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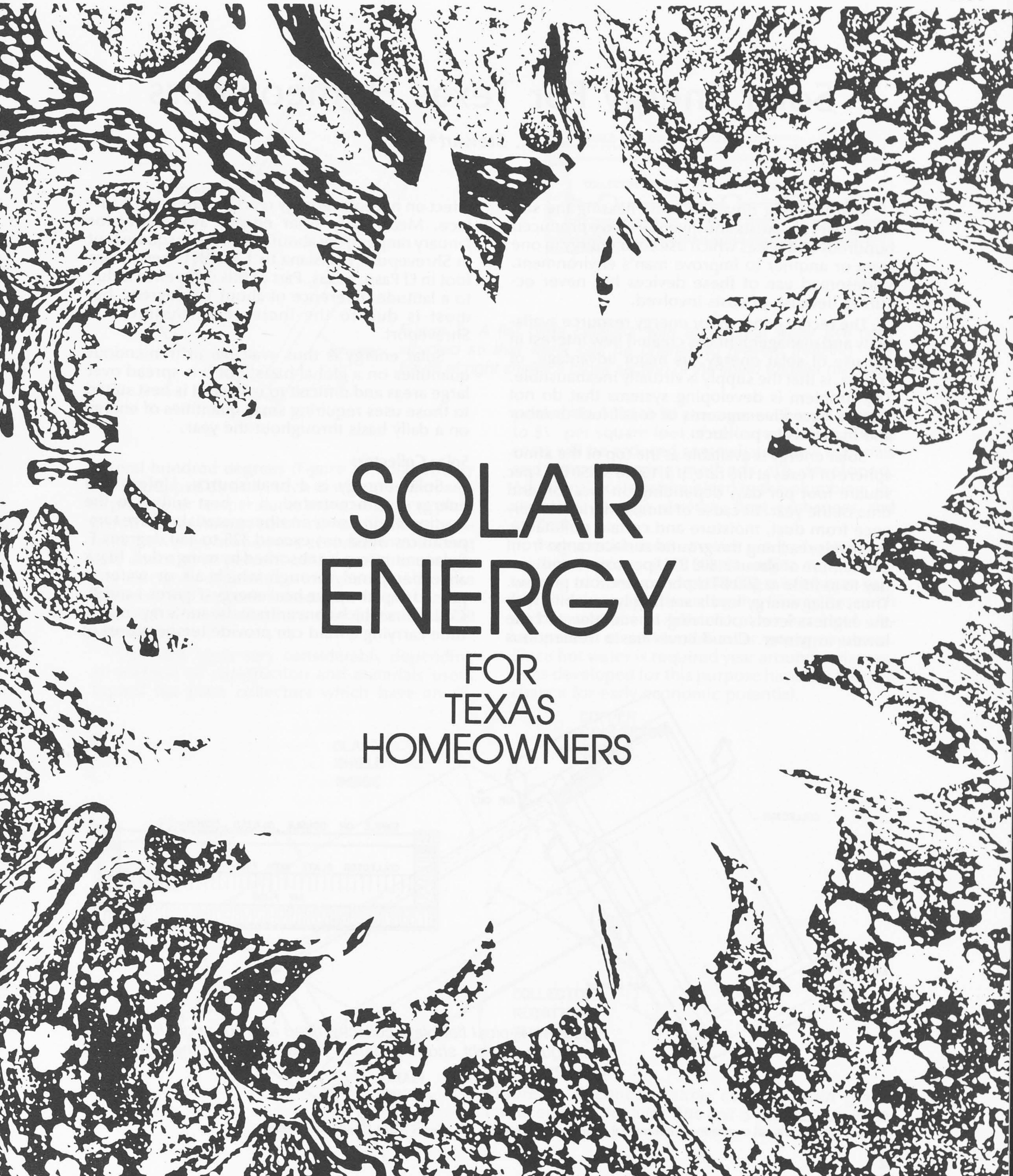


SOLAR ENERGY

FOR TEXAS HOMEOWNERS

Texas Agricultural Extension Service • The Texas A&M University System • Daniel C. Pfannstiel, Director • College Station, Texas

Solar Energy For Texas Homeowners

*B. R. Stewart**

Man has long dreamed of harnessing the sun for his use. Scientists and inventors have produced hundreds of devices which use solar energy in one form or another to improve man's environment. Widespread use of these devices has never occurred because of costs involved.

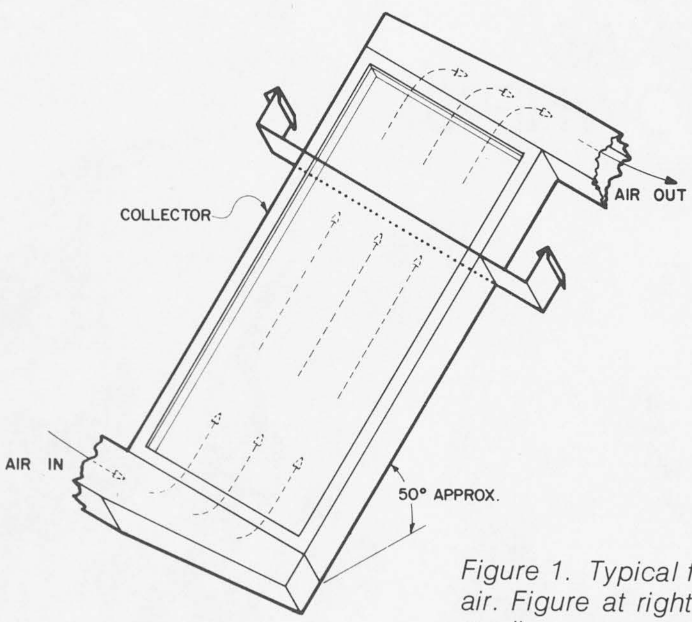
The recent concern for energy resource availability and management has created new interest in the use of solar energy. Its major advantage, of course, is that the supply is virtually inexhaustible. The problem is developing systems that do not require excessive amounts of fossil fuel or labor and materials to produce.

Solar energy is available at the top of the atmosphere of Texas at the rate of 1,160 to 3,650 BTU per square foot per day, depending on location and time of the year. Because of atmospheric interference from dust, moisture and certain pollutants, the levels reaching the ground surface range from a maximum of about 2,800 BTU per square foot per day to as little as 500 BTU per square foot per day. Thus, solar energy levels are highly variable, with the highest levels occurring in summer and the lowest in winter. Cloud cover has a tremendous effect on net solar energy reaching the earth's surface. Mean daily solar energy availability for January ranges from about 860 BTU per square foot in Shreveport, Louisiana to 1,250 BTU per square foot in El Paso, Texas. Part of this difference is due to a latitude difference of about 1.5 degrees, but most is due to the increased cloudiness at Shreveport.

Solar energy is thus available in tremendous quantities on a global basis, but it is spread over large areas and difficult to collect. It is best suited to those uses requiring small quantities of energy on a daily basis throughout the year.

Solar Collectors

Solar energy is a heat source. Unless this energy is concentrated, it is best suited to the heating of air, water or other materials where temperatures need not exceed 120 to 150 degrees F. Solar energy can be absorbed by using a dull, black absorber panel through which air or water is passed to pick up the heat energy (Figures 1 and 2). Collectors which concentrate the sun's rays onto a tube carrying a fluid can provide temperatures of



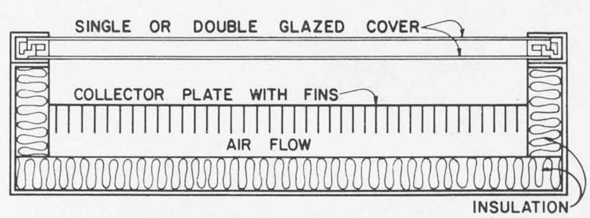


Figure 1. Typical flat plate collector tilted at a 50° angle for heating air. Figure at right shows a partial cross section of the air transfer medium.

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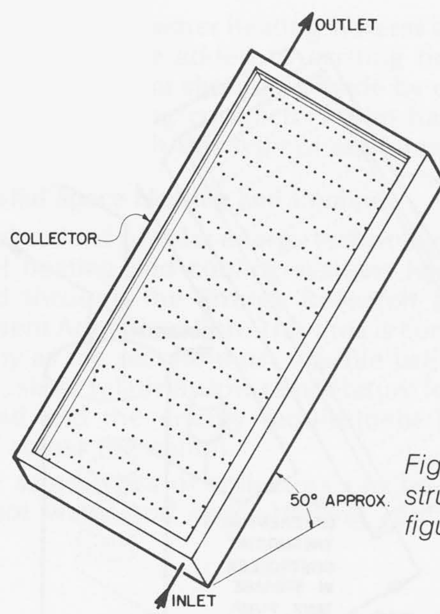

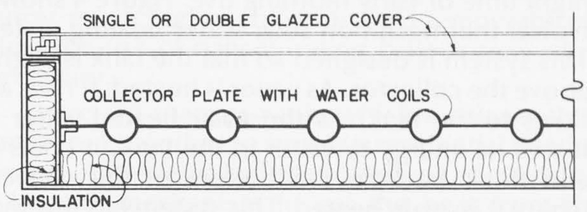

Figure 2. A flat plate collector with an integral water coil constructed so that water can be drained to prevent freezing. The figure at right shows a cross section of the liquid transfer medium.

several hundred degrees (Figure 3). Solar energy can be trapped directly, such as with greenhouses, to provide air temperatures more suitable to plant growth or for human comfort. Most collector systems, however, have been successful in collecting only about 40-70 percent of the available energy. The efficiency depends on many factors; in some instances the amount collected is nearer 90 percent and in other situations may be as low as 20 percent.

Collector costs vary considerably depending on method of construction and materials used. Typical flat plate collectors which have an expected life of 15 to 20 years generally cost from $8 to $12 per square foot of collector surface. These costs will be reduced somewhat as new materials and manufacturing methods are developed. Additional costs are involved in the plumbing, installation, storage devices, heat exchanges and controls.

Perhaps the most diverse use to be made of moderate temperature water and/or air is in the heating of homes and providing a hot water supply. Thus, a major thrust by the Energy Research and Development Administration has been development of residential solar energy systems. Since hot water is required year around, solar systems developed for this purpose have the greatest chance for early economic potential.

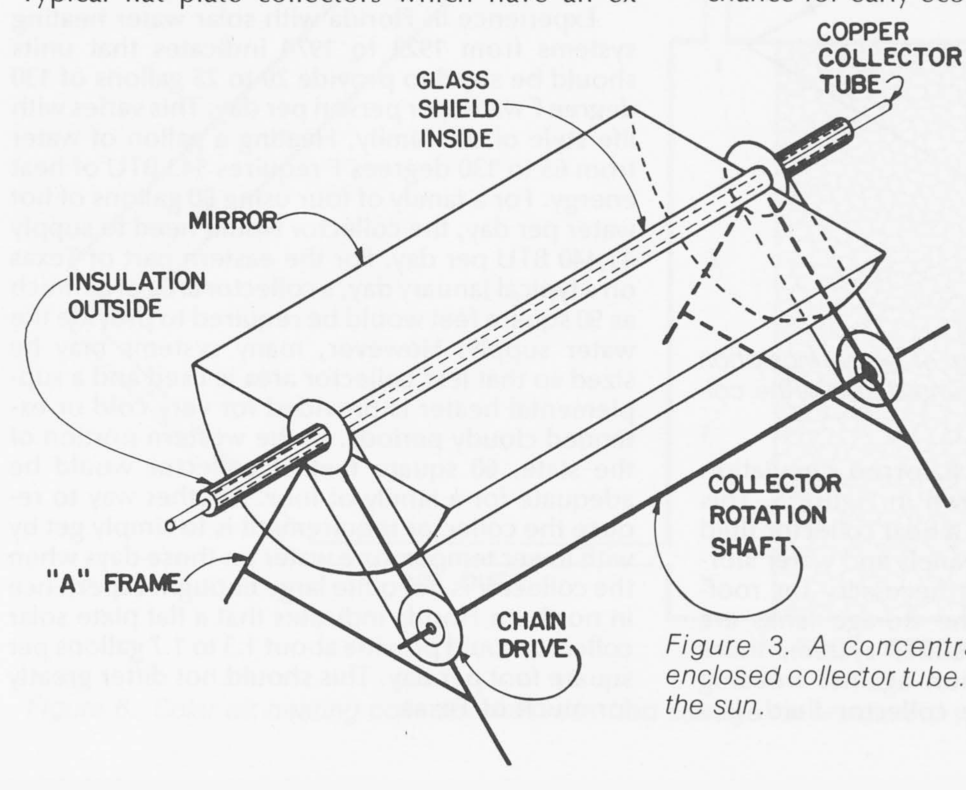

Figure 3. A concentrating collector with glass enclosed collector tube. The unit is designed to track the sun.

Hot Water Heating

Solar energy systems for heating water must include provisions for storing much of this heat for night time or early morning use. Figure 4 shows a typical thermosiphon solar water heating system. This system is designed so that the tank is slightly above the collector. As water is heated, it rises and flows to the tank. As the solar heated water releases its energy to water in the tank, it cools off and flows back to the bottom of the collector where it is again heated. This system has few moving parts and little or no operating cost.

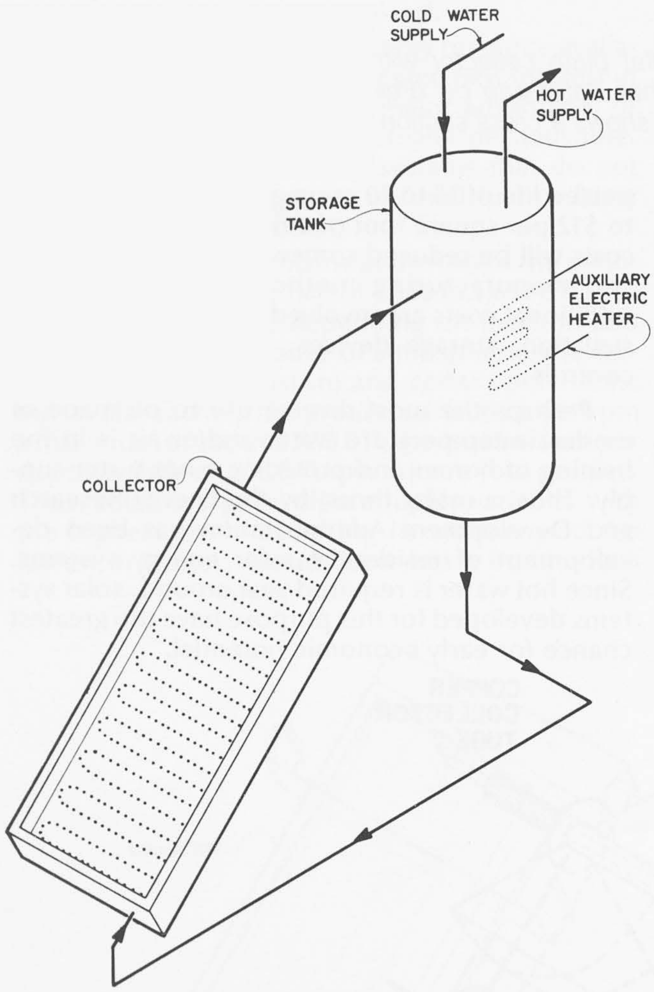

Figure 4 . Simplified drawing of a thermosiphon water heater. The tank is mounted above the collector.

A simplified drawing of a forced circulation water heating system is shown in Figure 5. This system uses a pump to force a heat collector fluid through the solar collector panels and water storage tank. Use of a pump is necessary for roof-mounted collectors when the storage tanks are below the collector. With either system, there must be adequate protection against freezing where water is used as the collector fluid. If a

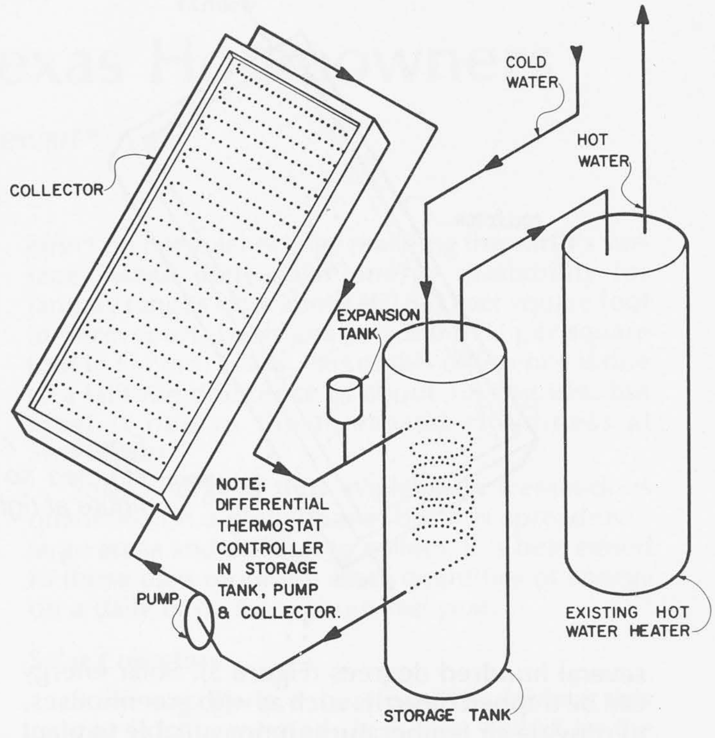

Figure 5. Typical forced circulation water heater which can be attached to an existing water heater system.

freeze-resistant fluid such as propylene glycol is used in the collector, the storage tank must have a heat exchanger installed to keep the collector fluid separate from the water supply system. Controls and plumbing can vary considerably and must meet local building codes.

Experience in Florida with solar water heating systems from 1923 to 1974 indicates that units should be sized to provide 20 to 25 gallons of 130 degree F water per person per day. This varies with life style of the family. Heating a gallon of water from 65 to 130 degrees F requires 543 BTU of heat energy. For a family of four using 80 gallons of hot water per day, the collector would need to supply 43,440 BTU per day. For the eastern part of Texas on a typical January day, a collector area of as much as 90 square feet would be required to provide the water supply. However, many systems may be sized so that less collector area is used and a supplemental heater is provided for very cold or extended cloudy periods. In the western portion of the state, 60 square feet of collector would be adequate for a family of four. Another way to reduce the collector requirement is to simply get by with lower temperature water on those days when the collector is not quite large enough. Experience in northern Florida indicates that a flat plate solar collector could provide about 1.3 to 1.7 gallons per square foot per day. This should not differ greatly for much of Texas.

Packaged solar water heating systems are available which can be added to existing hot water systems. Installation should be made by qualified heating and cooling contractors who have been trained to deal with this type of equipment.

Residential Space Heating and Cooling

Applications of solar energy technology to residential heating and cooling systems have been funded through the Energy Research and Development Administration. This area is considered by many as the second most feasible use of solar energy, since relatively low temperature levels are required and the energy requirement is widespread across the nation.

The same types of collectors can be used in both hot water and space-heating applications. The flat plate-type collector, with air as the heat collection medium, can be used more directly for residential heating than for water heating. Use of solar energy for summer cooling generally requires much higher collector fluid temperatures; thus, the use of concentrating collectors is often necessary.

There are many ways in which a solar system can be put together to supply a residential heating system. All systems include some type of collector, a transfer mechanism to get the heat from the collector to the inside air and finally a storage unit to carry excess daytime solar heat over to take care of nighttime peak-heating demands. Two types of systems most widely used at present are illustrated in Figures 6 and 7. The first system (Figure 6) illustrates an air collector system using a rock bed

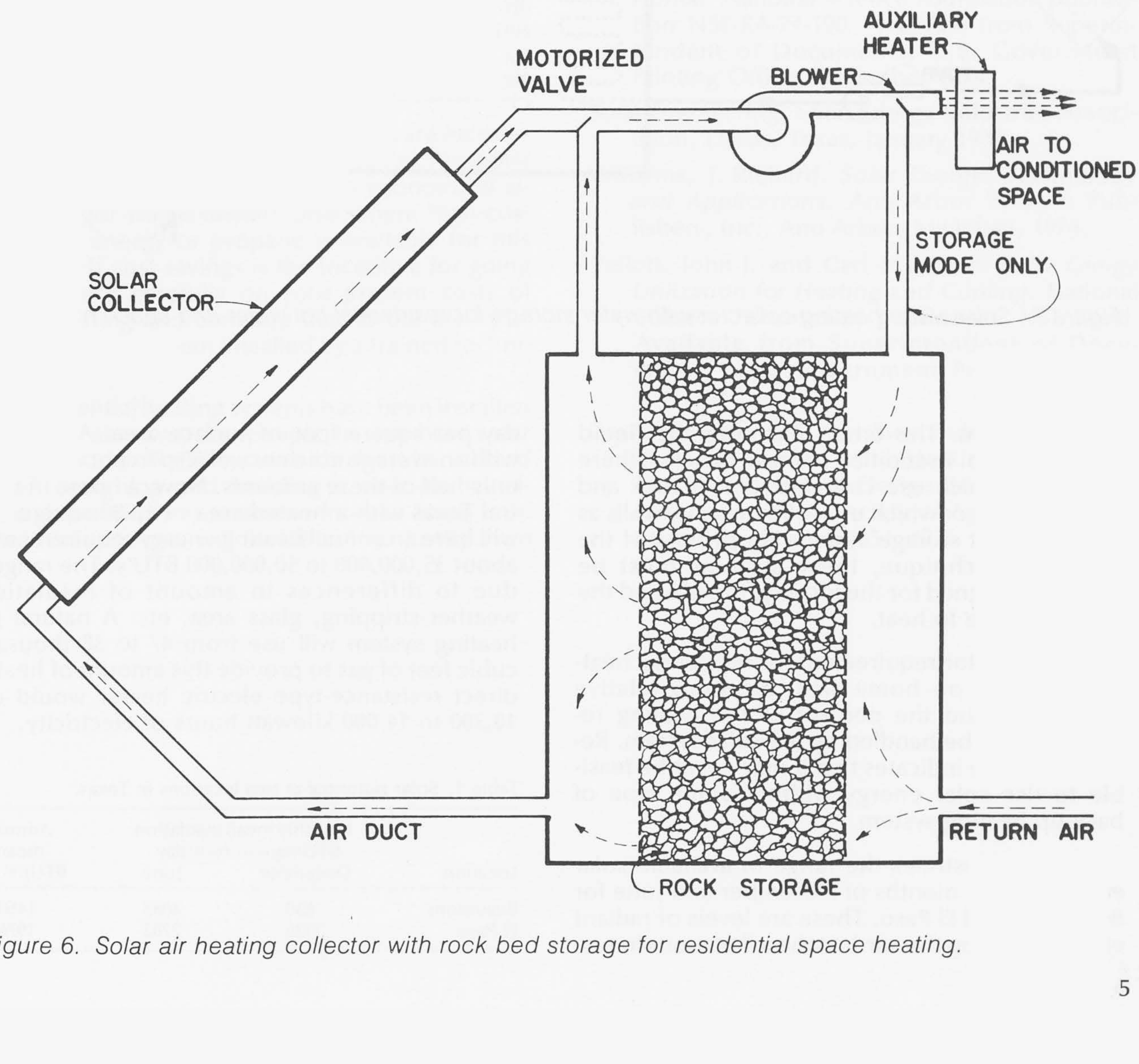

Figure 6. Solar air heating collector with rock bed storage for residential space heating.

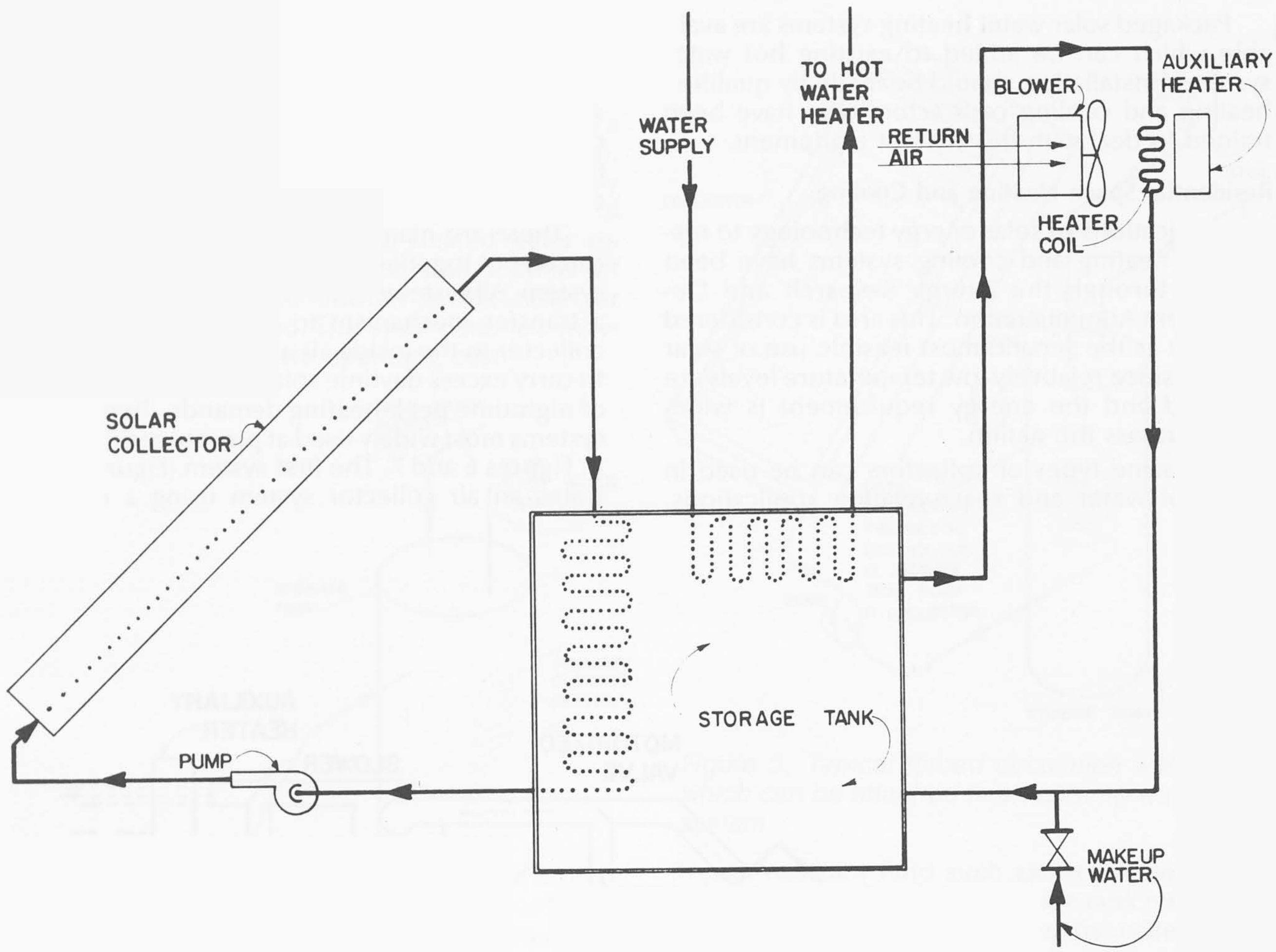

Figure 7. Solar water heating collector with water storage for residential hot water and space heating.

storage system. The other illustrates the liquid storage system. In addition to these systems, there are others which use combinations of rock and water storage, or which use solid masonry walls as a passive heat storage system. Regardless of the individual technique, these systems must be properly designed for the locality, the use and the home they are to heat.

The collector requirement for residential heating depends on home size, location, relative energy use and the percent of the heating requirement to be handled by the solar system. Research to date indicates that it may never be feasible to use solar energy without some type of back-up heating system.

Table 1 illustrates the range in available solar energy for the months of December and June for Beaumont and El Paso. These are levels of radiant energy reaching the earth at these locations in one day per square foot of surface area. A collector with an average efficiency of 50 percent will collect only half of these amounts. Now, a home in Central Texas with a heated area of 1,500 square feet will have an annual heating energy requirement of about 35,000,000 to 50,000,000 BTU's. The range is due to differences in amount of insulation, weather-stripping, glass area, etc. A natural gas heating system will use from 47 to 38 thousand cubic feet of gas to provide this amount of heat. A direct resistance-type electric heater would use 10,300 to 14,000 kilowatt hours of electricity.

Table 1. Solar potential at two locations in Texas.

Location	Monthly mean insolation BTU/square foot/day December	June	Annual mean BTU/ft² day
Beaumont	830	2083	1460
El Paso	1136	2702	1976

Considerable change must occur in energy cost as well as system cost before solar heating systems become economical for Texans. Systems which provide economical summer cooling must be developed, since from 50 to 60 percent of our annual residential energy use is for cooling.

According to a study prepared by researchers at the Los Alamos Scientific Laboratory in New Mexico, the collector area necessary to provide various percentages of the annual heating requirement is shown in Table 2 for various locations in Texas. These values represent a well-insulated home. A typical home with an insulation rating of R-7 in the walls and R-11 in the attic may require 40 percent more collector area.

Table 2. Collector areas required for a 1,500-square-foot, well-insulated home in Texas.

	Collector area, square feet		
	Percentage of heat provided		
Location	25	50	75
Amarillo	140	325	695
Beaumont	80	195	390
Brownsville	40	98	195
El Paso	85	230	435
Texarkana	120	300	590

Solar energy water heating systems are increasing in use throughout the United States. Presently available systems appear to be an economical alternative for home owners only where high-cost electrical energy or propane is available for this purpose. If cost savings is the incentive for going solar, check carefully on your present costs of water heating and compare that to the life cycle cost of a solar system installed by a trained technician.

Residential heating systems have been installed primarily as a way for people to see how solar energy works. These systems can best be utilized when designing and building a new home, although our heating season in most of Texas is so short that the cost will be difficult to justify even then. Before considering the installation of a solar heating system, contact an engineering firm or manufacturer with experience in design and installation of these systems. A source of information for firms in the solar energy business is the Solar Energy Industries Association, 1001 Connecticut Ave., N.W., Suite 800, Washington, D.C. 20036.

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