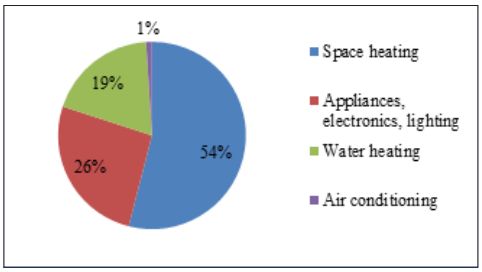
Colorado State University
Extension

Water Heating in Colorado Homes

Fact Sheet No. **10.637** Consumer Series | **Energy**

C. Weiner*

According to the U.S. Energy Information Administration, water heating makes up 19% of energy use in Colorado homes. This fact sheet examines ways to reduce energy use and expenses related to domestic hot water heating including simple conservation measures and investments in new equipment.



Use and Cost of Hot Water

Common uses of hot water and typical amounts associated with each are shown in the table below from the U.S. Department of Energy (DOE):

Activity	Gallons per Use
Clothes washer	7
Shower	10
Automatic dishwasher	6
Kitchen faucet flow	2 per minute
Bathroom faucet flow	.05 per minute

On average, homes in Colorado use about 20 gallons of hot water per person per day (600 gallons per person per month). In this case, a household of three people would use about 1,800 gallons of hot water per month. Assuming that cold water enters the home at 50 degrees F and the water heater is set to 130 degrees F, this would cost a household using a moderate efficiency natural gas storage hot water heater about $10/month but would cost a household using a moderate efficiency electric storage heater about $40/month at current energy prices. Propane users could expect to pay closer to what is paid by users of electricity for hot water although this can fluctuate greatly.

C. Weiner, Colorado State University Extension energy specialist. 9/2013

Households that heat water with natural gas and those that heat with electricity but do not have an active cooling system can more accurately estimate hot water energy use and costs by going through an energy bill analysis. Here's an example using a natural gas consumer:

Month	Therms
J	140
F	151
M	110
A	72
M	55
J	23
J	15
A	16
S	39
O	80
N	91
D	129

Natural gas would only be used for heating water and not for space heating in the summer months. So to most accurately capture domestic hot water use, we first take the average of June, July, and August's natural gas use: 23+15+16=54 *therms*/3 = 18 *therms/month*. Next we multiply that amount times 12 months = 216 therms for domestic hot water per year. At $0.60 therm, for example, this would equal $130 in annual water heating costs. The same can be done if heating water with electricity *only if an active cooling system is not used during the summer months* since that use would not allow us to isolate electricity use for hot water.

No- or Low-Cost Conservation Strategies

Many options exist for reducing hot water use that are simple and either free or inexpensive. These options include:

- Washing clothes in cold water whenever possible;
- Running only full loads of laundry and dishes;
- Taking shorter showers;

Quick Facts

- On average, homes in Colorado use about 20 gallons of hot water per person per day.
- Many options exist for reducing hot water use that are simple and either free or inexpensive.
- At present, greater savings can be expected through conservation and efficiency if using electricity or propane as the fuel source for water heating compared to natural gas.
- On-demand ('tankless' or 'instant') water heaters can provide hot water more efficiently than conventional storage water heaters but they may not be practical for all households.

www.ext.colostate.edu

- Using low flow showerheads—less than 2.5 gallons per minute (gpm);
- Using faucet aerators;
- Setting your water heater thermostat to 120 degrees F;
- Insulating hot (and cold) water pipes;
- Installing a hot water heater wrap or blanket.

To find out how many gallons per minute your current showerhead uses, put a 5-gallon bucket in the shower, run the water into the bucket for 1 minute, and estimate. Switching from a 2.5 gallon per minute showerhead to a 1.5 gallon per minute showerhead could save a typical family of three about 10,000 gallons of hot water per year—$50 per year or more in energy costs alone depending on your fuel source*. At costs of $10 and up, the return on investment for new low flow showerheads could be significant.

The temperature dial on many hot water heaters either has just 'low', 'medium', or 'high' settings or can be unreliable even if temperatures are displayed. The best way to test the temperature of your water heater is to run a cooking thermometer or hot water gauge under the faucet closest to the water heater. Adjust the thermostat on the water heater until the water temperature is 120 degrees F. (For electric water heaters you may need to turn the power off before removing the thermostat panel(s) and adjusting the thermostat(s).) This simple measure could save your household $20 per year or more depending on your fuel source**.

If installing a water heater blanket on a gas water heater, use particular care to follow the manufacturer's instructions or hire a contractor. Blankets can be especially cost-effective if your water heater storage tank is warm to the touch but might not be recommended by new water heater manufacturers if the units already have sufficient levels of insulation. As with other conservation measures at this time, financial savings will likely be greater if the fuel saved is electricity or propane versus natural gas. For example, under certain assumptions savings of around $2.50/year could be expected by adding a common $20 R-10 wrap to a natural gas water heater, whereas savings of over $13/year could be expected from adding that wrap to an electric water heater***.

Insulating closest to the tank (say the first 3 feet of hot (and cold) water piping as it leaves the water heater) is the most important to reduce energy loss—just be sure to leave at least 6 inches of space between the insulation and a flue.

In addition to the conservation strategies listed above, recent research has suggested that washing one's hands in water hot enough to kill bacteria would be uncomfortable and as a result there is no significant health difference between washing hands in cold or warm water. While hot water is better at removing grease from hands, it is the duration of the hand washing that is primarily responsible for removing bacteria. So washing hands in cold water is another strategy for conservation, and this might be especially appealing for those who experience long wait times before the hot water even reaches the faucet.

Of course, purchasing efficient equipment can result in more substantial savings than conservation alone can achieve. Numerous technology options for water heaters are on the market, including storage hot water heaters, on-demand water heaters, indirect water heaters, heat pump water heaters, and solar hot water heaters (which are covered separately in this CSU Extension fact sheet).

Types of Water Heaters—Storage

Storage hot water heaters can use a variety of fuel sources (including natural gas, propane, electricity, and even wood) to heat water in a storage tank to a given temperature. Hot water from the top of the storage tank is then ready for use when called for at a faucet. The efficiency of these units is measured by a value referred to as an Energy Factor (EF), listed on the hot water heater label. An EF of 0.65 indicates a high efficiency conventional gas-fired unit, whereas an EF of 0.95 indicates a high efficiency electric unit. Gas-fired units that use the gases created through fuel combustion to heat more water—called condensing units—can have EFs of 0.86. Keep in mind that the higher EF for electric water heaters does not account for the efficiency of the power plant used to generate the electricity. In addition, the current high cost of electricity relative to natural gas makes even the highest efficiency electric storage units more expensive to operate than natural gas storage hot water heaters.

One of the limits on the efficiency of storage water heaters is that the water in the storage tank gets heated to a set temperature even if the water isn't being used. The efficiency loss associated with this characteristic is called 'standby loss'. Standby loss can be minimized in storage tanks that are well insulated, with R-values as high as R-25.

As with all types of water heaters, it is important to properly size a new unit instead of simply purchasing the same size water heater as your existing unit. Hot water conservation can result in the need for a smaller unit, can save you money on your purchase, and can save you money when the unit operates. To properly size a storage hot water heater, you need to estimate the maximum amount of hot water your household would use in a one hour period (called 'peak hour demand'). Use the categories and averages in the table below to conduct this estimate.

In this example, the household would want to find a storage hot water heater with a 'first hour rating' within 1-2 gallons of its peak hour demand: 44-48 gallons.

Maintenance for storage hot water heaters may include periodic water flushes from the storage tank, checking pressure and temperature valves, and other manufacturer recommendations.

Assumptions – 60% efficient natural gas storage water heater providing 64 gallons of hot water per day going from 130 to 120 degrees F at $0.60 per therm

***Assumptions – 60% efficient natural gas storage water heater at 130 degrees F going from 64 to 43 gallons of hot water per day (based on a three household members each taking 7 minute daily showers) at $0.60 per therm*

****Assumptions – 28 ft.2 water heater surface area at 130 degrees F in a 60 degree F room going from R-16 to R-26 with the addition of a wrap at $0.60 per therm or $0.11 per kWh*

Use	Average gallons per use		Maximum times used in 1 hour		Gallons used in 1 hour
Shower/bath	10	x	2	=	20
Shaving (0.05 gpm)	2	x	1	=	2
Hand dishwashing/food prep	4	x	1	=	4
Automatic dishwashing	6	x	1	=	6
Clothes washing	7	x	2	=	14
			Total peak hour demand		46

Types of Water Heaters—On Demand

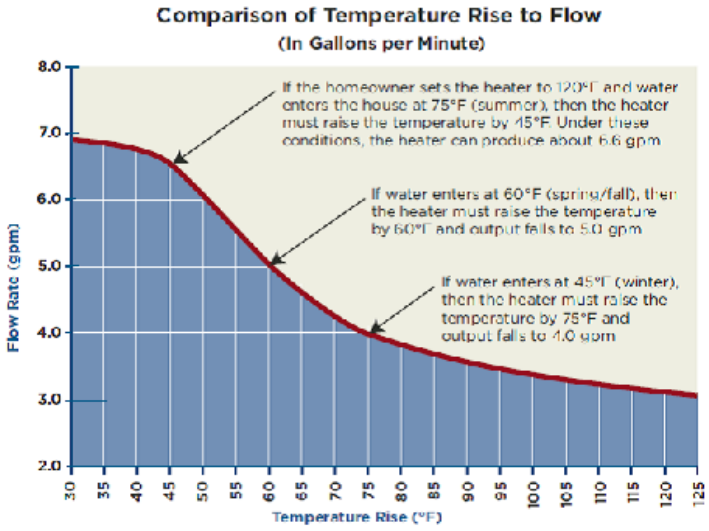
On-demand ('tankless' or 'instant') water heaters provide hot water more efficiently than conventional storage water heaters because they only heat water when it is called for at a faucet. (Gas on-demand units have EFs around 0.82, and electric units have EFs around 0.98.) Instead of making use of storage tanks for heating large quantities of water, when hot water is called for at a faucet it passes from the tap through a small on-demand unit where it is heated by burning natural gas or propane or by an electric heating element. One advantage of this type of system is that the amount of hot water it can provide is not limited by the amount of hot water in a storage tank. On the other hand, on-demand water heaters are limited by the amount of water they can heat at any one time.

Gas on-demand water heaters can typically provide a greater flow of hot water—about 5 gpm—than electric on-demand water heaters. Electric on-demand water heaters also require a significant amount of electricity to heat water so quickly. Some electrical panels may need to be upgraded to accommodate the high demand of electric units. The diameter of gas lines will often need to be increased for gas units as well. If electric on-demand water heaters became widespread it might also require electric utilities to add power capacity to deal with these increased loads.

It is critical when deciding if an on-demand water heater is right for you to calculate your maximum use at a given time in gallons per minute (the 'flow rate'). For example, if you have a showerhead that emits 2 gpm and might run a kitchen faucet at 2 gpm at the same time, you'd need an on-demand water heater capable of delivering at least 4.0 gpm. Installing an aerator could decrease your flow rate for the kitchen faucet to 1 gpm, so hot water conservation is especially important when considering an on-demand system. Multiple on-demand units can be installed in a household if more hot water is desired than can be provided by a single unit or if one faucet is relatively far from the others.

The volume of water that can be produced by on-demand water heaters depends on the temperature of the incoming water from the tap. The warmer the water is (as in summer and in warmer climates), the greater the flow that can be delivered at the desired temperature. Most on-demand unit manufacturers can provide a graph that compares flow rates at different temperature rises above the incoming water like the one here. Because most new on-demand water heaters vary their application of heat according to the flow rate, households on well water may experience cold slugs as the pressure provided by the well pump changes. Solutions to this issue might include installing a water pressure regulator or adjusting the setting of your well pump switch and can be discussed with a qualified contractor.

Other considerations for on-demand water heaters include: their relatively high upfront cost and potentially high cost of repair (offset by lower energy costs over time); longer lifetime compared to storage water heaters (20 year expectancy); the creation of space in homes when replacing storage water heaters (most on-demand units are small and are wall-mounted in inconspicuous locations or are mounted at the point of use such as under sinks); and the requirement of a minimum flow rate for the burner to start in gas units (uses such as shaving that require small trickles of hot water may not meet this minimum). And unless they are optimized for elevation, on-demand water heaters will not perform as advertised at high altitudes. Some units may not be suitable at all for use at high elevations.



Source: "Installing On-Demand Water Heaters", Journal of Light Construction, Feb. 2006

Types of Water Heaters—Indirect Water Heaters

An indirect water heater: the blue boiler heats water in a pipe that runs in a coil through the storage tank for both space and domestic hot water heating.

Indirect water heaters consist of a single boiler, a stand-alone storage tank for both domestic hot water and space heating, piping, and other associated components. Water is run in a piping loop from the boiler (where it is heated) through a coil in the storage tank. In the storage tank the coil of water exchanges its heat with the surrounding storage water before returning to the boiler. Domestic hot water is usually controlled as its own 'zone' of the house. In warm weather, the boiler is used only to produce domestic hot water. In cold weather, very little extra energy is used for domestic hot water since energy is used to heat water for space heating anyway. Boilers can be heated with a variety of heating fuels.

The main drawback of these systems is the upfront cost: even though the space heating and domestic hot water heating

needs are combined into one unit, the purchase price can be more than buying a space heater and water heater separately. Installation costs, however, may make up for at least some of this difference since only one heating unit (a boiler) is being installed. The nameplate efficiency of indirect water heaters is referred to by the combined appliance efficiency (CAE), which can vary from 0.59 to 0.90.

Because indirect water heaters need to accommodate both space and domestic hot water needs, they should be sized carefully by qualified contractors. Maintenance requirements are similar to the requirements for conventional boilers and storage tanks.

Types of Water Heaters—Heat Pump Water Heaters

Heat pump water heaters are a relatively new technology. Most units extract heat from air in the room in which the unit is located and use it to heat water in a storage tank that is often taller than a conventional storage tank. In some cases, heat can be pulled from the ground (ground source or geothermal heat pumps) to heat a home's space and then an additional unit called a desuperheater uses gases from the heat pump's compressor to heat water for domestic uses.

In theory, 'air source' heat pump water heaters can have Energy Factors between 2.0 and 2.5, but in practice this can vary widely based on climate, the conditions of the room in which the unit is installed, and other factors. A significant caution in regards to air source heat pump water heaters is that pulling heat from the air of the surrounding room will cool the space. Because Colorado homes have more heating needs than cooling needs, this can add to the energy needed for space heating, which offsets some of the benefit of the heat pump water heater. And because heat pump water heaters require backup electric resistance heat when the surrounding air is less than 40 degrees F, they will not function efficiently in rooms that tend to be cold. These units are more expensive to purchase than electric storage water heating units.

Heat pump water heaters with tanks are sized in the same way other storage hot water heaters are sized. Consult with a contractor if you are interested in integrating water heating to a heat pump that currently provides only space heat. Because the technology is relatively new, little is definitively known about the lifetime of these units.

Other Considerations

Rebates and tax credits may be available for the purchase of high efficiency hot water heaters although these offers can change rapidly. Check with your local utility, your contractor, and on www.dsireusa.org for up-to-date incentive information. Keep in mind that purchasing efficient appliances that use hot water—such as dishwashers and clothes washers—is another way to save on domestic hot water heating and that financial incentives are often available for these items as well.

Another less-known equipment purchase that can reduce hot water use is a drain water heat recovery system. Although there are many variations of these systems, in its most common and simple form, hot water exiting a shower drain will be wrapped by a coil of incoming cold water so that the cold water is preheated before it flows to the shower itself or to the hot water storage tank. This means that less fuel needed to heat that water. These systems can also work with dishwashers and clothes washers but in those cases require separate storage tanks so the release of the warmed water can be timed appropriately. In any case, the new plumbing may require 3 feet or more of clearance beneath the existing drain (i.e. in a basement or crawlspace) so is not feasible in all situations. It is important to find a qualified contractor to install a drain water heat recovery system, and they may cost around $1,000 to install depending on the complexity of the installation.

Conclusions

Saving hot water reduces not only the energy used to heat the water but also water use and bills. There are a variety of hot water conservation and efficiency strategies available to households that range from no-cost to the replacement of the water heater itself. At present, greater savings can be expected through conservation and efficiency if using electricity or propane as the fuel source for water heating compared to natural gas. High-efficiency storage water heaters with well insulated storage tanks and/or the ability to heat water using combustion gases are available. On-demand units can be a sound investment as long as household needs are considered and the units are sized appropriately. Indirect water heaters can be particularly efficient in cold climates since they heat water for both space and domestic purposes. The performance of heat pump water heaters can vary significantly from the nameplate rating of the unit and they can increase space heating needs. Be sure to work with a qualified contractor who is willing to understand your household use patterns and goals when installing new water heating equipment.