DOE/CE-0068

INFORMATION
U.S. DEPARTMENT OF ENERGY

CONSERVATION AND RENEWABLE ENERGY INQUIRY AND REFERRAL SERVICE

Solar Energy and Your Home: Questions and Answers

DOE/CE--0068

DE84 008981

About a million Americans now live in solar homes. For the most part they are pleased with their solar energy systems and have become enthusiastic supporters of solar energy.

This factsheet provides a basic introduction to solar heating and cooling systems. It is intended for the many other homeowners who could benefit from living in a solar home.

Q. How Do Solar Energy Systems Work?

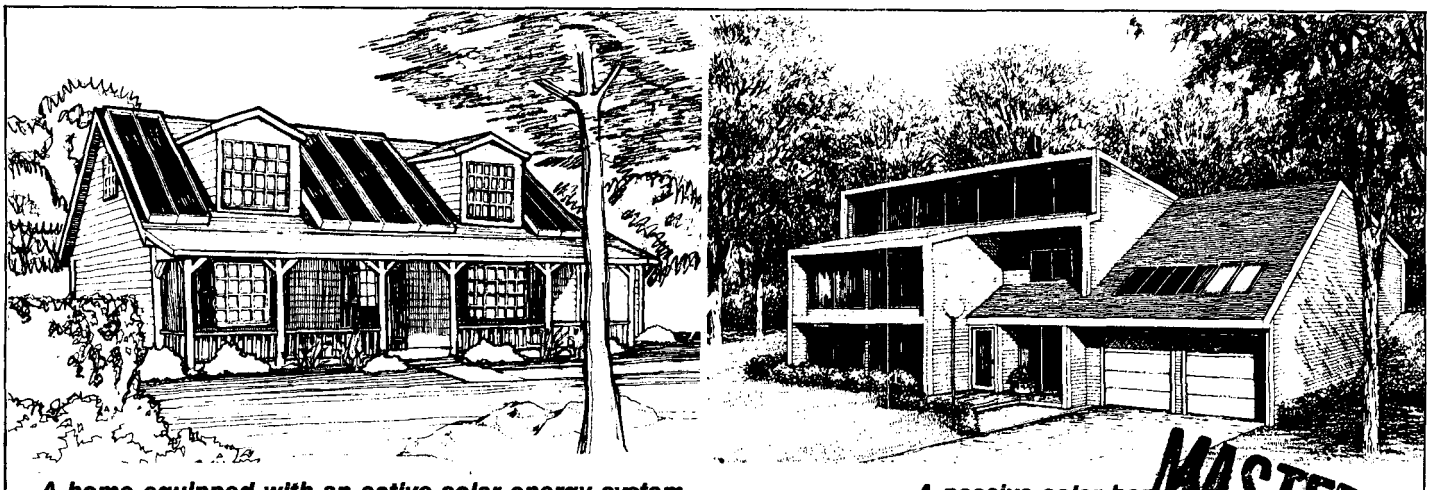
A. Solar radiation is absorbed by a collector and placed in storage. From there the stored heat is distributed to your living space. The performance of each operation is maintained and monitored by either automatic or manual controls. An auxiliary heater provides backup for times when the solar system is not working.

Q. What Kinds Of Solar Energy Systems Are There?

A. There are two basic types: active and passive. *Active* systems are divided into liquid and air systems. They use pumps and pipes (or fans and ducts) to carry heat from the collectors to storage, and from storage to the rooms of the house. *Passive* systems use the building itself to collect and store solar heat. Large windows act as solar collectors, and thick walls or floors store some of the heat for later use. Sunspaces that collect solar energy for the main living area are one of the most popular passive systems.

Q. What Should I Consider Before Deciding to Invest In Solar?

A. You should look carefully at the



A home equipped with an active solar energy system

A passive solar hom

FS 176, 2nd Edition, January 1984

DISCLAIMER

trade-offs between the higher installation and equipment costs of a solar energy system compared to the money you will save by using a smaller amount of conventional fuel.However, there may be non-economic reasons for using solar too. For example, people living in passive solar homes report that they prefer the radiant heat emitted by passive storage elements to the heat provided by conventional systems.

Q. Will I Be Able To Get A Mortgage Or A Home Improvement Loan To Install A Solar Energy Domestic Water Or Space Heating System?

A. Obtaining a loan for solar energy retrofit or a mortgage for a new solar home should not pose any special problems. Most lending institutions will consider making solar loans, and some are promoting the use of solar energy by offering better terms for solar loans. If possible, try to secure a loan from a bank that has financed solar energy systems before. As banks become more familiar with solar, their terms sometimes become more favorable.

The Federal Housing Administration will insure mortgages for homes with solar systems that meet HUD standards. The maximum level of mortgage insurance allowed by the Federal Housing Administration (FHA) may be increased by 20% to cover the additional cost of the solar system. In addition, the Farmers Home Administration and Veterans Administration operate loan insurance programs for solar energy systems.

ACTIVE AND PASSIVE SYSTEMS - A COMPARISON

ACTIVE	*PASSIVE*
Q. Will I Have To Modify My Home Before Installing A Solar Energy System?	
A. Probably. Unless your home is very tight (air infiltration is at a minimum) you should add insulation, caulking, weatherstripping, and storm windows. Solar collectors are usually mounted on the roof. Storage tanks or bins are usually located in basements, but they can be placed underground or outside the home. If you add solar equipment to your existing heating system, you may have to allow for piping or duct work connections.	**A.** As with active systems, you will need to take conservation measures first if your house is not sufficiently sealed against infiltration. The simplest passive retrofit uses one or more south-facing windows. Sometimes existing windows can be used as they are. However, "thermal storage," such as containers of water or a masonry floor or wall, must be added if it's not already present. This will allow some heat to be stored for sunless periods.
Q. Should I Use An Active System Or Passive System?	
A. Active systems can be used in either new or existing houses. Although they are easier to install in existing homes, active systems are more complicated and expensive than passive systems.	**A.** Passive solar energy systems are simple, and less likely to need repairs than active systems. They are best suited to new constructions - where the passive elements can be included in the home's design. However, passive systems can sometimes be added to existing homes.
Q. How Does The Heat Get Distributed Throughout The House?	
A. There are basically two ways that the heat from the collector or storage area can reach the rooms of your house. Heat can circulate through a forced air duct system that distributes the warm air. Or it can be circulated as hot water in radiators or baseboard units, with the water being preheated by solar and brought up to the required tempertature by the backup system. In many cases, this means that your present heating system can be adapted to distribute solar heat.	**A.** Naturally, through convection, conduction, and radiation. *Conduction* occurs when heat moves through a solid. If you've ever touched the metal handle of a frying pan while cooking, you've experienced conductive heat transfer. *Convection* is how heat moves through air or water. For example, warm air rises because it is lighter than cold air, which sinks. This is why the second floor of a house is warmer than the first floor. *Radiation* is heat moving as a wave, similar to light. Inside a house, a warmed surface emits heat, (infrared) radiation, that travels toward cooler areas.

ACTIVE AND PASSIVE SYSTEMS - A COMPARISON

ACTIVE	*PASSIVE*
Q. How Do I Heat My House At Night?	
A. All day the heat generated in the collectors has been transferred to the storage system (liquid systems store heat in a water tank while air systems use a rock-filled bin). A second set of pipes (for liquid) or ducts (for air) is used to circulate heat from storage to the rooms of your house.	**A.** As mentioned before, passive systems usually include at least one storage mass that absorbs heat all day. Enough heat can be stored by a well-designed passive building to keep it warm after the sun has set and through the night.
Q. But What Happens If There Are A Few Cloudy Or Very Cold Days In A Row?	
A. After the heat in storage is exhausted, an auxiliary heater takes over. Any standard furnace fueled by oil, electricity, coal, or gas can be used.	**A.** The storage components can absorb enough heat to last through a day or two of sunless weather. After that, an auxiliary heater is used. Many passive homeowners find that a wood stove provides all the backup heat they need.
Q. Can A Solar Energy System Produce Air Conditioning?	
A. The heat from an active solar energy system can be used to drive an absorption air conditioner, but these systems are much more expensive than conventional systems. This may change within the next several years as research and development in this area continues.	**A.** Homes can be designed to incorporate passive solar air conditioning systems. Such systems are inexpensive and efficient, but they work best in climates with low humidity and cool nights. However, basic passive cooling techniques such as shading windows with overhangs, awnings, or trees can be used anywhere.
Q. How Is Hot Water Produced For Household Use With A Solar Energy System?	
A. Active solar hot water systems are basically smaller and simpler versions of space heating systems. In most systems, heated fluid is drawn from the solar collectors and runs through a coil in the water tank. Water is circulated through a second coil in the tank, heated, and drawn off for domestic use. Constructing a solar domestic hot water system this way prevents any anti-freeze solution from leaking into your hot water supply.	**A.** Passive water heaters, like all passive solar energy systems, operate without external power. They rely on gravity and natural convection instead of electricity. Thermosiphon systems - the most common passive water heater - consist of a solar collector panel to absorb solar heat and a separate storage tank to hold solar heated water. When the water in the collector is heated it becomes more buoyant and rises to the top of the storage tank.

Q. Are There Tax Advantages To A Solar Energy System?

A. As of February 1984, forty-two states had passed legislation to encourage the use of solar energy. These laws are usually in one of the following forms:

- Property tax exemptions or deductions
- Income tax credits or deductions
- Sales tax exemptions

Call your state energy office to find out about the solar legislation in your state. Also, federal tax incentives for solar installations were increased by Congress in 1980. For more information about these laws contact the Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS).

Q. How Can I Obtain Detailed Information About Building A Home Using Solar Energy Or Installing A Solar Energy System In My Present Home?

A. If you are interested in building a solar home or incorporating a solar energy system into your present home, you will probably need to hire a professional. Your state energy office or local solar association may be able to provide a list of solar professionals in your state.

In addition, you can contact the local chapter (or the national headquarters if necessary) of one of the following associations:

NATIONAL ASSOCIATION
OF HOME BUILDERS
15th and M Streets, NW
Washington, D.C. 20005

AMERICAN INSTITUTE
OF ARCHITECTS
1735 New York Avenue, NW
Washington, D.C. 20006

AMERICAN INSTITUTE
OF BUILDING DESIGN
1421 19th Street
Sacramento, CA 95814

ACTIVE AND PASSIVE SYSTEMS - A COMPARISON

ACTIVE	*PASSIVE*
Q. How Much Will A Solar Energy System Cost?	
A. That depends on the design and size of the house, climatic conditions, and the type and size of the desired system. Combined active space heating and hot water systems range in price from $10,000 to $20,000. Domestic hot water systems alone run between $3,500 to $4,500 in northern climates, and $2,000 to $4,000 in the Sunbelt.	**A.** Generally, incorporating passive features for space heating and cooling will add 5-10% ($5,000-$10,000) to the cost of a new home. Adding a greenhouse or other passive system to an existing house will also cost $5,000-$10,000. Owner-built systems may cost less than this, and some custom-designed systems will cost more. Passive water heaters retail for between $400 and $3,000. They can be built by do-it-yourselfers for under $650.

Q. How Can I Locate Manufacturers And Distributors Of Solar Energy Equipment?

A. Check your yellow pages. If you are interested in an active system look under "Solar Energy Equipment" or "Water Heaters - Dealers." Passive products are not listed under a central heading, so you'll have to look under the specific product heading such as greenhouses, glass, or window shades.

Q. I Would Like To See Some Solar Homes In My Area. Where Can I Find Them?

A. Your state energy office may be able to provide you with a listing. Also check with local solar associations; often these groups conduct tours of solar homes.

Q. Where Can I Get More Information On Solar Energy?

A. The Conservation and Renewable Energy Inquiry and Referral Service, P.O. Box 8900, Silver Spring, MD 20907, will be happy to answer your questions about solar heating and cooling systems. If CAREIRS cannot answer your question, they will refer you to the public or private organization that can.

The following books and periodicals are non-technical sources of more detailed information.

Books

A GOLDEN THREAD: 2500 YEARS OF SOLAR ARCHITECTURE AND TECHNOLOGY ... K. Butti and J. Perlin; Van Nostrand Reinhold Co., New York, NY 10020, 1980, 297 pp, $4.95. The history of solar energy usage from the Greeks to today.

ENERGY FUTURE - REPORT OF THE ENERGY PROJECT AT THE HARVARD BUSINESS SCHOOL ... R. Stobaugh and D. Yergin; Random House, New York, NY 10022, 1980 (2nd ed.), 493 pp, $2.95. Considers the role various energy technologies can play in our future. Concludes that more emphasis should be placed on conservation and solar energy.

THE FOOD AND HEAT PRODUCING SOLAR GREENHOUSE ... B. Yanda and R. Fisher; John Muir Publications, P.O. Box 613, Santa Fe, NM 87501, 1980 (revised), 208 pp, $9.00. Explains how to design and construct a solar greenhouse. Covers the state of the art and describes a planting, maintenance and harvesting procedure for producing fruits and vegetables.

HOT WATER FROM THE SUN ... B. McPherson; Franklin Research Center, 1980, 123 pp, $6.50, GPO Stock No. 023-000-00620-1, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. A complete guide to active solar hot water systems. Includes feasibility, types of systems, choosing a solar contractor, and economics.

HOW TO BUILD A SOLAR HEATER ... T. Lucas; Crown Publishers, Inc., New York, NY 10016, 1980 (revised), 256 pp, $7.95. How to build both air and liquid active solar collectors. Also covers choosing between systems.

THE INTEGRAL PASSIVE SOLAR WATER HEATER BOOK ... D. Bainbridge; Passive Solar Institute, P.O. Box 722, Bascom, Ohio 44809, 1981, 102 pp, $10.95. Covers the history, design, and operation of breadbox water heaters. Also tells you how to build your own.

NEW INVENTIONS IN LOW-COST SOLAR HEATING ... W. Shurcliff; Brick House Publishing Co., 34 Essex St., Andover, MA 01810, 1979, 239 pp, $12.00. Describes over 65 low-cost solar energy systems, both passive and active. Evaluates each system in terms of performance and practicality.

PASSIVE RETROFIT HANDBOOK ... Thompson, Hancock, Witte and Associates, Inc., 1980, 174 pp, $10.00. Available from Southern Solar Energy Center, 61 Perimeter Park, Atlanta, GA 30341. A handbook written for consumers. Describes how passive systems work and how to build them.

THE PASSIVE SOLAR ENERGY BOOK ... E. Mazria; Rodale Press, 33 E. Minor St., Emmaus, PA 18049, 1979, 435 pp, paperback $14.95, hardback $16.95, professional edition $29.95. Provides detailed information on the design of passive solar homes and greenhouses. Gives the rules-of-thumb needed for sizing any passive system.

PASSIVE SOLAR ENERGY: THE HOMEOWNERS GUIDE TO NATURAL HEATING AND COOLING ... B. Anderson and M. Wells; Brick House Publishing Co., 34 Essex St., Andover, MA 01810, 1981, 208 pp, $8.95. A basic introduction to passive solar heating and cooling.

SOLAR DWELLING DESIGN CONCEPTS ... AIA Research Corporation; Stock No. 023-000-00334-1, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, 1976, 146 pp, $6.50. Discusses all facets of solar home heating, includes information on the impact of solar energy use on traditional dwelling design.

SOLAR FUN BOOK: 18 PROJECTS FOR THE WEEKEND BUILDER ... J. Barling; Brick House Publishing Co., 34 Essex St., Andover, MA 01810, 1979, 120 pp, $7.95. Complete instructions for building cooking devices, water and air heaters, concentrating collectors and other solar gadgets and systems.

THE SOLAR HOME BOOK ... B. Anderson and M. Riordan; Brick House Publishing Co., 34 Essex St., Andover, MA 01810, 1976, 297 pp, $14.95. Covers active and passive systems, do-it-yourself solar water heating, retrofitting, and social and cultural implications.

SOLAR RETROFIT: ADDING SOLAR TO YOUR HOME ... D. Reif; Brick House Publishing Co., 34 Essex St., Andover, MA 01810, 1981, 206 pp, $8.95. Gives step-by-step instructions for adding four systems to a home: Direct Gain (passive), Thermosiphoning Air Panel (passive), Horizontal Air Flow Collector (active), Attached Solar Greenhouse (passive).

SUN REFLECTIONS: IMAGES FOR THE NEW SOLAR AGE ... J. Cole; Rodale Press, 33 E. Minor St., Emmaus, PA 18049, 1981, 250 pp, $10.95. All about the sun - its characteristics and how its has been viewed through the ages. Includes the pictures and words of scientists, philosophers, and other men and women from all walks of life.

SUNSET'S HOMEOWNER'S GUIDE TO SOLAR HEATING ... Sunset Books; Lane Publishing Co., Menlo Park, CA 94025, 1978, 96 pp, $3.95. An introduction to active and passive solar energy systems; includes many photographs and drawings.

Periodicals

RODALE'S NEW SHELTER ... Rodale Press, 33 E. Minor St., Emmaus, PA 18049, published 9 times per year, $10.97/year. Written for do-it-yourselfers. Often contains articles on solar energy projects.

SOLAR AGE ... Solar Vision, Inc., Church Hill, Harrisville, NH 03450, published monthly, $24.00/year. Surveys new solar buildings and technological breakthroughs.