



E³A: Solar Hot Water Applications for the Home, Farm or Ranch

Steps in the Solar Hot Water Series

Building and Site Assessment

Conservation and Efficiency

System Options

System Sizing

Costs

Installation

Operation and Maintenance

Solar Hot Water Collector Sizing Worksheet

System options

Solar hot water systems can be designed for different climates. Most systems include a solar collector, pump, controller, piping and a backup source. The existing conventional water heater is typically used as the backup. Solar hot water systems have collectors that absorb the sun's energy to heat water or antifreeze. The heated fluid goes to a storage tank where its heat is transferred to the potable tank water. Once the heat has transferred to the tank water, the fluid is pumped back to the collector to be reheated by the sun.

There are several system types that work well in Missouri to keep collector fluids from freezing. The system options discussed in this guide apply to small systems, such as those used for homes. Consult a qualified solar hot water system installer regarding larger systems.

Collectors

Flat-plate and evacuated-tube collectors are the two types commonly used for cold-climate solar hot water systems. There are other collector types that can be used for larger commercial and industrial applications.

Flat-plate

Flat-plate collectors are made of copper flow tubes connected to a dark absorber plate in an insulated, weatherproof box covered with hail-resistant tempered glass or plastic. These collectors can heat water or antifreeze.

Evacuated-tube

Evacuated-tube collectors are composed of parallel rows of clear glass tubes. Each tube has an inner tube that absorbs solar energy and heats either water or antifreeze. Air is removed, or evacuated, from the glass tubes to form a vacuum that reduces heat loss. They work well in cloudy conditions but are not as hail-resistant as flat-plate collectors.



Flat-plate collectors (left) consist of a dark absorber plate with copper flow tubes to carry heated fluids to and from the plates. Evacuated-tube collectors (left) have parallel rows of glass tubes.

Complete system

Active systems work well in Missouri — so-called because they have moving parts necessary for operation. Passive systems, typically used in warmer climates, have no moving parts and rely on gravity or convection to move fluids. Active systems can be open- or closed-loop.

Open loop is direct

- Collectors directly heat the water in an open loop.
- Hard or acidic water can cause scale and corrosion in tubes and pipes.
- A recirculation system pumps warm storage tank water to the collector during freezing weather but is best for mild climates.

Antifreeze system

Heat-transfer fluid: propylene-glycol

- Uses a low-freezing-point antifreeze — typically a mixture of food-grade propylene glycol and water mixture — in the collector to absorb the sun's heat energy.
- A pump circulates the antifreeze through the collector pipes to the storage tank.
- In the storage tank, a heat exchanger transfers heat from the antifreeze to the storage tank water.
- Solar-powered electric pumps can be used.
- Tilting collectors more toward the lower-angled, winter sun (latitude +15 degrees) minimizes overheating the tank in the summer.

Backup water heater systems

In warmer months, solar hot water systems can generate a large portion of your hot water but typically not all of it in colder climates. Backup systems turn on when there are prolonged cloudy days or excessive hot water demands cannot be met by the solar system. For an existing home or building, the conventional hot water system can be used as the backup for the new solar hot water system. For a new home or building, a backup system is installed along with the solar hot water system.

More home and business owners are considering tankless water heaters as a primary water heating system. Tankless heaters, also called on-demand or instantaneous water heaters, serve as excellent backups for solar hot water systems.

Tankless, on-demand water heaters

A flow sensor detects when an appliance or faucet needs hot water. For a gas-powered tankless system, the gas valve opens and the burner fires up. The system measures the incoming water temperature and calculates how quickly water should flow past the burner to the faucet or appliance.



Closed loop is indirect

- In a closed loop, collectors indirectly heat water with heat-transfer fluids and a heat exchanger.
- There are two active, closed-loop systems that work well in cold climates:

Drainback system

Heat-transfer fluid: water

- Uses water in the collector to absorb the sun's heat energy.
- A pump circulates water through the collector pipes and gravity drains the heated water to the storage tank.
- In the storage tank, a heat exchanger transfers the water's heat to the storage tank water.
- They require minimal maintenance.
- When the controller detects extreme temperatures, it turns the pump off to allow the collector water to drain to a reservoir, thereby avoiding overheating issues in the summer.

These systems can supply a limitless amount of heated water, but there are flow-rate limits. An average flow rate is two to five gallons per minute, but a system must be sized for your specific hot water needs.

Gas-powered units

Gas-powered units provide higher flow rates than electric units. If considering a gas-powered model, ask the manufacturer how much gas the pilot light uses. In a gas-powered unit with a standing pilot light, the pilot light can be turned off when not in use to conserve energy; intermittent ignition devices are another energy-saving option. If a lot of hot water is used at the same time each day in your home or building, you might need more than one unit.

Conventional tank water heaters

Conventional storage tank water heaters are less expensive to buy, but they are more expensive to fuel and maintain. Storage tank heaters vary in efficiency and last about 15 years, whereas tankless systems can be up to 96 percent efficient and last 20 years or more.

Note: Consult the manufacturer of your tankless water heater to determine whether it will work with a solar hot water system. Some manufacturers have special models that work with solar hot water systems. If you're considering a gas-powered tankless water heater, determine if your existing gas line can handle the greater natural gas demand, based on distance to the gas meter, other gas appliances, etc.

SRCC certification

To be sure you are buying a reliable, high-performance solar hot water system, ask for and buy Solar Rating and Certification Corporation (SRCC)-certified collectors and systems. SRCC is an independent, nonprofit organization that measures system performance in accordance with national ratings standards. The SRCC certifies almost every solar hot water heater on the market. Visit www.solar-rating.org for complete and up-to-date information.

References

- National Renewable Energy Laboratory (produced) for the U.S. Department of Energy.
(1996, March). *Residential Solar Heating Collectors*. DOE/GO-10096-051.
(1996, March). *Solar Water Heating*. DOE/GO-10096-050.
(1999, September). *Solar Water Heating: Using the Sun to Heat Domestic Water Makes Sense in Almost Any Climate*. DOE/GO-10099-726.
- Patterson, John. (n.d.). *Solar Hot Water Basics*. *Home Power Magazine* on-line. Retrieved February 22, 2011, from: <http://homepower.com/basics/hotwater/>
- U.S. Department of Energy.
(2010, October). *Demand (Tankless or Instantaneous) Water Heaters*. Retrieved January 24, 2011, from: http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12820
(2010, October). *Solar Water Heaters*. Retrieved January 19, 2011, from: http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12850



Photo credit: DOE NREL

Some tankless water heaters will not work with a solar system, so check with the manufacturer to ensure your system is compatible.

