U.S. Department of Energy - Energy Efficiency and Renewable Energy

Energy Savers

Active Solar Heating

There are two basic types of active solar heating systems based on the type of fluid—either liquid or air—that is heated in the solar energy collectors. (The collector is the device in which a fluid is heated by the sun.) Liquid-based systems heat water or an antifreeze solution in a "hydronic" collector, whereas air-based systems heat air in an "air collector."

Both of these systems collect and absorb solar radiation, then transfer the solar heat directly to the interior space or to a storage system, from which the heat is distributed. If the system cannot provide adequate space heating, an auxiliary or back-up system provides the additional heat. Liquid systems are more often used when storage is included, and are well suited for radiant heating systems, boilers with hot water radiators, and even absorption heat pumps and coolers. Both air and liquid systems can supplement forced air systems. To learn more about these two types of active solar heating, see the following sections:

- Solar Air Heating
- Solar Liquid Heating

Economics and Other Benefits of Active Solar Heating Systems

Active solar heating systems are most cost-effective when they are used for most of the year, that is, in cold climates with good solar resources. They are most economical if they are displacing more expensive heating fuels, such as electricity, propane, and oil heat. Some states offer sales tax exemptions, income tax credits or deductions, and property tax exemptions or deductions for solar energy systems.

The cost of an active solar heating system will vary. Commercial systems range from $30 to $80 per square foot of collector area, installed. Usually, the larger the system, the less it costs per unit of collector area. Commercially available collectors come with warranties of 10 years or more, and should easily last decades longer. The economics of an active space heating system improve if it also heats domestic water, because an otherwise idle collector can heat water in the summer.

Heating your home with an active solar energy system can significantly reduce your fuel bills in the winter. A solar heating system will also reduce the amount of air pollution and greenhouse gases that result from your use of fossil fuels such as oil, propane, and natural gas for heating or that may be used to generate the electricity that you use.

Selecting and Sizing a Solar Heating System

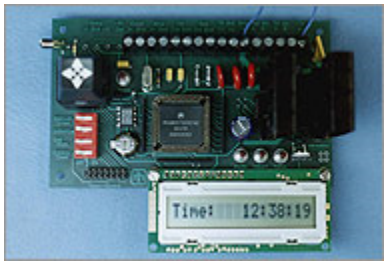
Selecting the appropriate solar energy system depends on factors such as the site, design, and heating needs of your house. Local covenants may restrict your options; for example homeowner associations may not allow you to install solar collectors on certain parts of your house (although many homeowners have been successful in challenging such covenants).

The local climate, the type and efficiency of the collector(s), and the collector area determine how much heat a solar heating system can provide. It is usually most economical to design an active system to provide 40%–80% of the home's heating needs. Systems providing less than 40% of the heat needed for a home are rarely cost-effective except when using solar air heater collectors that heat one or two rooms and require no heat storage. A well-designed and insulated home that incorporates passive solar heating techniques will require a smaller and less costly heating system of any type, and may need very little supplemental heat other than solar.

Besides the fact that designing an active system to supply enough heat 100% of the time is generally not practical or cost effective, most building codes and mortgage lenders require a back-up heating system. Supplementary or back-up systems supply heat when the solar system can not meet heating requirements. They can range from a wood stove to a conventional central heating system.

Controls for Solar Heating Systems

Controls for solar heating systems are usually more complex than those of a conventional heating system, because they have to analyze more signals and control more devices (including the conventional, backup heating system). Solar controls use sensors, switches, and/or motors to operate the system. The system uses other controls to prevent freezing or extremely high temperatures in the collectors.



Solar system controls.
Photo credit: Sandia National Labs.

The heart of the control system is a differential thermostat, which measures the difference in temperature between the collectors and storage unit. When the collectors are 10°–20°F (5.6°–11°C) warmer than the storage unit, the thermostat turns on a pump or fan to circulate water or air through the collector to heat the storage medium or the house.

The operation, performance, and cost of these controls vary. Some control systems monitor the temperature in different parts of the system to help determine how it is operating. The most sophisticated systems use microprocessors to control and optimize heat transfer and delivery to storage and zones of the house.

It is possible to use a solar panel to power low voltage, direct current (DC) blowers (for air collectors) or pumps (for liquid collectors). The output of the solar panels matches available solar heat gain to the solar collector. With careful sizing, the blower or pump speed is optimized for efficient solar gain to the working fluid. During low sun conditions the blower or pump speed is slow, and during high solar gain, they run faster.

When used with a room air collector, separate controls may not be necessary. This also ensures that the system will operate in the event of utility power outage. A solar power system with battery storage can also provide power to operate a central heating system, though this is expensive for large systems.

Building Codes Covenants and Regulations for Solar Heating Systems

Before installing a solar energy system, you should investigate local building codes, zoning ordinances, and subdivision covenants, as well as any special regulations pertaining to the site. You will probably need a building permit to install a solar energy system onto an existing building.

Not every community or municipality initially welcomes residential renewable energy installations. Although this is often due to ignorance or the comparative novelty of renewable energy systems, you must comply with existing building and permit procedures to install your system.

The matter of building code and zoning compliance for a solar system installation is typically a local issue. Even if a statewide building code is in effect, it's usually enforced locally by your city, county, or parish. Common problems homeowners have encountered with building codes include the following:

- Exceeding roof load
- Unacceptable heat exchangers
- Improper wiring
- Unlawful tampering with potable water supplies.

Potential zoning issues include these:

- Obstructing sideyards
- Erecting unlawful protrusions on roofs
- Siting the system too close to streets or lot boundaries.

Special area regulations—such as local community, subdivision, or homeowner's

association covenants—also demand compliance. These covenants, historic district regulations, and flood-plain provisions can easily be overlooked. To find out what's needed for local compliance, contact your local jurisdiction's zoning and building enforcement divisions and any appropriate homeowner's, subdivision, neighborhood, and/or community association(s).

Installing and Maintaining Your Solar Heating System

How well an active solar energy system performs depends on effective siting, system design, and installation, and the quality and durability of the components. The collectors and controls now manufactured are of high quality. The biggest factor now is finding an experienced contractor who can properly design and install the system.

Periodic visual inspection may be necessary to properly maintain your solar system. Photo credit: Robb Williamson.

Once a system is in place, it has to be properly maintained to optimize its performance and avoid breakdowns. Different systems require different types of maintenance, but you should figure on 8–16 hours of maintenance annually. You should set up a calendar with a list of maintenance tasks that the component manufacturers and installer recommends.

Most solar water heaters are automatically covered under your homeowner's insurance policy. However, damage from freezing is generally not. Contact your insurance provider to find out what its policy is. Even if your provider will cover your system, it is best to inform them in writing that you own a new system.

Learn More

Codes & Standards

- 2006 Uniform Solar Energy Code
  Association of Plumbing and Mechanical Officials
- Solar Rating and Certification Corporation (SRCC)

Evaluation Tools

- SunAngle
  DOE Building Energy Software Tools Directory

Financing & Incentives

- Find Federal Tax Credits for Energy Efficiency
  ENERGY STAR®
- Find State and Local Incentives
  Database of State Incentives for Renewables and Efficiency

Professional Services

- Find a Solar Pro
  Solar-Estimate.org

Related Links

- PATH Tech Set #6, The Sun in the 21st Century: Passive and Active Solar Systems
  Partnership for Advancing Housing Technology

Reading List

- *The Borrower's Guide to Financing Solar Energy Systems: A Federal Overview* (PDF 501 KB). (September 1998). U.S. Department of Energy. This booklet provides an extensive overview of government-authorized special financing programs available to consumers interested in installing solar energy systems for heat and electricity.
- Starrs, T.; Nelson, L.; Zalcman, L. (1999). *Bringing Solar Energy to the Planned Community* (PDF 1 MB). U.S. Department of Energy. Describes neighborhood covenants as they relate to rooftop photovoltaic and solar water heating installations. Includes information on obtaining approval for your design, your legal

options, and removing barriers to solar installations.
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