

## WATER HEATING

In the average American home, water heating accounts for about 20% of total household energy consumption. In Virginia, the average household spends between \$200 and \$500 per year for heating water. Households with natural gas water heaters spend about \$250, while those with electric water heaters are likely to spend closer to \$400 or \$500.

If your gas or oil water heater is more than fifteen years old, it probably has an efficiency no higher than 50%. If you have an electric water heater, its efficiency is probably high, but the high cost per Btu of electricity makes it expensive to operate. One obvious way to reduce water heating energy costs would be to replace your old heater with a higher efficiency model or with one using a cheaper source of energy. However, before looking at new water heaters, you should consider several no cost/low cost measures to improve the efficiency of your current system. This chapter begins

with a discussion of ways to improve your current system and then describes how to select a new high-efficiency replacement water heater for your home.

### Types of Residential Water Heaters

Several different types of residential water heaters are available. Table 6-1 on page 79 gives approximate installation and operating costs for each type of heater.

#### Storage water heaters

The vast majority of water heaters are storage type, which consist of an insulated tank with gas burner, oil burner or electric resistance heating element. As hot water is drawn off near the top of the tank, cold water replaces it at the bottom.

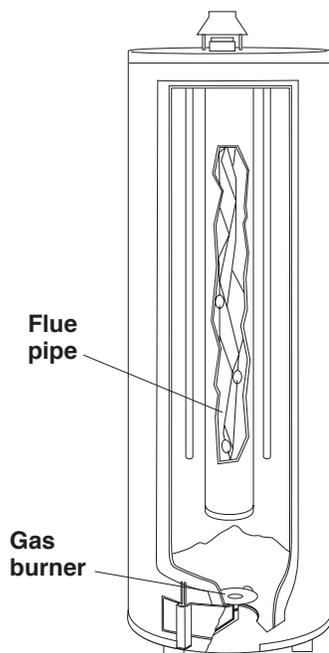


Figure 6-1a

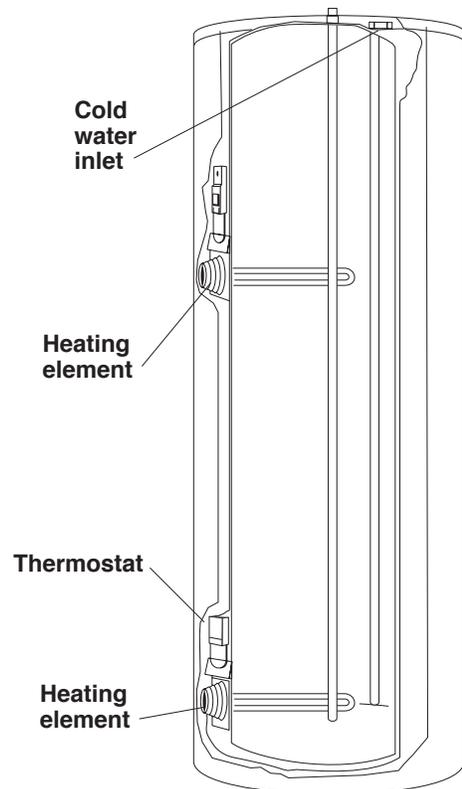


Figure 6-1b

Figure 6-1 - Storage type water heaters are by far the most common type of residential water heater. Figure 6-1a: Gas and Figure 6-1b: Electric

**Table 6-1- Life-Cycle Costs for 13-year Operation of Different Types of Water Heaters**

Water Heater Type	Eff.	Cost(1)	Yearly Energy Cost(2)	Life (years)	Cost over 13 years(3)
Conventional gas storage	55%	\$425	\$163	13	\$2,544
High-eff. gas storage	62%	\$500	\$145	13	\$2,385
Oil-fired free-standing	55%	\$1,100	\$228	8	\$4,751
Conventional Electric Storage	90%	\$425	\$390	13	\$5,495
High-eff. electric storage	94%	\$500	\$374	13	\$5,362
Demand gas	70%	\$650	\$140	20	\$2,243
Demand electric (2 units)	100%	\$600	\$400	20	\$5,590
Electric Heat Pump	220%	\$1,200	\$160	13	\$3,280
Indirect water heater with efficient gas or oil boiler	75%	\$700	\$150	30	\$2,253
Solar with electric back-up	(4)	\$2,500	\$125	20	\$3,250

Notes:

1. Approximate cost of appliance plus installation.
2. Energy costs based on hot water needs for typical family of four and energy costs of 8c./kWh for electricity; 60c./therm for gas; \$1.00/gallon for oil.
3. Future operating costs are neither discounted nor adjusted for inflation. Source: American Council for an Energy-Efficient Economy, *Consumer Guide to Home Energy Saving*, 1996.
4. The efficiency value normally listed for solar water heating systems is not the same as for fuel-burning systems. It is the percent of the total solar radiation that is captured as useful heat. Since the solar energy itself is free, efficiency comparisons electric, gas, or oil heaters are not meaningful.

The most important energy related feature of storage water heaters is the amount of insulation on the tank. The best heaters have 2 to 3 inches of urethane foam, providing R-values as high as R-20. Other less expensive models have fiberglass tank insulation with R-values ranging between R-7 and R-10. (See Chapter 3 for discussion of R-value and insulation.) Storage water heaters range in size from 20 to 80 gallons.

## Demand water heaters

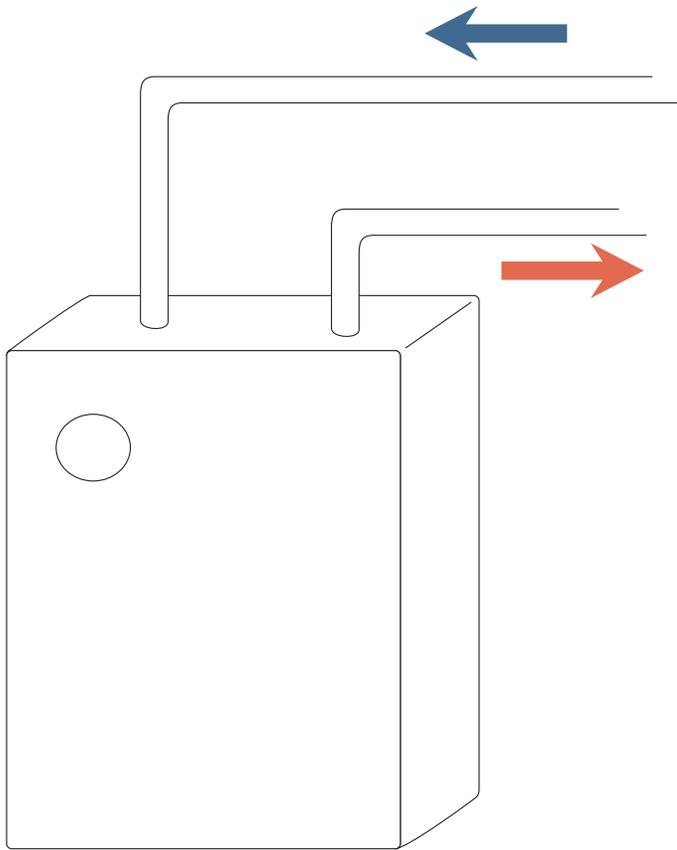
Demand or instantaneous water heaters have no storage capacity. Water is heated as needed. When you turn on the hot water tap, the gas burner or electric element comes on and water is heated as it flows through the water

heater.

One drawback of demand water heaters is limited output capacity. The largest gas-fired demand water heater can supply only 3 gallons per minute at a temperature rise of 90°F (from 50° to 140°, for example) — not enough for two simultaneous showers.

Electric models typically have even lower output. As a result, demand water heaters are better suited for low-use applications like vacation homes, rather than full-size homes with two or three baths.

It is possible to install a separate demand heater for each bath. This is energy efficient since it reduces heat losses from pipes, and saves water since it eliminates most of the wait for hot water to reach the tap. Initial costs, however, are high.



*Figure 6-2 - Demand water heaters offer energy savings, but they can't heat water quickly enough to satisfy most American households.*

## Indirect water heaters

Indirect water heaters do not have their own heating source, but instead use the hot water from the boiler of the house heating system. The hot water from the boiler is circulated through a submerged heat exchanger in the water heater tank. When used in conjunction with a high efficiency boiler, this is one of the most efficient ways to heat water.

## Heat pump water heaters

Heat pump water heaters use electricity, but work on a completely different principle than regular electric water heaters. A heat pump water heater extracts heat from the air inside the house, air outside, or spaces like the garage or basement, concentrates it to a higher temperature, and uses it to heat water in a storage tank. Just like heat pumps for home heating (see Chapter 5), they use a compressor to “pump”

heat from a cooler source (air or the ground) into the hot water.

Since much of the heat required by heat pump water heaters comes from the surroundings, rather than the power line, they are very efficient.

## Triple-integrated heat pumps

A few manufacturers now sell “triple integrated” heat pumps that not only heat and cool the house, but also heat water with very high efficiency. During summer, the heat pump uses waste heat from the air conditioner to heat domestic water — essentially providing free hot water. During winter, the system takes heat from outdoors to provide both space heating and water heating. The winter efficiency varies with outdoor temperature, but is always significantly better than a conventional electric resistance water heater.

## Solar water heaters

Since they use free solar energy as the heat source, solar water heaters can provide the greatest savings of all. With solar water heaters, you spend most of the money up front to buy the system; operating costs are quite low. With good solar exposure, a properly designed system should be able to provide up to 80% of hot water requirements in the Virginia climate.

There are a number of different types of solar water heaters. Most common is a flat-plate collector system in which heat transfer fluid is piped through one or more collectors on the roof where it is heated, then through a heat exchanger in a hot water tank where the sun's heat is transferred to your water. Flat plate collectors differ according to the type of piping used (usually copper, but some plastics and EPDM rubber are also used). There are various strategies used for pumping the fluid through the collectors and preventing risk of freezing in cold weather. A few flat-plate collector water heaters operate passively (without pumps), circulating water by natural convection or using a unique geyser-pumping principle. Finally, the simplest solar water heaters of all—called batch solar water heaters—just have a tank of water in an insulated glazed enclosure exposed to sunlight.

Prices for solar water heaters have dropped considerably since they first became popular in the 1970s and 80s. An

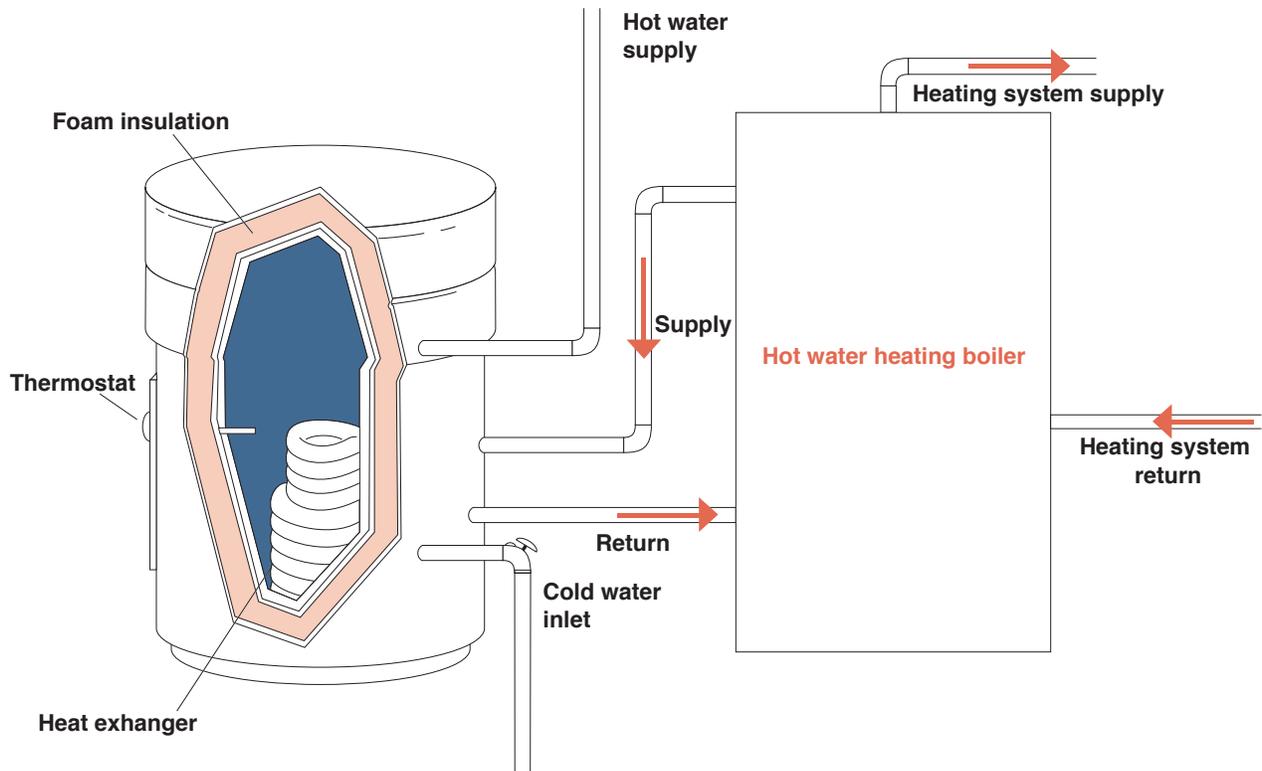


Figure 6-3 - Indirect water heaters take advantage of the higher efficiency of a heating system to provide inexpensive hot water.

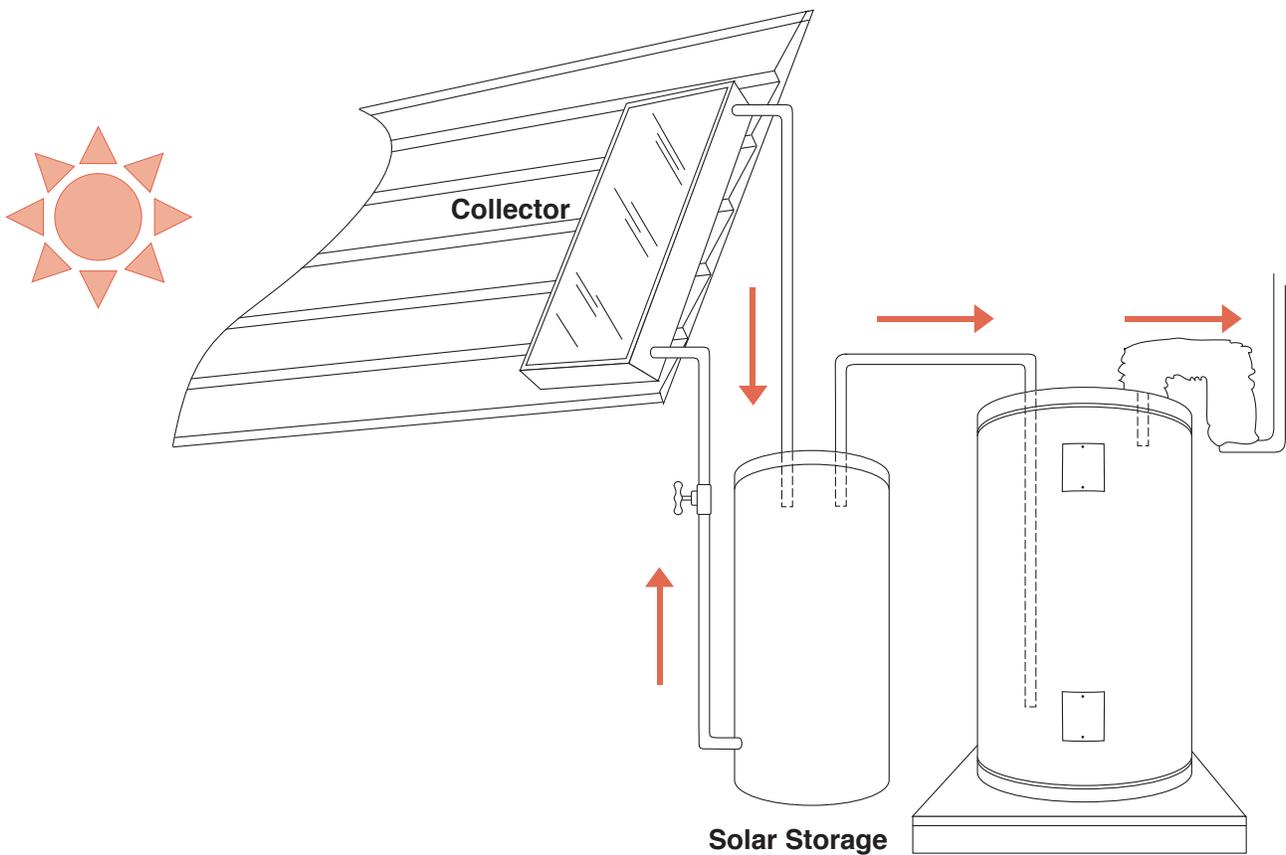


Figure 6-4 - Solar water heaters typically consist of a roof-mounted collector and storage tank in the house.

installed system typically costs less than \$3,000. Despite the high installation cost, solar water heaters can compete economically with electric when total “life-cycle cost” is taken into account. Life-cycle costing takes into account both installed cost and cost of operation over the life of the heater. Table 1 on page 79 compares the life-cycle cost of solar water heaters to conventional gas, electric and oil heaters. Notice that although it is not the least expensive heater on the list, the solar water heater costs far less to own and operate than several of the conventional water heaters.

## Energy Efficient Water Heating

### Turn down your water heater temperature

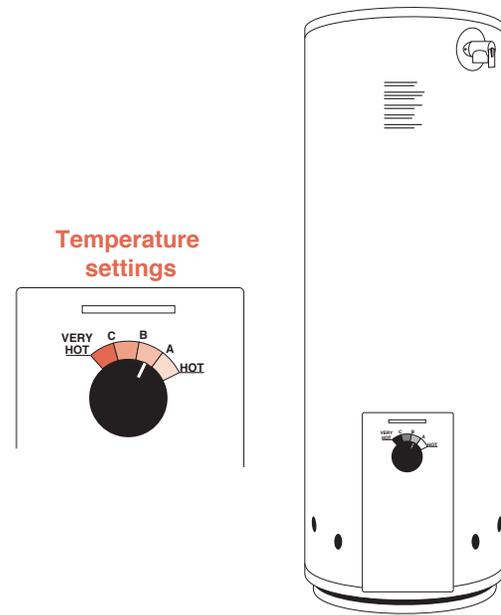
Each 10°F reduction in your water heater temperature will save 3-5 percent on your annual water heating bills. Lowering the water temperature will also increase the lifetime of your water heater and reduce the risk of scalding.

Most water heaters are factory set at around 140°F. For most household uses, that is higher than necessary. Usually, 120 degree water is perfectly adequate for household needs. (One exception is if you have a dishwasher without a booster heater. In this case, you may need to keep the temperature set at 140° for optimal dishwashing performance – see Chapter 7.)

Water heater temperature is controlled by one or more thermostats on the water heater (large electric models have two). With electric water heaters, first turn off power to the water heater at your electric control panel, then open the access panel to get to the controls. If the water heater has been insulated, you will have to open up the blanket to reach the access panel. Simply adjust the dial to the desired temperature level. With larger electric water heaters, be sure to adjust both the upper and lower thermostats. If your water heater only has a few relative settings (“Warm,” “Normal,” etc.), you can set the dial between these for an intermediate temperature. Consider turning your water heater off or significantly lowering the temperature setting if you are going on vacation or leaving the home unoccupied for more than a few days.

### Insulate your water heater

Wrapping your water heater with insulation can reduce water heating energy use by 4% to 9% and pays for itself in less than one year. Some new water heaters come with high



*Figure 6-5 - Lowering the temperature setting on your water heater is one of the easiest ways to save on water heating costs.*

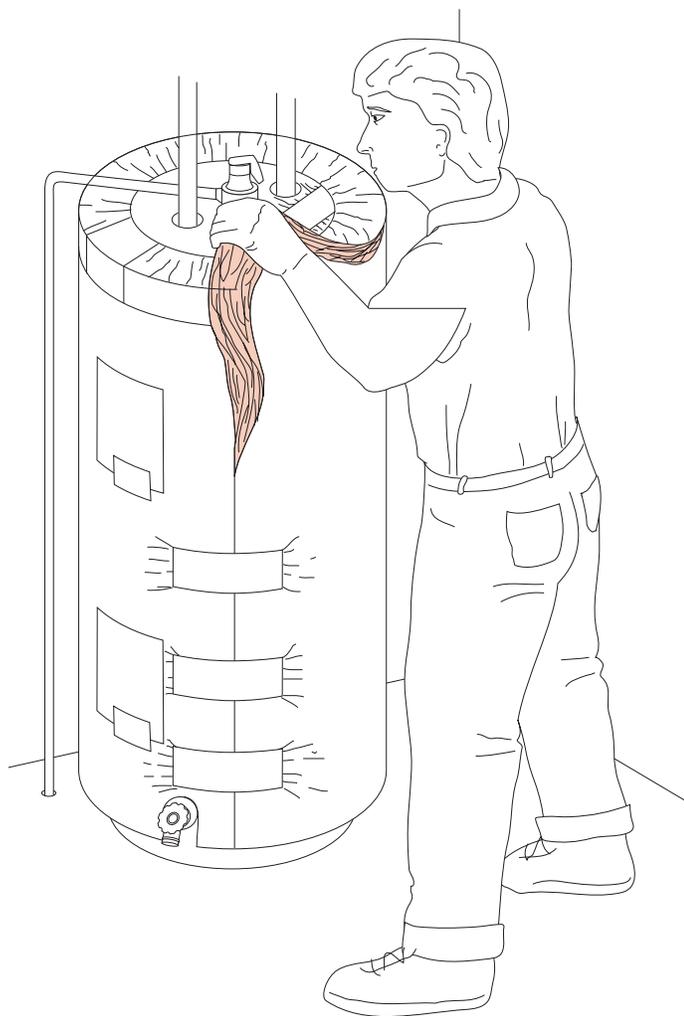
levels of foam insulation and do not require blankets, but the extra insulation is cost-effective with most older models.

Water heater insulation blankets are widely available at hardware stores and come in standard sizes to fit 40, 60, and 80 gallon water heaters. Most consist of 2" or 3" fiberglass insulation with vinyl facer.

Follow the manufacturer’s instructions for installing the blanket. With gas or oil fired water heaters, the insulation must not interfere with the air inlet or the exhaust hood, and the control panel should not be covered. With electric water heaters, it is okay to wrap the entire tank. To allow future temperature adjustment, position the blanket so that the seam lines up with the access panel(s). Pay attention to newer models that specifically say “Do Not Wrap” – this warning is always found on the outside of the tank.

### Install water-conserving plumbing fixtures (see Chapter 9)

Reducing hot water consumption naturally reduces the amount of energy necessary for water heating. Studies have shown that low-flow showerheads and faucet aerators reduce



*Figure 6-6 - Adding insulation to your water heater is almost always cost-effective, especially with older models.*

water heating energy use by up to 50%!

A low-flow showerhead delivers between 2 and 3 gallons per minute — about half the volume of a standard shower head. And unlike some of the early “flow-restrictor” types that produced only a fine mist, high-quality low-flow showerheads now on the market provide perfectly comfortable hot showers.

A top quality low-flow showerhead costs \$10-20 and will typically pay for itself in hot water savings in only a few months.

Water saving faucet aerators are another good way to reduce hot water use. Faucet aerators cost just a dollar or two and like low-flow showerheads, pay for themselves in energy savings in just a few months.

Look for aerators that deliver between 1/2 and 1 gallon

of water per minute. Some faucet aerators also offer convenient shut-off levers.

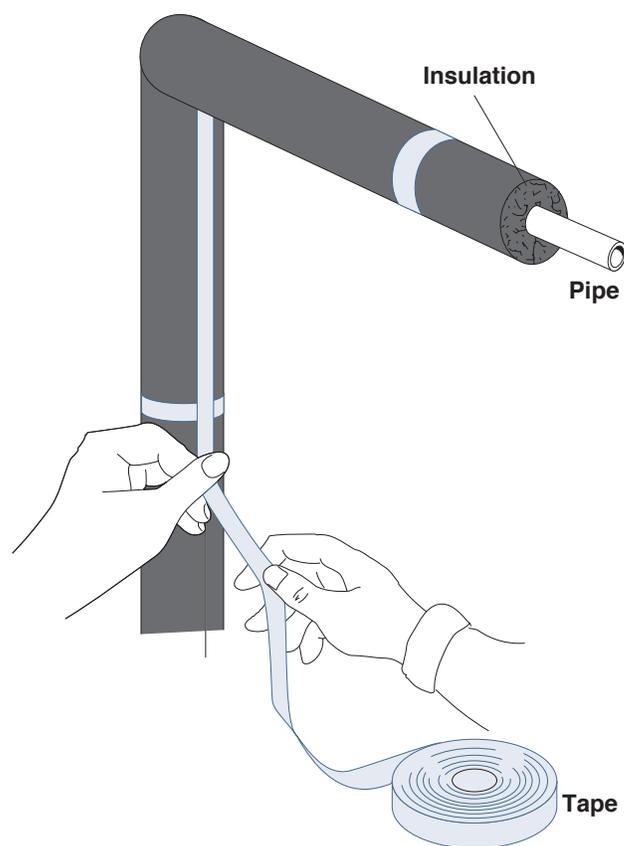
Before putting water saving aerators on all your faucets, think about the specific uses. For example, in the kitchen, where you want high flow to fill cooking pots, an aerator may be annoying.

Showerheads and faucet aerators are easy to install. Removing the old one is often the most difficult part and may require pliers or a pipe wrench. Use a cloth to protect chrome pipes and fittings.

## Insulate hot water pipes

Hot water pipes should be insulated wherever they are accessible. Pipe insulation not only saves energy, but also keeps water in the pipes warm. Either pre-formed foam insulation or wrap-around fiberglass insulation can be used. Costs range from about \$.10 per foot for fiberglass up to about \$.60 per foot for foam.

Cold water pipes should also be insulated within 3 or 4



*Figure 6-7 - Pipe insulation around your hot water pipes is good both for energy savings and comfort.*

feet of the water heater, or between the water heater and heat traps (see heat traps below).

### Install heat traps

Heat traps are valves or piping loops that are installed in the hot and cold water lines to prevent water from circulating when the heater is off. They cost around \$30 plus installation.

Experts disagree as to the effectiveness of heat traps. If no other work is being done to your water heater, it will be hard to justify the cost of having a plumber make a special trip just to install heat traps (insulating the pipes is more cost-effective). If the water heater is being relocated or replaced, heat traps are probably a good idea.

### Fix leaky faucets

Dripping faucets can waste significant quantities of water and energy. A leaky hot water faucet dripping at a rate of one pint per hour will waste 1,092 gallons of water per year. Dripping faucets can often be fixed simply by replacing a washer. (see Chapter 9)

### Use appliances efficiently

Whenever possible, use the warm water or cold water cycles on your washing machine and the light wash cycle on your dishwasher (see Chapter 7).

### Don't heat water when you don't need it

Special water heater timers are available that turn the heater off at night when you don't need hot water and on again in the morning in time for the morning showers. A simple timer costs around \$30; more sophisticated multi-setting timers cost up to \$100.

Another obvious energy saver is to turn your heater down or off completely when away on vacations.

### Buying a New Water Heater

If you are replacing an older water heater, you have an opportunity to choose a more efficient model. Even if your existing water heater is in good working order, it makes sense to give some thought to what you might replace it with if and when it does fail. That way, when your water heater dies, you'll be less likely to replace it with just any model your

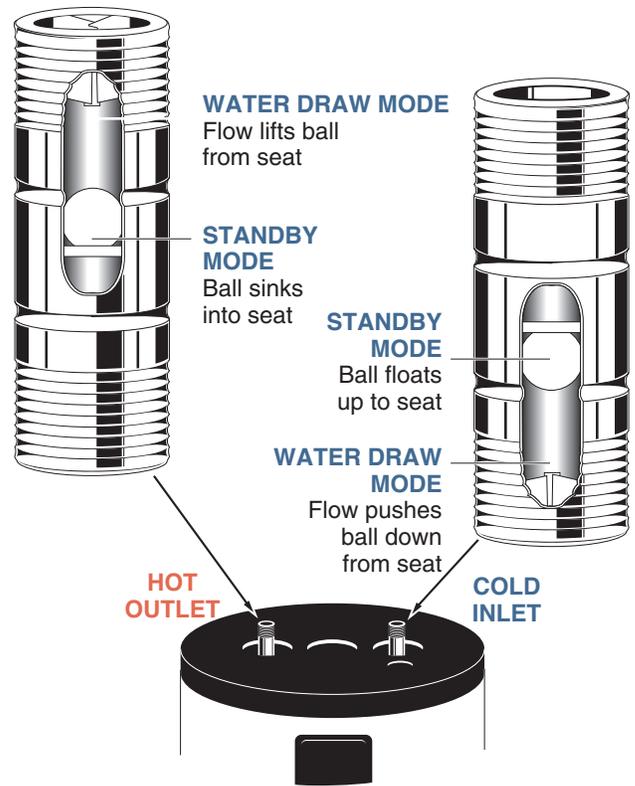


Figure 6-8 - Heat traps installed on the pipes leading to and from your water heater help to reduce stand-by losses.

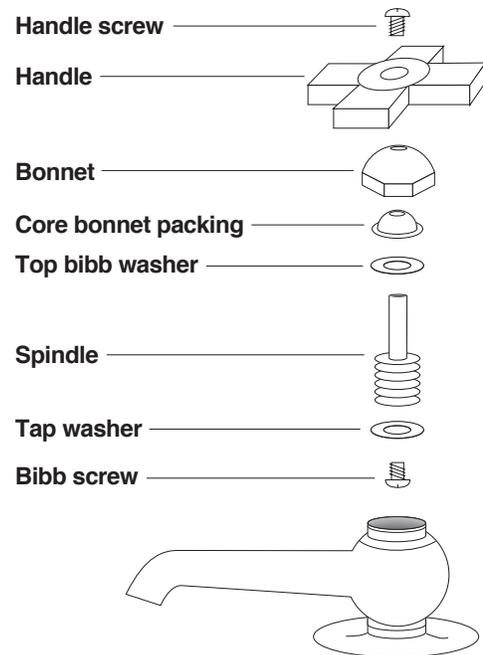


Figure 6-9 - Many costly leaks can be easily repaired by replacing the tap washer in the faucet.

plumber suggests—without thinking about energy. Estimate how much hot water you and your family may use and try to select the proper size of storage tank that is needed. Buying a water heater that is too big or too small will ultimately lead to inefficient water heating.

To make a well-informed decision on a new water heater, it makes sense to understand the options. The most common types of water heaters are described below, along with tips on the selection of new equipment.

## EnergyGuide labels for water heaters

All new water heaters sold must have yellow EnergyGuide labels that provide information on energy use. The EnergyGuide label for a water heater provides one large number, at the bottom of the label, that represents the approximate annual operating cost for that model given average national energy costs. The label also provides estimates of the appliance's annual energy use and a range of ratings for similar models – from “uses least energy” to “uses most energy.” For electric water heaters, the fuel costs will be in cents per kilowatt-hour; for natural gas models, fuel costs will be in cents per therm or ccf (hundred cubic feet); for propane and oil-fired models, fuel costs will be in cents per gallon. While EnergyGuide labels provide an excellent way to compare the energy efficiency of different models, they do not necessarily provide an accurate representation of how much you will actually spend for water heating. Your water use habits and the temperature setting on your water heater will also affect yearly operating cost.

## Selecting a storage water heater

### Select an efficient model

Storage water heaters are rated according to their Energy Factor (EF) which ranges from about .50 to 1.0. An EF of 1.0 would be equivalent to 100% efficiency. The most efficient electric water heaters have EF ratings up to .98, and a few gas-fired models have EF's as high as .86, while most are in the range of .50 to .70. Larger water heaters have somewhat lower EFs than smaller water heaters because of their greater surface area.

The National Appliance Energy Conservation Act (NAECA) sets minimum efficiency standards for water

Based on standard U.S. Government tests

# ENERGYGUIDE

Water Heater – Natural Gas  
Capacity (first hour rating):  
60 gallons

XYZ Corporation  
Model(s) RP23  
RP38

**Compare the Energy Use of this Water Heater with Others Before You Buy.**

**This Model Uses**  
240 Therms/year

**Energy use (Therms/year) range of all similar models**

<b>Uses Least Energy</b> 245	<b>Uses Most Energy</b> 295
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**The Estimated Annual Energy Consumption of this model was not available at the time the range was published.**

Therms/year is a measure of energy use. Your utility company uses it to compute your bill. Only models with first hour ratings of 56 to 64 gallons are used in this scale.

**Natural gas water heaters that use fewer therms/year cost less to operate. This model's estimated yearly operating cost is:**

**\$165**

Based on a 2000 U.S. Government national average cost of 68.8¢ per therm for natural gas. Your actual operating cost will vary depending on your local utility rates and your use of the product.

Important: Removal of this label before consumer purchase violates the Federal Trade Commission's Appliance Labeling Rule (16 C.F.R. Part 305).

Figure 6-10 - Water heater EnergyGuide label

heaters. All new equipment for sale must meet NAECA standards. You can save money and energy, however, by buying equipment that exceeds the minimum NAECA standards.

The Federal Energy Management Program (FEMP) lists recommended efficiencies and the efficiencies of the best equipment currently available. The FEMP recommended efficiency is also the minimum efficiency allowed for *Energy Star* labeling.

### Sealed combustion and power venting

With oil or gas-fired water heaters, look for “power-vented” or “sealed combustion” models which use a small blower to exhaust flue gases up the chimney or out through a side vent. The advantage of these heaters is that they are not subject to “back-drafting” or “spillage” of exhaust gases into the house.

Table 6-2 – Recommended and Best Available efficiencies for water heaters according to the Federal Energy Management Program.

Heater Type	Measurement Units*	Recommended	Best Available
Electric	Energy Factor	0.92	0.95
	Annual Energy Use (kWh)	4773	4622
Gas	Energy Factor	0.61	0.72
	Annual Energy Use (therms)	246	208

\* A higher energy factor indicates a more efficient heater, while a lower energy use indicates a more efficient heater

## Selecting a demand water heater

Choose a model that can provide constant temperature water at varying flow rates. This feature is sometimes called “modulating temperature control.” Without this feature, water temperature will vary whenever another faucet or shower is turned on or off.

If you are considering an electric demand water heater, make sure your house has adequate electric supply. Some electric demand water heaters use as much as 75 amps (18 kW at 240 volts), yet provide less than 2 gallons per minute at a 70° temperature rise.

## Energy Tips and Recommendations

1. Improve the efficiency of your existing water heater by:
  - Lowering the water temperature.
  - Installing low-flow water conserving fixtures.
  - Fixing any existing water leaks.
  - Installing an insulation blanket.
  - Insulating hot water pipes.
  - Installing heat traps.
2. If your water heater is over ten years old (life expectancy of water heaters is 10-15 years) consider replacing it with a high efficiency model. Older water heaters are generally no more than 50% efficient.

3. Always consider life-cycle costs when purchasing a new water heater. The cheapest model may not be the smartest choice.
4. Use the EnergyGuide label to help compare the efficiency of water heaters. This label, which is required by law to be displayed on all new water heaters, provides important information on annual energy use and expected yearly costs with different fuel costs.