Chapter Nine
Water Conservation and Energy Efficiency

Hot water conservation is an important step to take before investing in a solar water heater. Learning how to use hot water more efficiently not only reduces current and future water-heating costs, it can also allow you to install a smaller, and therefore less costly, solar water heating system. The monthly energy savings resulting from conservation steps can be applied to paying for a future solar water heating system.

The steps to efficient hot water use begin with simple tasks that only need to be done once to save energy for years to come.

1. Turn Down the Thermostat

Turn down the thermostat on the water heater to 115°F or 120°F. The unit will still provide hot water but will use substantially less energy. For example, a typical 52-gallon water heater set back from 140°F to 120°F will save 410 kWh/year of electricity or about 17 therms/year of gas.[1] At $0.07/kWh, $28.70 would be saved, and at $0.60/therm, $10.20 would be saved, every year. Saving this much energy would reduce the size of solar collector needed by up to 10 square feet. This would result in significant savings, considering that a 52 square foot collector area, composed of two 4-foot by 6.5-foot collectors, retails for about $1030, whereas a 4-foot x 10-foot, 40 square foot collector retails for about $655.

Adjusting the Thermostat on a Water Heater

To turn down the thermostat on an electric water heater, first switch off the circuit breaker for the heater before removing the cover plates over the thermostats. Electric water heaters typically have an upper and a lower element. Set the upper thermostat five degrees higher than the lower one. For gas water heaters, the fuel doesn't have to be turned off to adjust the thermostat. Simply turn the knob. In either case, gradually adjust the temperature over a period of days until you find the minimum satisfactory setting. If you use a dishwasher, its cleaning power may be affected by lower water temperatures. If your dishwasher has an electric water-heating booster, that may compensate for the lower incoming water temperature.

Note: If it seems that you run out of hot water too quickly, your tank may have a broken dip tube (a tube that extends inside the tank from the cold water inlet to the bottom section of the tank). This is not uncommon and can easily be repaired by disconnecting the cold water supply line, removing the old dip tube, and replacing it with a new one (available at most hardware stores).

2. Insulate the Water Heater

Most water heaters have only one or two inches of insulation and adding an additional two to six inches can produce significant savings. You can buy a tank insulation kit or simply wrap the heater with six inches of fiberglass insulation. Tie the insulation with wire or cord and seal the seams with duct tape. Be sure not to obstruct the pressure-and-temperature relief valve at the top of the heater. On electric water heaters, cut out a plug of insulation over each thermostat, allowing easy access to the thermostat adjustment knobs. The insulating plug can be reinserted after the tank is wrapped. For gas fired heaters, make absolutely sure not to cover up the combustion air intake vents at the base of the unit. Also leave a gap a couple of inches wide between the insulation and the flue pipe at the top of a gas or oil heater. Insulating your water heater should take less than an hour and should cost $10 to $30. Within a year the insulation will save you this much on your electric or gas bill.

A slightly more expensive, but possibly more aesthetic, option would be to wrap two layers of "Reflectix" aluminum foil/"bubble-pack" insulation around the water heater. In tight spaces the Reflectix may be easier to install than fiberglass.

3. Prevent Heat Loss through Plumbing

Insulate exposed hot water pipes with pipe insulation rated R-4 or better. (Don't bother with pipes buried in walls - it's not worth the trouble of ripping apart walls.) Also insulate cold water supply pipes six to eight feet from the hot water tank. This will reduce heat loss from pipes and will at times allow hot water to flow immediately from the taps (alleviating the need to wait while cold water is flushed from the lines).

Install heat traps on the cold and hot water connections to the water heater. Heat traps are check valves that "prevent heat from migrating by natural convection into service pipes when in standby mode. Some look like a simple ball-check valve. A 360-degree loop in the piping can also serve as a heat trap."[2] Many newer water heaters are now sold with heat traps.

4. Install a Timer on the Water Heater

If you only use hot water during one or two distinct periods during the day, energy can be conserved by installing a timer. The timer will turn the heater on and off around those times of peak use. While one study by the Florida Solar Energy Center (FSEC) found the savings from using a timer to be minimal ($0.21/month),[3] other studies have found substantial savings from the use of timers. These different findings may be due to factors such as hot water use schedules, water heater thermostat set-points, the temperature in the room where the water heater is located, water delivery temperatures, the cost of heating and cooling energies, and whether the water heater is also used for solar storage.[4]

Using a Timer in a Solar Water Heating System

Timers can be beneficial in solar water heating systems that use a single electric tank. Try to buy the tallest tank available with the proper volume, disconnect the bottom element, and install a water heater timer to control the operations of the upper element. (These specifications are difficult to achieve with a natural gas- or LP-burning water heater.) Especially in households where the major demands for hot water (i.e. pre-school and pre-workday showers, dishwashing, etc.) occur in the morning, set the timer to prevent the heater element from reheating water before the sun can accomplish its heating. For optimum timer operation, the element should be shut off BEFORE the start of early morning hot water demand, so that the coolest water is sitting in the tank, ready to be heated later by the sun. The timer's next on-cycle can be easily adjusted to ensure adequate hot water for the next major period of hot water use, like evening showers or dishwashing when everyone is home from school or work.

Since electric water heater timers offer at least two on-off cycles per day, you can easily turn the heater off again in the evening, to reduce standing losses when everyone is asleep. As with morning operation, it is most efficient to heat up the water right before it is needed, then make sure there is no reheating during the actual hot water use. Unless hot water use is so large that reheating during use is necessary to keep pace with demand, a well insulated tank will typically keep the water hot long after the heating elements are turned off. For more casual hot water needs, like mere hand washing, where warm water is usually adequate, no periodic reheating is required, if the water heater and pipes are well insulated.

If you are interested in reducing your demand for electricity during utility peak demand periods, you can also use timers to schedule major backup water heating between midnight and dawn when most electric utilities experience their lowest electric demand. Although not uniform in all areas, electric utility systems commonly experience their peak electric demand in early mornings and early evenings during the heating season, afternoons and early evenings during the cooling season.

5. Install a Non-Electric Flue Damper

For gas-fired water heaters, install a non-electric flue damper, which opens automatically when the hot exhaust from the gas burner flows up the tank. One model available from Advanced Conservation Technologies is priced around $50. The American Gas Association tested a water heater with no hot-water demand (it simply maintained a set water temperature), and found that the damper reduced heat loss per hour by 45 percent.[5]

6. Use Less Hot Water

Reduce hot water consumption without sacrificing convenience by using more efficient fixtures, appliances, and other strategies. Saving hot water doesn't necessarily mean taking fewer or shorter hot showers. Changes can be made that will go mostly unnoticed, except for the monthly savings in energy costs, which can range from 25 to 50 percent.

First, install low-flow showerheads and faucet aerators throughout your home. Low-flow showerheads can dramatically reduce water consumption in showers while still providing a powerful and comfortable spray. These low-low fixtures are inexpensive, easy to install (they just screw onto the end of existing fixtures), and can be found in most hardware stores.

Second, consider washing laundry with cold or warm water rather than hot water. Use hot water only when truly necessary, and look for detergents designed for washing with cold water.

Third, when you buy a new washing machine, consider buying a high-efficiency model. Look for the Energy Star label to help you identify washers that use water and energy most efficiently. These washers can produce dramatic savings in energy and water use.

Fourth, check the water pressure coming into your house. You can do this with a pressure gauge (available from most hardware stores) that can screw onto a hose faucet fixture. If the pressure is continuously above 45 pounds per square inch (psi) you could reduce your hot water use by installing a pressure-reducing valve. By reducing the pressure in your water lines, the flow rate of water will be reduced, thereby conserving both hot and cold water. The pressure-reducing valve, along with a pressure gauge, should be installed where the water main enters the house, downstream from the shutoff valve and water meter (between the shutoff valve and the house). You may also want to install the pressure-reducing valve downstream from an outdoor

Comparing Conventional and High-Efficiency Washing Machines[6]

In one year, compared to a typical new conventional (top loading) washing machine running 8 loads/week, the front-loading, Energy Star-rated Kenmore 41042 clothes washer can save:

6,377 gallons of water
683.8 kilowatt-hours of electricity
(from washer operation and heating the water)
$79 in energy and water costs
(at $0.847 per kWh of electricity
and $2.45 per CCF (100 cubic feet) of water)

Figure 9.1: Front-loading washing machines can save tens of thousands of gallons of water and hundreds of dollars over their lifetime.
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faucet fixture, so that you will still have full pressure available for washing cars, watering lawns, putting out a fire, etc. The reducing valve and pressure gauge can usually be acquired for $40 from a plumbing supply store.

Once the valve is installed, the pressure is reduced by turning an adjustment nut on the valve, while keeping an eye on the pressure gauge downstream. Open a cold-water tap to assess the water pressure, and reduce it until the flow rate is satisfactory, but not excessive (perhaps 30 psi). Lower water pressure will reduce monthly water bills and the amount of water that needs to be heated. It will also reduce sewer bills for homes whose bills are based on gallons of water used. Lower pressure will extend the life of the water heater and can solve "water hammer" problems—annoying rumbles caused by shaking pipes.

7. Using Solar-Heated Water More Efficiently

Some simple household habits can help you to use solar-heated water more efficiently. For example, scheduling large hot water demands (such as showering or washing clothes) in the early to mid-afternoon on sunny days will allow the sun time to reheat the water afterwards. Evening or early morning showers, by contrast, may trigger the thermostat to kick on the element in the back-up heater before the sun has a chance to re-heat the water.

Tankless Water Heaters

Tankless (a.k.a. instantaneous or on-demand) water heaters heat water as it is used at the tap, avoiding the need for a storage tank. Tests have shown that tankless water heaters offer from 10 to 20 percent savings versus conventional tank-type water heaters.[7] and their popularity is increasing due to their improved energy efficiency. However, this is one efficiency improvement that is best considered after installing a solar water heating system, because the solar water heater will require an insulated storage tank, in any case, and you may be able to use your existing conventional water heater in your solar system (especially if the tank holds 60 gallons or more). In this case the electric or gas heater can provide backup heating when the solar system doesn't keep up with hot water demand.

A further consideration is that the price of a tankless water heater ($600 to $1000) could go a long way towards the purchase of a solar water-heating system. As a solar system can offer 100 percent savings during summer months and up to 80 percent annual savings, it represents a better investment than a tankless water heater.

Should a tankless water heater be purchased, be sure it has the ability to control the burner output based on the incoming water temperature, thus having the capacity to backup a solar water-heating system. Be aware that the gas supply line and flue size may have to be increased to handle the demands of an on-demand, tankless water heater.

End Notes

1. B. Keisling, *The Homeowner's Handbook of Solar Water Heating Systems*, Rodale Press, Emmaus, PA, 1983, p.4.
2. Source: www.jacksonemc.com/news/glossary.html
3. Tom Lane, *Solar Hot Water Systems 1977 to Today, Lessons Learned*, 26th Edition, Energy Conservation Services of North Florida, Inc., Gainesville, FL, 2003, p.88.
4. John F. Robbins, CEM, personal communication, February 11, 2005.
5. Home Energy Magazine Online, July/August 1997. Article available on-line at: http://homeenergy.org/archive/hem.dis.anl.gov/eehem/97/970714.html
6. "Sustainable Energy Solutions: Buying Green Power

and Investing in Energy Efficiency," Andy McDonald and Thomas Reynolds, a poster presentation at Slippery Rock University of Pennsylvania, 2003.

7. Tom Lane, p.88.