



## Building America Case Study

Technology Solutions for New and Existing Homes

# Addressing Multifamily Piping Losses with Solar Hot Water

Davis, California

### HOMEOWNERS INVEST VERY LITTLE IN ENERGY UPGRADES

**Project Name:** Addressing Multifamily Piping Losses with Solar Hot Water

**Location:** Northern California

**Partners:**

Sun Light & Power, TRC

Building America Team: Alliance for Residential Building Innovation  
[arbi.davisenergy.com](http://arbi.davisenergy.com)

**Building Component:** Water heating

**Application:** New multifamily

**Year Tested:** 2014

**Climate Zones:** All, but greatest value in climates suitable for use of solar water heating

### PERFORMANCE DATA

Cost of energy-efficiency measure (including labor): About \$500 in new buildings and \$5,000 in existing buildings

Projected energy savings: 11%–32% of yearly water heating energy use, depending on climate and other factors

Projected energy cost savings: \$280–\$870 per year, depending on climate and other factors

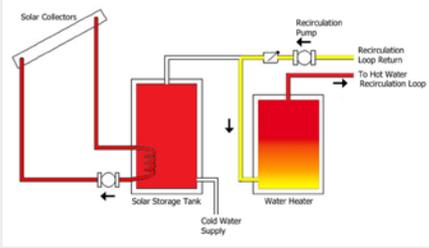
Heat losses from piping used to recirculate hot water in multifamily buildings can be as high as 40% of total water heating energy use. Controls that limit recirculating pump operation include timers, temperature controls, and demand controls; however, they have limited value in reducing pipe heat loss because they compromise the ability of occupants to obtain hot water at any time of day or night without suffering long waiting times. As a result, these controls are frequently disabled, which causes pumps to operate continuously.

When solar water heating systems are installed, the conventional practice is to connect them so that the solar water heater delivers heat only when there is a hot water draw from fixtures and appliances. Conventional solar water heating systems cannot contribute solar-heated water to displace heat lost in the recirculation piping so they serve only part of the water heating load.

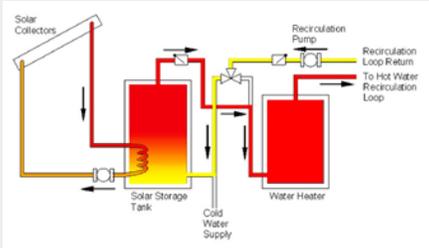
Sun Light & Power, a San Francisco Bay Area solar design-build contractor, teamed with the U.S. Department of Energy's Building America partner the Alliance for Residential Building Innovation (ARBI) to study this heat-loss issue. The team added three-way valves to the solar water heating systems for two 40-unit multifamily buildings. In these systems, when the stored solar hot water is warmer than the recirculated hot water returning from the buildings, the valves divert the returning water to the solar storage tank instead of the water heater. This strategy allows solar-generated heat to be applied to recirculation heat loss in addition to heating water that is consumed by fixtures and appliances.

The value of this design modification is that the energy production by the solar water heating system is significantly improved. Two methods were used to estimate the value of this solar recirculation strategy: the two retrofitted buildings were monitored for three months, and a typical system was modeled to compute full-year energy savings in several climates.

## Description



Normally, recirculated water that has cooled off in the piping is returned to the water heater where it is reheated with gas or electricity. Heated water in the solar storage tank cannot be used to heat the recirculated water, and during the day solar collector temperatures are typically high.

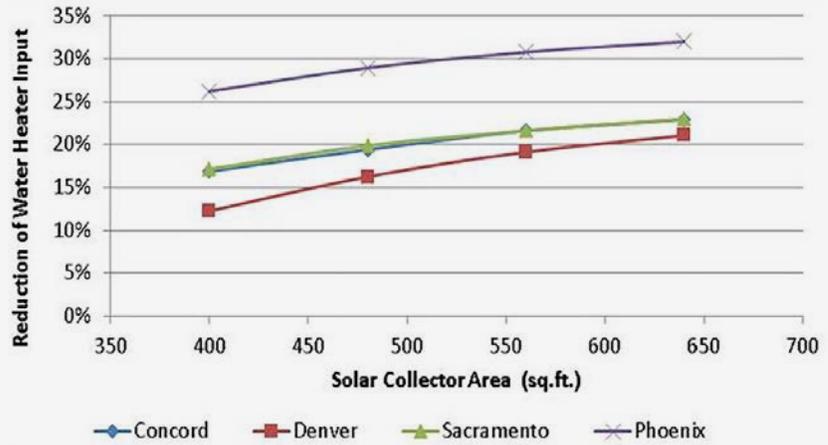


With the modifications shown above, recirculated water can be returned to the solar storage tank so that “free” solar heat can be used to replace heat that is lost in the recirculation piping. This keeps solar collector temperatures lower, improving collector efficiency and providing energy savings.

When hot water is drawn, the system operates normally, delivering cold water to the solar storage tank and solar preheated water to the water heater.

For more information see the Building America report *Addressing Multifamily Piping Losses with Solar Hot Water* at [buildingamerica.gov](http://buildingamerica.gov).

Image credit: All images were created by the ARBI team.



Simulation results (above) show how energy savings vary with climate and solar collector area, but savings also vary with hot water use and the amount of heat loss in the recirculation piping.

## Lessons Learned

- The estimated cost of \$500 for equipping new systems in new buildings with solar recirculation capability can be repaid in less than one year in some climates. The cost to retrofit existing systems can be much higher because of the need to restructure piping.
- To comply with plumbing codes, valves must have zero lead content. Stainless steel three-way valves are readily available and can be installed at a lower cost than the two-way solenoid valves used in the field tests.
- Measured energy savings of 25%–41% were obtained between July and October 2014 by operating the systems with and without the solar recirculation controls enabled. Simulations predicted full-year savings ranging from 11%–32%.
- Measured piping losses showed that recirculation pipes with R-4 insulation behaved more like pipes with R-2 insulation.
- Solar collectors should be sized for the combined recirculation plus hot water use loads, but storage tanks can be sized only for hot water use loads.

## Looking Ahead

The contractor will offer this option to all multifamily builders in California that choose to install solar water heating in accordance with the state’s prescriptive standards. The measure will be proposed as a code requirement for forthcoming California Title 24 standards.