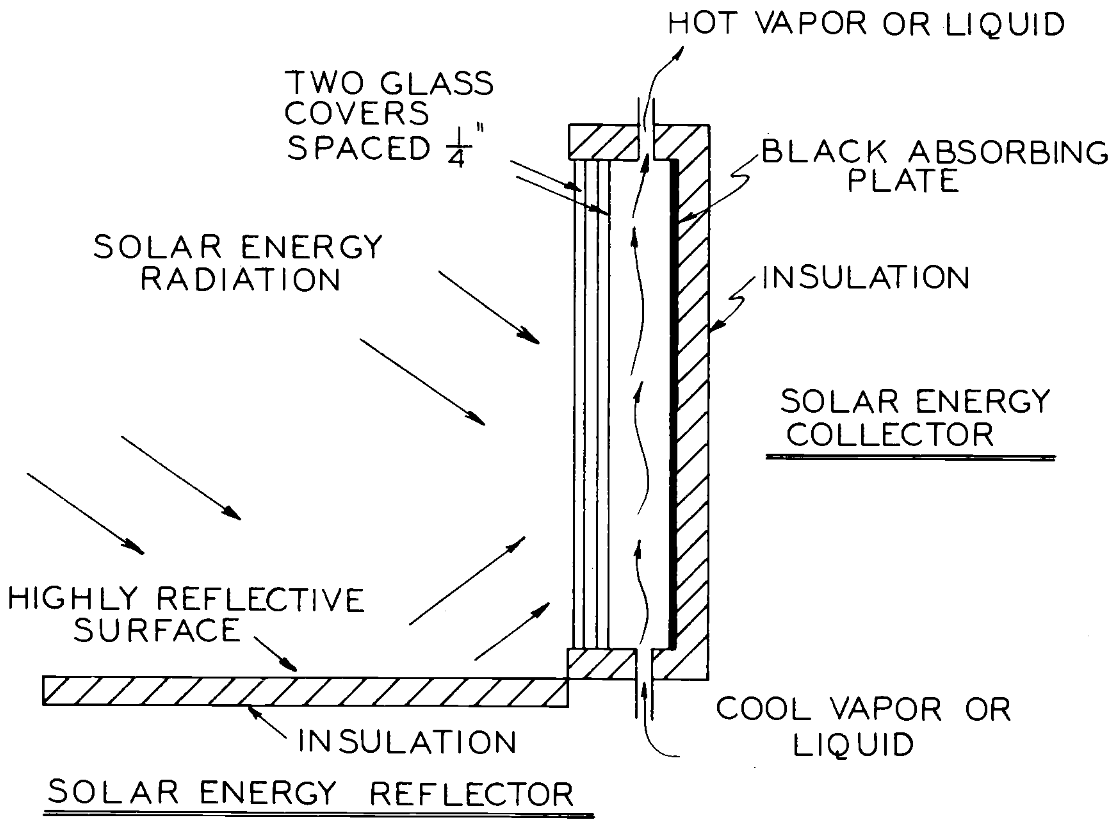
The solar energy generally received on the earth's surface on a clear day is under 280 Btu per hour per square foot. One Btu of energy will raise 1 pound of water 1° F; 3413 Btu equal one kilowatt hour. The amount of radiation received depends on the length of the path a ray travels through the atmosphere. Both direct and diffused solar radiation is received by the earth's surface. Diffused radiation results when direct beams of solar energy scatter after colliding with dust, smoke, water vapor, and other gases. On a cloudy day, most solar radiation is diffused; while on a clear day, the radiation is direct. The intensity of radiation from the sun at any one location varies with the time of day, time of year, and atmospheric conditions.

Reflecting Solar Energy

An object on the earth's surface receives additional solar energy when solar rays glance off a reflecting surface and hit the object. An average of 20 percent of the solar energy hitting an object on the earth's surface is from reflected radiation. Light colored surfaces are usually good reflectors. Some efficient reflecting surfaces for directing energy to a solar heat collector are bright aluminum sheet metal, aluminum paint with at least 20 percent metallic aluminum content, galvanized sheet metal, and polished copper plate. Bright surface conditions reflect over 60 percent of the radiant energy. A highly polished plate of aluminum or copper reflects over 80 percent of the solar heat rays.



A reflector can increase by at least 20 percent the amount of solar energy trapped by a collector, but even a large system may provide only half the heating needs of a three bedroom home.



This simple solar energy reflector and collector design traps the heated air or liquid between glass covers and a black insulation that absorbs heat.

Solar Heat Collection

A variety of solar heat collector designs are being researched. One simple design is shown above. The two glass covers on the front surface accept solar radiation readily and help trap the heat in the collector space behind the covers. (The narrow air space between the glass covers helps prevent heat from flowing back out of the glass surfaces.) The solar radiation goes through the glass and hits the black absorbing plate at the back of the collector space. The black surface will not reflect the sun's radiation, so much of the solar energy is collected and converted to heat. Air or liquid is passed over the black surface to transfer the heat to a heat storage area. The insulation on the three sides of the collector reduces heat loss.

Research investigations in western Oregon and Washington indicate that a fairly efficient solar heat collector surface facing south will collect, on an average January day, about 200 Btu of heat per square foot of collector surface per day. This is assuming that 30 percent of the solar radiation is collected. If we add a fairly efficient reflector to this collector and place it at a 90 degree angle to the collector surface, we can increase the collector heat capacity to about 300 Btu/ square feet of collector surface per day.

The collector in the design above is positioned at a 90 degree angle to the horizontal surface and reflector surface. In the Northwest a collector used without a reflector should tilt at a 50 to 60 degree angle to the horizontal surface. If a reflector is used, the angle should be increased to between 80 and 90 degrees.

Size of Collector

The size of the collector needed to supply an average three bedroom home with heat in January in the Northwest depends on many design factors. The simple collector-reflector combination design will collect approximately 300 Btu per square foot of collector surface on an average January day. Use the following guide to determine the size needed.

An average three bedroom home in western Oregon during January needs about 600,000 Btu per day for heating. This is in addition to the heat given off by home appliances and assumes a 15° F outdoor temperature. A well-insulated home of the same size needs about half that amount or 300,000 Btu per day.

If we build the collector to supply 300,000 Btu per day, the collector surface would need to be 1,000 square feet. If we need 600,000 Btu per day, the collector surface needs to be 2,000 square feet. These are large surface areas and in addition, the reflector surface should be much larger than the collector for good collection efficiency.

A well-insulated home reduces the size of the collector significantly. A well-insulated home has insulated windows, three inches of insulation in the walls, six inches or more in the ceiling, and two inches under the floor.

The collector surface areas of the few systems in use in the Northwest vary considerably with the system design and the use of reflectors. For a home system, the range of sizes varies from 400 to 800 square feet of collector surface and from zero to 2,000 square feet of reflector surface. Even the largest of these systems, operating efficiently, would provide only 50 to 70 percent of the heat needs for an average three bedroom home.

The range of solar heating capacity suggested for a Northwest home is from 40 to 70 percent of the total heating needs. The major limitation to size is economic: the amount of the capital investment as it relates to useful solar heat. The solar heating system must, in most cases, be considered a supplement to the standard home heating system.

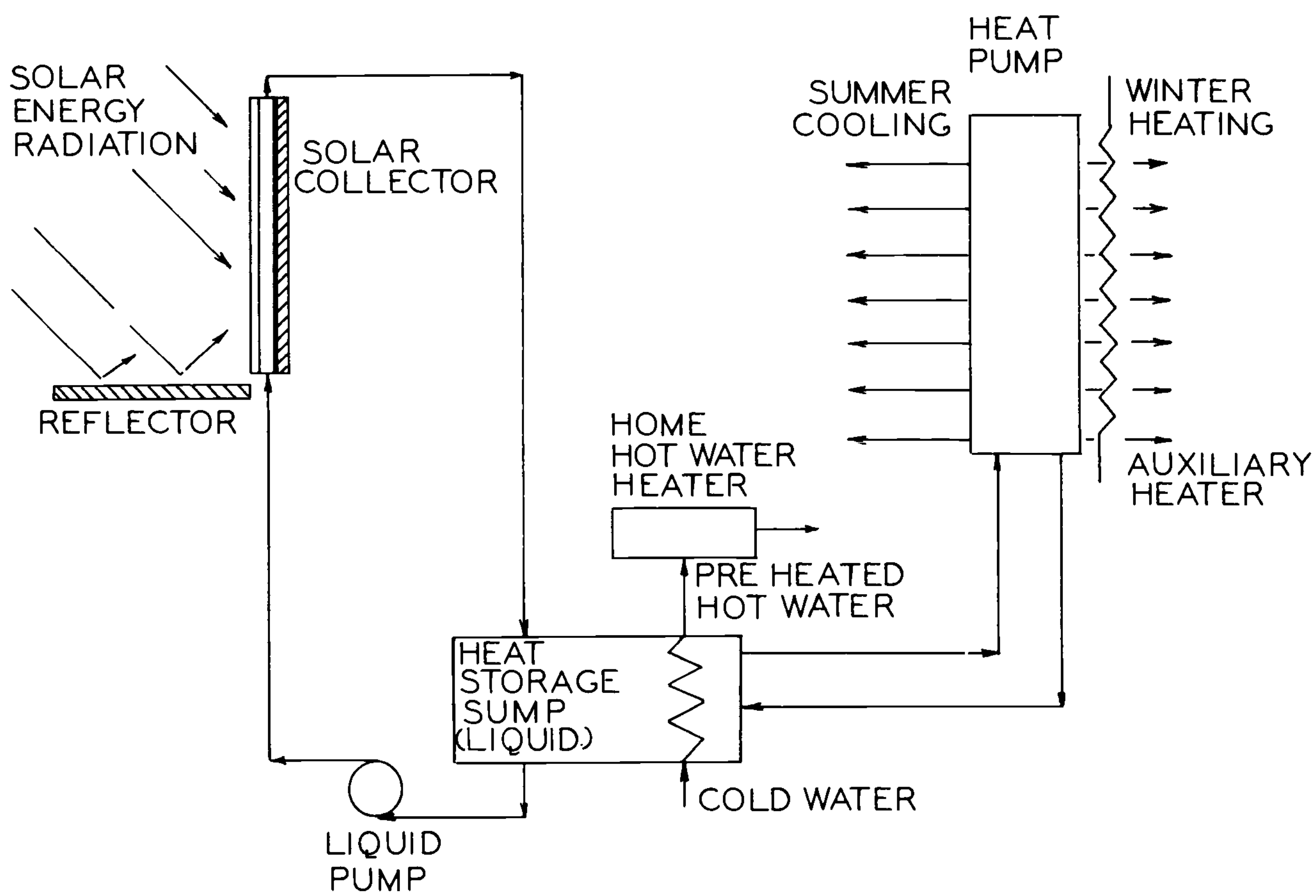
Storage of Solar Heat

Solar radiation provides an instant heat. On clear days, there is a relatively large amount of heat, but at night there is none. During a cloudy day, there is usually very little heat. During the cool season, continual heat is needed in a home to maintain a comfortable temperature. In order to use solar energy with some sort of uniform control, we need to store the heat.

Many storage systems are being investigated and have met with varying degrees of success. In one case, tons of rocks have been placed in a chamber and a vapor or liquid pumped through to heat the rocks during periods of solar radiation. This heat stored in the rock mass then can be used when solar energy is not available. Another storage system uses 1,000 or more gallons of water or similiar liquid stored in a container heated by solar energy. This hot liquid is then the source for uniform heat. For a three bedroom home, the heat storage chambers for water vary in size from 800 to 8,000 gallons, depending on other heating units used. This wide variation in liquid storage capacity is a result of such considerations as a lack of technical design data.

The solar collector, water heater and heat pump system shown below does not indicate the necessary controls and valves, but it does show one way a solar energy heating system can be combined with a conventional heat pump system. The heat pump works like a refrigerator, but with special controls, valves, and other devices, it either cools like an air conditioner or heats like an electric heater. During the winter, the heat pump takes heat from the heat storage sump tank; in the summer, the pump puts heat into the tank. Excess heat in the summer can be dispersed through the collector system at night or by evaporative cooling of the liquid during the day. Hot water for the home comes from the solar-heated water.

Water heated by the solar collector is both stored for home use and utilized by the heat pump for either home heating or cooling.



Solar System Cost and Evaluation

Solar heating for the home is still in the experimental stage. It is more economical in the northern United States to meet primary heating needs with a conventional heating system supplemented by a solar heating system than to rely only on solar heat. The cost of a supplemental solar heating system for a home varies from $2,000 to $10,000. The cost depends on the home owner's technical abilities and the amount of time he can devote to the project. A person planning a home solar heating system should consider the following points:

- A well-insulated home.
- A new home or an older home with a design allowing additions and modifications.
- Adequate space for a collector and an orientation to a southern exposure.
- Collector site free of shadows from buildings, terrain, and vegetation during the heating season.
- Local zoning and building codes that allow the system design.
- A climate that justifies using a solar system.

We can expect by 1985 that one percent of our home and building heating energy will come from solar energy. Home heating using solar systems primarily will be developed in southern United States. Other locations where sunny days are frequent during the heating season may also have some home solar heating systems. It is possible that by 1985 a housing group could be served by its own centrally located solar energy plant rather than being dependent on small, individual solar heating systems. The centrally located solar plant might also be suitable for a group of older homes that individually would not have suitable sites for solar heat collection and storage.

Solar heating for hot water has a popular appeal in southern United States and many foreign countries. In 1974, Japan reportedly sold 160,000 hot water units, and over 5,000 solar water heaters were known to be operating in southern United States.

The recommended references will be useful for those interested in learning more about solar energy.

Prepared by Walter E. Matson, Extension agricultural engineer, Oregon State University.

Recommended Reading

Energy Primer, Solar, Water, Wind and Bio Fuels, $4.50. Available from Whole Earth Truck Store, 558 Santa Cruz Ave., Menlo Park, CA 94025.

"Save Energy, Save Money" 303C. Free from Consumer Information, Public Documents Distribution Center, Pueblo, CO 81009.

"Solar Energy Utilization for Heating and Cooling," Chapter 59, *1974 Applications Handbook,* American Society of Heating, Refrigerating and Air Conditioning Engineers.

Solar Heating Systems for Houses, J. S. England, College of Engineering Circular 53, Washington State University, Pullman, WA 99163.

A catalog of solar products, research companies, projects and legislation is available for $20 from Environmental Action of Colorado, 2239 East Colfax, Denver, CO 80206.

Check your library for these:

"Can Sunshine Heat (and Cool) Your House?" *Popular Science*, March 1974.

"How to Trap Solar Heat with Your Windows," *Popular Science,* February 1975.

"Now You Can Buy Solar Heating Equipment for Your Home," *Popular Science,* March 1975.

"Solar Water Heater for Your Vacation Home," *Popular Science,* September 1974.

"Sunpower: The Heat's on for Real," *Popular Mechanics,* September 1975, pgs. 53-63, 119.

Available from: The Center for Environmental Research, School of Architecture & Allied Arts, University of Oregon, Eugene, OR 97403:

The Atypical Mathew Solar House at Coos Bay, Oregon. 1975. J. S. Reynolds, M. B. Larson and M. S. Baker. $1.00.

Insolation on Tilted Surfaces for Pacific Northwest Locations, 1975. M. S. Baker and J. S. Reynolds. $1.00.

Solar Energy for Pacific Northwest Buildings, April 1975. John S. Reynolds. $3.00.

Survey of Solar Buildings, 1975. R. L. Gray and M. S. Baker. $2.50.

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