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Water Heaters, Part 2: Solar Water Heaters

Solar water heaters can play an important role in reducing the electrical power demand of a particular building, and if they are used widespread in many buildings or entire neighborhoods, they can reduce a city's peak electrical loads.

According to the Solar Rating and Certification Corporation (SRCC), a 64-square-foot residential solar water heater panel delivers the equivalent of 4 kilowatts of electrical thermal power. A photovoltaic panel would have to be 400 square feet to generate the same amount of power.

This same small solar water heater can defer 0.5 kilowatt of peak demand load, or about 2,400 kilowatt-hours per year. Thus, entire communities that install solar water heaters can make a big difference in the electrical load on the municipal system. For example, if 1,000 solar heaters were installed in place of electric heaters, then the electrical load of the community could be reduced by 2.4 million kilowatts a year.

SOLAR WATER HEATER TYPES AND COMPONENTS

Several types of solar water heating systems are available. The simplest direct systems route water through flat-plate panels, typically located on the roof. The water is heated by the sun and then is routed to a storage tank for later use. While this system is simple, it has its limitations, one of which is that it must be drained in the winter to prevent freezing.

In another type of solar water heating system, a glycol mixture flows through the solar panels, is heated, and is routed to a heat exchanger where the energy is transferred to the potable domestic water system, which then is stored in a tank (see Figure 1).

Some systems employ vacuum tube technology in a double-wall glass piping system. In such systems, energy efficiency is increased because energy loss is reduced.

Several packaged solar water heater systems are available from the major water heater manufacturers. A typical small commercial or residential 120-volt system has a minimum of two panels typically 20 inches tall by 10 inches wide by 5 inches deep.

Solar water heaters usually employ pumps that require electrical power. However, photovoltaic systems can provide power for the pump system. Systems also include a controller, isolation valves, fill and drain valves, check valves, temperature gauges, a pressure gauge, solar loop pressure relief valve, flow meter, and air eliminator. The system should include a complete kit for mounting the solar collectors, and the plumbing engineer must verify the type of roof on which the panels will be installed.

To qualify for most federal, state, and local rebate programs, the system must be SRCC certified. Systems are rated by a solar energy factor (SEF), which is the energy delivered by the system divided by the electrical or gas energy put into the system. A typical SEF for an 80-gallon tank, two-panel configuration is 2.5.

DESIGN AND INSTALLATION CONSIDERATIONS

The plumbing engineer will need to size the system based on the facility's hot water load. The electric or gas backup system must be sized for 100 percent of the load to cover periods when sunlight is not available to heat the water.

To achieve the greatest benefit from solar water heaters, systems should be installed in projects in which the hot water demand aligns with the maximum availability of hot water from the solar system. For example, in a food service establishment with high lunchtime traffic, food preparation activities that require little hot water occur in the morning when the solar water heater has the least amount of hot water. After lunch, dishwashing, which requires the highest hot water demand, begins, coinciding with the peak hot water production of the solar water heater. Solar heaters also work well for locker rooms where staff members shower in late afternoon before leaving for home.

Some people may be tempted to build their own solar water heaters or alternate fuel water heaters because the concept is very simple. However, it is very important to remember the basics: All water heater systems must comply with codes and regulatory requirements. Energy sources feeding water heaters such as steam, gas, electric, solar, or other alternative fuels shall meet all regulatory, insurance, and testing requirements. Equipment shall be used according to the manufactured intent. System water temperatures

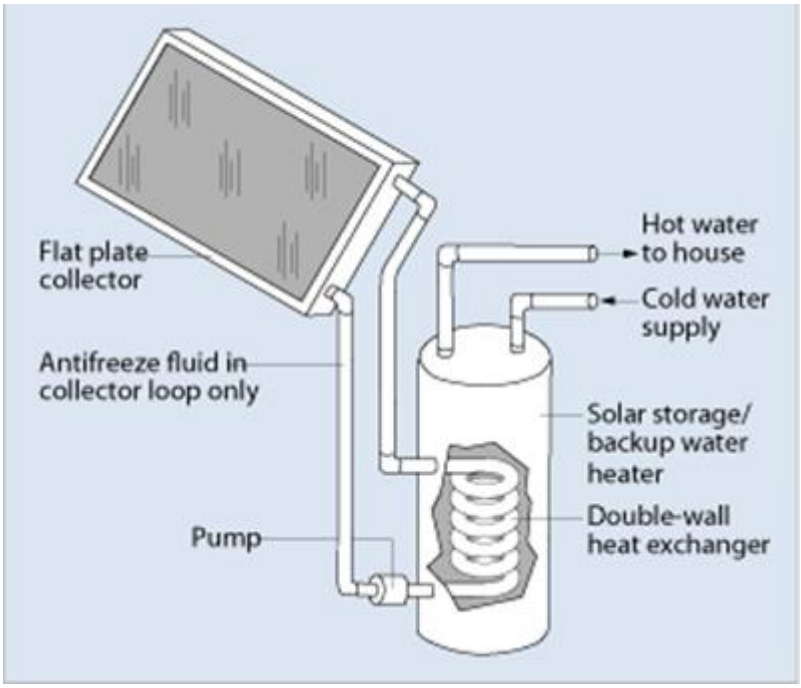

Figure 1 Active, closed-loop solar water heater

shall be maintained to reduce the risks of temperature spikes that can cause bodily harm. Piping systems shall be installed to reduce the risk of Legionella or other contaminants. Cross-contamination requirements must be maintained to ensure the sanitation of the domestic water system, and cross-connection protection from the facility to the city water system must be maintained according to regulatory standards. System pressure ratings for piping, valves, fittings, and equipment shall not be exceeded. All of these precautions are the responsibility of the building design and operations teams.

In some projects, the owner is fortunate to have the option to incorporate solar systems either initially or in the future. If so, the architect, solar consultant, electrical engineer, and plumbing engineer should develop alternative designs to use solar power during the schematic development phase of construction. The design team should set up a decision-making procedure, such as in the *ASHRAE Solar Design Manual,* to determine if a solar water heater system is appropriate for the particular site. The intent is to provide space for both solar water heater panels and electrical power generation systems. At some point, the team will decide if solar panels will be used in the project, if provisions can be made for future installation of panels, or if solar panels are not possible for the project.

Space inside the building can be designated for a future solar water heater system. The domestic hot water system can provide connection points to future solar water heater piping.

If a solar system is not installed, the plumbing engineer should specify a high-efficient water heating system as discussed in Part 1 of this series. Using efficient water heaters can be included in the calculation for LEED Energy and Atmosphere (EA) credits, such as EA Credit 2 for on-site renewable power. The plumbing engineer should coordinate with the mechanical engineer and LEED specialist to ensure that the LEED calculation is correct and that all requirements and documentation for the submittal package are complete.

The building operations team should develop a procedure to maintain the solar water heating system and the glycol system, as appropriate, and to ensure that the panels are cleaned regularly.

REGULATIONS

During the schematic design of a project, the mechanical engineer, plumbing engineer, architect, and structural engineer must review the applicable codes and regulations for solar water heating systems in the particular jurisdiction. Following are examples of some of the relevant issues in the New York City Mechanical Code, Chapter 14.

- Access shall be provided to solar energy equipment and appliances for maintenance, firefighting, doors, windows, and fire escapes, to name a few.
- Roof-mounted solar collectors that also serve as a roof covering shall conform to the requirements for roof coverings in accordance with the New York City Building Code.
- System components shall be protected from damage by freezing.
- Liquid single-phase solar energy systems shall be equipped with expansion tanks.

RENOVATION

Solar water heating systems can be included in retrofit projects. When designing the system, access to the exterior building and existing conditions must be analyzed. Space will need to be provided for both solar water heater panels and electrical power generation systems. PSD

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