



WATER HEATERS

Minnesota Department of Commerce Energy Information Center

Water heating is often the second largest energy expense in the Minnesota home, and may account for up to 20 percent of annual household energy costs.

Buying a new water heater

Sizing and installing a water heater system

Avoiding waste in using hot water

There are three ways to reduce hot water expenses: use less hot water, improve the efficiency of your present hot-water heater or purchase a new high efficiency model. This guide offers help in all three areas.

Buy new, or keep the old?

Water heaters have an average life expectancy of 10-12 years, but they can last much longer. Most are not replaced until the tank fails and begins leaking. In many cases, however, it is wise to change the heater long before water begins leaking on the floor.

An old water heater can operate for years at very low efficiencies before it finally fails. It is often cheaper to remove an operating, but inefficient, older unit and replace it with a new highly efficient model.

There are also instances when even a properly operating model should be replaced. For example, if you have an energy efficient furnace that exhausts through the side of your house, and your chimney is in need of repair or a liner, you may want to consider replacing the existing water heater with one that will exhaust through the basement wall. Fixing the chimney while continuing to pay more for hot water may cost considerably more than simply capping the chimney and buying a new water heater that doesn't need a chimney.

If your water heater tank is leaking, then your course is clear: buy a new unit. But if it isn't, your answer is less obvious.

Ask yourself the following questions:

- Does the water heater make popping or cracking noises?
- Have you been forced to turn up the temperature setting over time to maintain an adequate supply of hot water?
- Do you have very hard water?
- Look under the burner. Is there a buildup of rust or other deposits?
- Open the drain tap at the bottom of the heater. Is the stream of water equal to any faucet? If the stream is small or nonexistent, then you have a big buildup of scale inside the heater that is wasting energy and can also mean that your water heater is approaching the end of its useful life.

CAUTION: If your heater is old and does have a scale buildup, you may not be able to close the drain tap. Be prepared to shut off the water with the valve at the top of the tank and use a wrench to tighten the drain tap. The water heater gas valve should be placed on "pilot" when doing this.



Related Guides:

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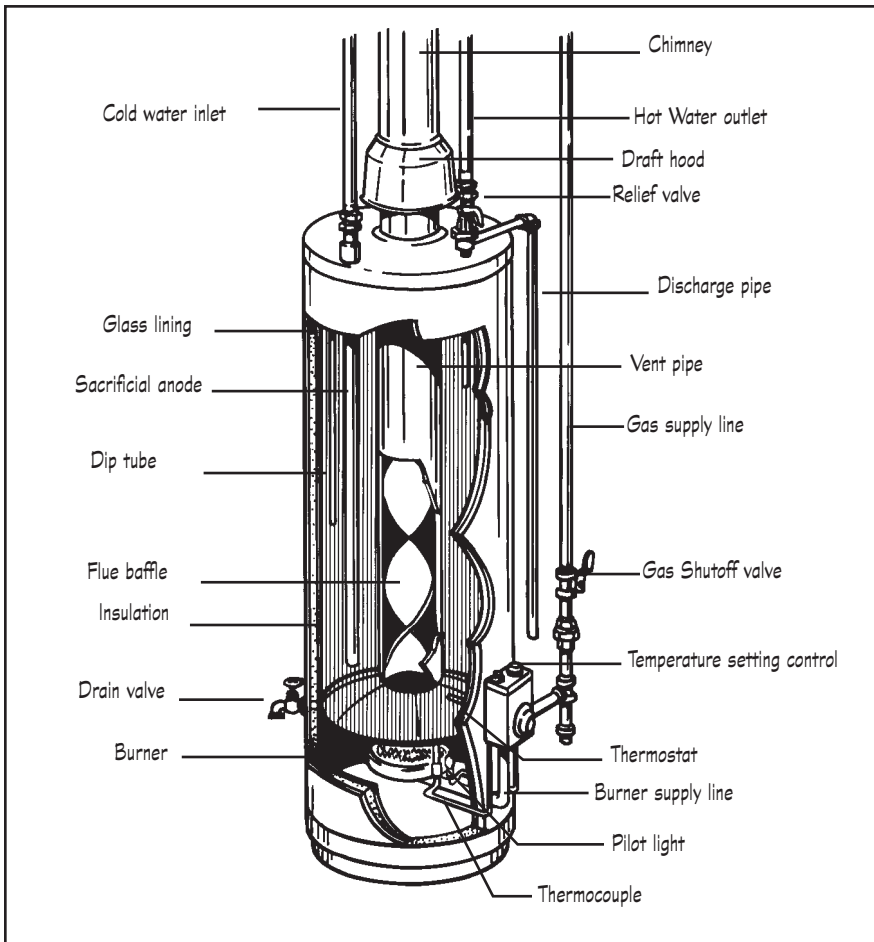


Figure 1
Gas water heater

If you answered “yes” to several of these questions, a new hot-water heater is probably a good investment.

If your answers indicate that the heater is operating well, call the Energy Information Center and ask for the Home Energy Guide, “Low Cost & No Cost Energy & Money Saving Ideas.”(Or download it from the department web site). It contains several good tips on improving the operation of hot water heaters.

Switching fuels

Before switching to a different fuel, make sure it will really save you money. Bear in mind that future variations in fuel prices are very difficult to predict. (See sidebar, “Comparing fuel costs”). Find out how much it will cost for piping and wiring. Make sure there is proper space for the water heater. Check to see if additional plumbing will be needed.

If you use or are considering electricity as a fuel for water heating, call your utility and ask how off-peak rates or interruptible rates can save money.

If you must replace an old water heater, you may save money by using a different fuel – but not always. If gas is already used for clothes drying or space heating, replacing a malfunctioning electric hot water heater with a natural gas unit may be a good decision.

Buying a new hot water heater

When purchasing a new water heater, buy an energy efficient model. It will cost a little more, but the extra cost will pay for itself in a few years time. After that, the better efficiency will save you money for the life of the water heater.

Don’t rely on design features alone to assure energy efficiency. Read and use the rating found on the yellow and black Energy Guide tag found on all new water heaters. The tag will tell you the estimated yearly cost of operating the unit.

The best indicator of a water heater’s efficiency is its Energy Factor (EF). The EF takes into account both the efficiency of heat transfer into the water and the ‘standby heat loss’ of the storage tank. The Energy Information Center recommends an EF of 0.64 or greater for gas water heaters, and an EF of 0.93 or greater for electric water heaters.

Buy the right size hot-water heater: Too small and you may run out of hot water in the middle of a shower; too large and you’ll pay for hot water that is never used. To find the proper size, determine the time of the day when your household uses the most hot water. Use the chart on page 6 to list where and how many times the hot water is used in one hour during the peak period. Multiply the number of uses by the average amount of hot water consumed by each activity and add the totals to find your peak demand.

The peak hour demand capacity, referred to as

the first-hour rating (FHR), is more important than the actual size of the tank because it is an estimate of how much hot water the unit will deliver in an hour. The FHR is displayed on the Energy Guide label. Look for a new water heater with an FHR that is close to the estimate of your household's peak hour demand. If you only reach your peak once a week, and use less hot water the rest of the time, consider adjusting your use to spread out demand and buy a smaller heater.

Mobile home water heaters

It is very important to install the correct type of gas water heater in a mobile home (or manufactured housing). If your mobile home has an exterior access door you may use a standard mobile home water heater with an open draft hood (atmospheric vent). If your water heater access door opens to the interior or your water heater is located in a cabinet or closet, you must install a direct vent mobile home water heater. A direct vent water heater is designed to prevent the accidental spillage of flue gases into the home. The letters "DV" will appear in the model number.

For both types, it is important to seal the compartment housing the water heater from other parts of the house. Seal off any holes for plumbing pipes or electrical wires between the compartment and the home. Make sure that the access door seals tightly and is made of a fire resistant material like sheetrock. Often the floor of the water heater compartment needs to be repaired or replaced because of water damage. Make sure that a combustion air intake is installed through the new flooring and that the pressure release valve, (T&P valve), has an extension that passes through the floor into the crawlspace. It is recommended that a contractor certified to work on manufactured housing should do the installation.

Types of water heaters

A conventional water heater is a fairly simple appliance. It consists of a storage tank and a source of heat. The tank is usually steel and



Figure 2
Power vented water heaters can be vented through a sidewall or vertical vent.

Source:
CenterPoint Energy Minnegasco

coated with glass or enamel to prevent corrosion. It is covered with insulation and enclosed in a steel jacket.

The most common sources of heat are a gas burner or an electric resistance heating element. Both are controlled by a thermostat that responds when hot water is drawn from the tank.

Gas hot-water heaters. The most common size natural gas water heater is 40 gallons. Typical gas models have a burner under the tank and an exhaust stack/heat exchanger, which runs through the middle of the tank (Figure 1). The exhaust stack has two functions: it is a vent for the burner and it transfers heat to the water. A double-wall (class B) venting system is used to expel flue products through the roof of the

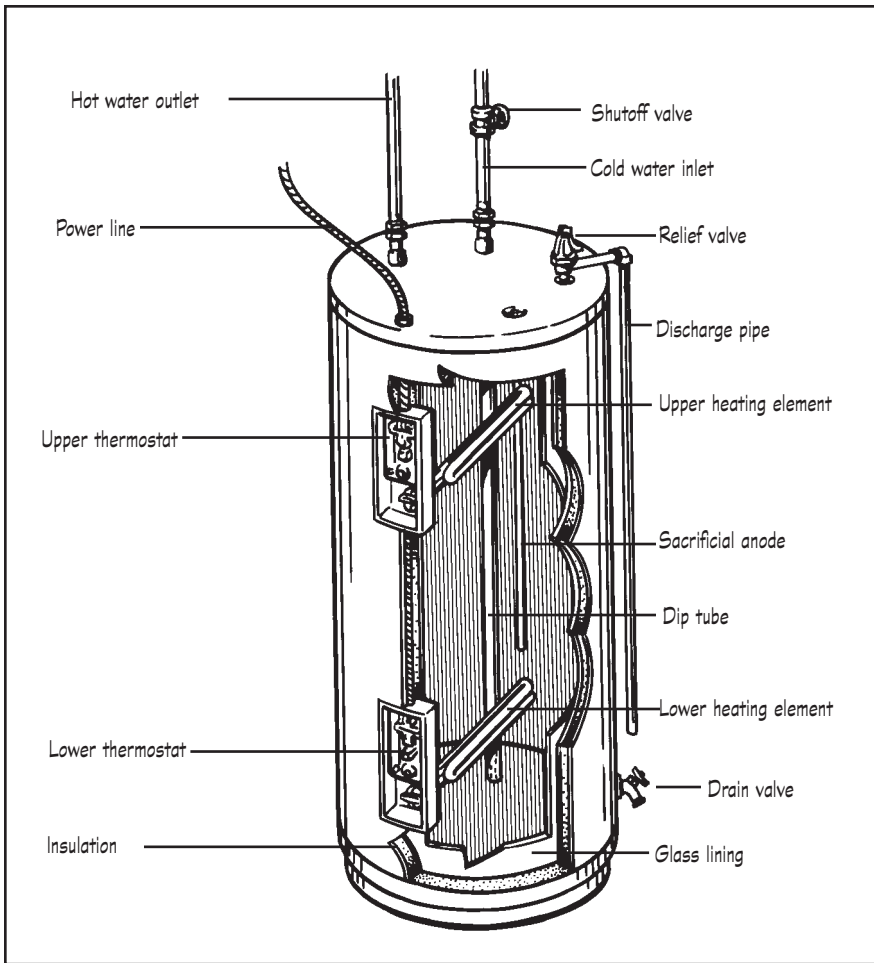


Figure 3
Typical electric water heater.

house. These units use room air for combustion and exhaust, and are often referred to as atmospheric-vent units.

A major difference with some newer gas water heaters is in how the exhaust gases are vented from the house. Following is a description of the types of new gas water heaters that are available.

- **Power-vented water heaters** are similar to atmospheric models in that they rely on room air for combustion, but they feature a re-engineered exhaust (Figure 2). Power-vented units require no chimney or chase. They can be vented through a sidewall or vertical roof vent and can be placed up to 40 feet from the side venting.

- **Atmospheric direct-vent water heaters** (sometimes referred to as sealed combustion) are particularly good for airtight energy efficient construction because they use outside air for both combustion and exhaust. Intake air for combustion and exhaust gases are conducted to and from the side of the house. They operate independently of other exhaust systems in the house. Like a power-vented unit, an atmospheric direct-vent water heater does not need a chimney and allows for greater installation flexibility.

- **Powered direct-vent models** (also sometimes referred to as sealed combustion) combine the features of power- and direct-vent models. Only outside air for both combustion and exhaust is used. Because of the power-assisted exhaust, the unit can be placed up to 40 feet from a sidewall. It uses PVC plastic pipe as a venting material. This unit is perfect for airtight construction and offers flexible installation.

Backdrafting and combustion air. The Energy Information Center recommends sealed combustion natural gas water heaters. The main advantage is that they greatly eliminate the potential danger of the hot-water heater backdrafting into the house, which can be a problem in even moderately tight homes. Backdrafting occurs when fuel-burning appliances are not receiving enough combustion air.

A sample of 7,000 houses that were tested in the Minneapolis-St. Paul area indicated that about 20 percent of the atmospheric water heaters failed to draft properly when subjected to a “worst case spillage test.” The problem appears to have greater potential with systems vented by masonry chimneys on an outside wall. The best option to remedy this situation is to either install a new power-vent water heater or add a power vent kit (see below) to the existing water heater.

In many homes, a new energy efficient furnace that vents out of the sidewall of the house has replaced the original heating system. If the water heater continues to be vented through the

flue, backdrafting can occur. Additional combustion air is often needed to correct this problem. For information on testing for and installing a combustion air supply in your home call the Energy Information Center and ask for a copy of the Combustion and Makeup Air Home Energy Guide.

The Energy Information Center also recommends that you purchase an electronic carbon monoxide alarm. Make sure it is listed by the Underwriters Laboratory and has a digital display and memory feature.

Power-vent kits. Kits are available that modify an older atmospheric-vent water heater to exhaust through the sidewall. The kits essentially turn the old unit into a power-vented one but can be expensive to buy and install. In some cases, the cost can be as much as a new sealed combustion water heater. As with any product added to an appliance, power-vent kits should have an American Gas Association, Underwriters Laboratory or other appropriate listing agency approval. Also make sure the kit will not void your warranty.

Remember: any modification work done on your vent system must be inspected and approved by your local building inspection office.

Electric water heaters. Most electric models use resistance coils inside the tank (Figure 3). Electric water heaters typically have slower recovery rates than many gas models. They make up for that with larger tanks.

Although electric water heaters are generally more expensive to operate than natural gas models, they do have some advantages over gas. Electric units have no flue pipe, so you can put one almost anywhere in your home, for instance, in a closet, or under a sink.

The entire tank is surrounded with insulation so less heat is lost when compared to a standard gas model.

Figure 4
An electric storage water heater commonly used for off-peak and interruptible electric service.

Source: Water Heater Innovations, Inc.; Eagan, MN.



Off-peak electric options. “Storage heating” is an inexpensive and efficient method of electric water heating (Figure 4). Many utilities offer low cost off-peak night electrical rates for water heating. Water is heated at night, storing all you need for daily use. Providing adequate water heater storage capacity is an issue – at least 100 gallons of capacity is recommended, but larger homes may need up to 160 gallons.

Another option is “interruptible” electric water heating, which allows the utility to temporarily interrupt electricity to the water heater during times of peak electrical usage – usually for a few hours only on the hottest or coldest days of the year.

Check with your local electric utility to find out if it offers time-of-use rates or interruptible rates for residential customers. Some utilities offer incentives for installing storage heaters for off-peak applications or control devices that shut off the water heaters for interruptible service.

Space heat-water heater combinations.

Almost all high efficiency boilers can be made

GALLONS OF HOT WATER X TIMES USED = GALLONS

	USED PER ACTIVITY	IN ONE HOUR	=	PER HOUR
Shower	20	_____	=	_____
Bath	20	_____	=	_____
Shaving	2	_____	=	_____
Hand, face wash	4	_____	=	_____
Shampoo	4	_____	=	_____
Hand dish washing	10	_____	=	_____
Auto dish washing	14	_____	=	_____
Food preparation	5	_____	=	_____
Auto clothes washer	32	_____	=	_____
PEAK HOURLY DEMAND			=	_____

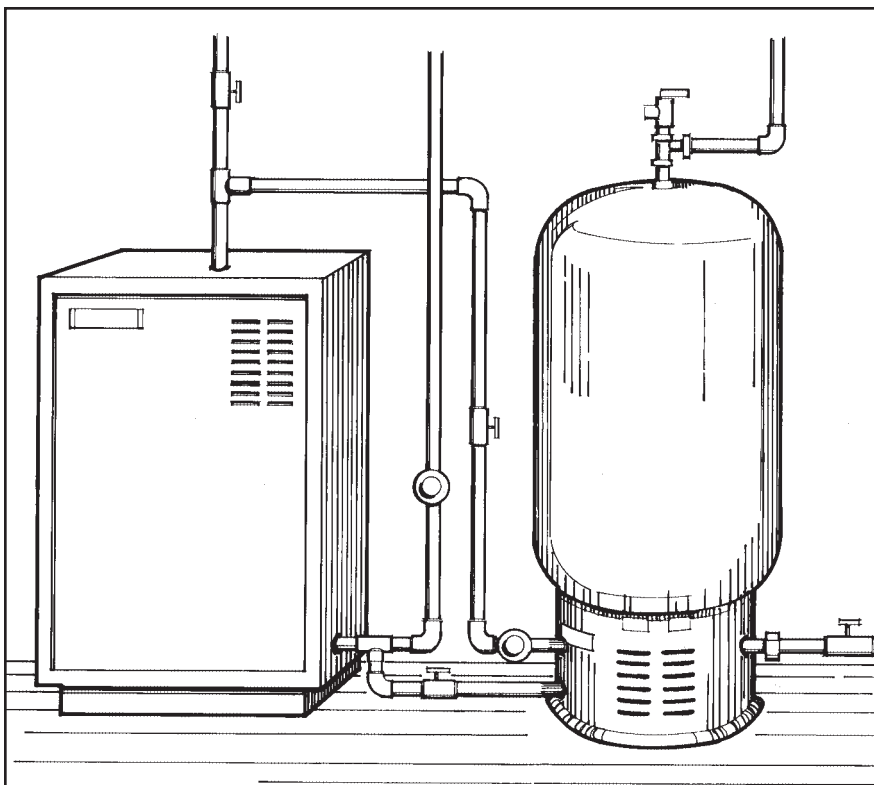


Figure 5
Space heat-water heater combination (also known as a "sidearm" water heater).

to heat potable water. This may be done with an indirect fired water heater, also known as a "sidearm" water heater (Figure 5). This provides a separate zone of heat flow from the boiler to an insulated tank. The hot water flows through a water-to-water heat exchanger which in turn heats the water in the tank. Some boilers may also have a coil inserted into the boiler itself, but this is not as good an idea: it's less efficient than the sidearm. When considering such a unit, make sure that the boiler is not too large for your home heating needs and that the water heater is reasonably priced.

Some high efficiency furnaces and most high efficiency boilers can provide hot water throughout the year. For health and safety reasons, only a unit specifically approved to do this should be used.

Tankless (Demand, Instantaneous, or Point-of-use) water heaters. Point-of-use water heaters are also called "tankless" heaters because they have no storage tank. They are relatively small units that provide hot water on demand, heating water as it is needed rather than drawing it from a tank. They use either gas or electricity and can be installed near demand points, such as under kitchen sinks. In many instances additional plumbing work will be required. Gas units may require a large, expensive flue (some power vent models are available) and will increase space heat loss up the chimney. The large energy input may overload many existing chimneys, preventing them from exhausting properly. Also, in some instances gas units may exceed the delivery capacity of the house's existing gas system. Electric units may need updated wiring.

Typically, a pressure sensor controls the operation of the heater. If the water flow is too low, the sensor will not turn on the heater to heat the water. Conversely, if the flow is too high, the heater will not be able to heat the water adequately.

Another major drawback is capacity. A tankless heater typically provides 1-2 gallons of hot

Comparing fuel costs

To compare costs, it is common to compare costs based on 1 million BTUs (1 MMBTU) of energy. The following shows the conversion factors for common fuels.

Fuel	Units equal to 1 MMBTU	Units per year*
Natural Gas	10 Mcf	20 Mcf (or therms)
Electricity	293 kWh	5,860 kWh
Propane	10.9 gallons	218 gallons

The table below lists the average cost per MMBTU of various fuels and calculates the annual cost of producing 20 million BTUs of useable heat per year. It is important to note that the efficiency of the equipment must be taken into consideration. For the purposes of the comparison below, electric water heater efficiency is assumed to be 0.92. Propane and natural gas efficiency is assumed to be 0.62.

Fuel	Cost per unit	Cost per MMBTU	Annual Cost*
Natural Gas (EF = .64)	\$1.004 per Mcf (or therm)	\$10.04	\$314
Electricity (EF = .93)	\$0.085 per kWh	\$26.77	\$535
Propane (EF = .64)	\$1.56 per gallon	\$18.88	\$531

*The comparison assumes an energy requirement of 20 MMBTU per year for hot water heating, which is typical for the average Minnesota household. If you want to change the assumptions, use the following formula:

$$[(\text{Cost per fuel unit} \times \text{MMBTU conversion factor}) / \% \text{ equipment efficiency}] \times \text{annual MMBTU energy requirement} = \text{annual cost}$$

water a minute. You may find this adequate. However, you may not have enough hot water for more than one use at a time. Before installing a tankless water heater, make sure its capacity will be adequate for your needs.

Heat pump water heaters (HPWH). The heat pump water heater takes heat from the surrounding air inside the house, or air that is ducted to the unit, and transfers it to the water in the tank. Benefits are free dehumidification and a reduced cooling load in the summer. Self-contained “drop-in” HPWH units are available for easy installation.

Although an air-source heat pump water heater may cost \$800 - \$1,000, it is two to three times more efficient than electric resistance water heaters. Typical energy factors are 1.8 to more than 2.0, compared to a standard electric EF of 0.91. The Energy Information Center recom-

mends an EF of 1.9 or greater for heat pump water heaters.

There are two types of heat pump water heaters: integral and remote. The integral unit is a heat pump with its own water tank. The remote unit is a heat pump that can be connected to an existing electric resistance water heater tank. The remote unit is less expensive than an integral heat pump and can be easily added to an existing system. Both types have a resistance element as a backup, either built into the integral unit or left over in the old system to which the remote unit was added.

A HPWH also lowers the temperature of the air around or ducted to the heat pump. In summer the cooling and dehumidification provided by the HPWH amounts to free air conditioning. During the heating season, the HPWH unit robs heat produced by the space heating system and

Don't set water temperature too high

Very hot water can cause scalding burns and be a severe hazard, especially to small children or the elderly. To reduce the danger of scalding, turn the temperature setting down to 120 degrees. In most cases, that will be the low setting.

The water heater may not have a temperature control setting marked in degrees; measure the temperature at the tap with a thermometer.

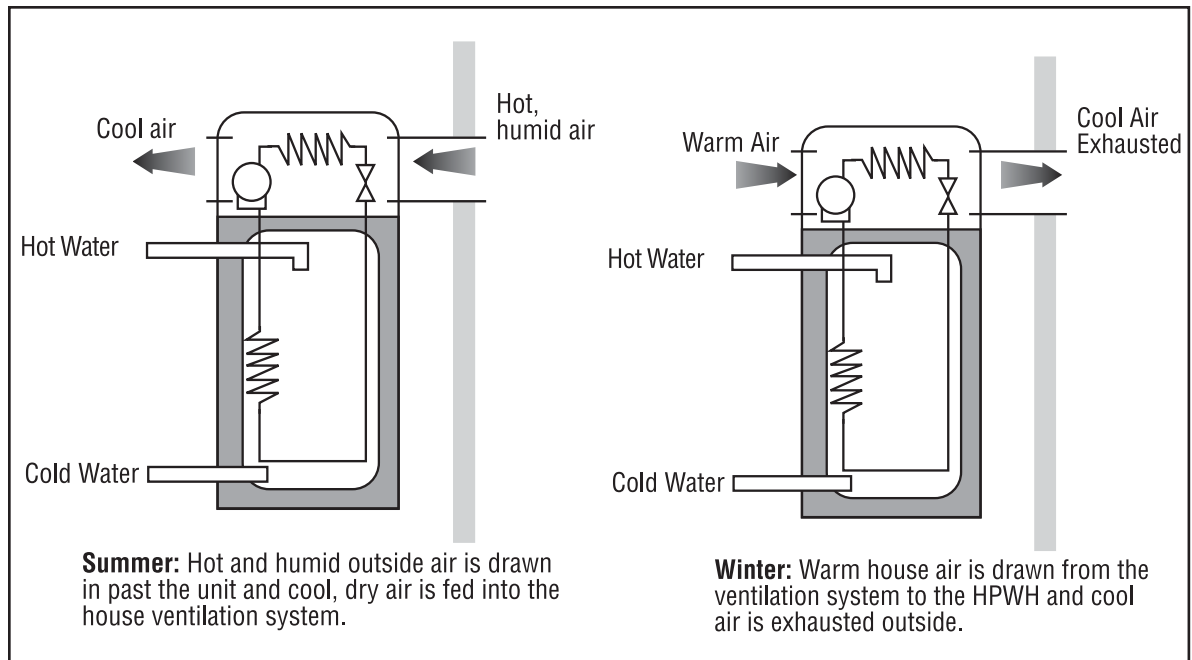


Figure 6

A heat pump water heater as part of a ventilation system.

uses it to heat the hot water. Whether or not this is a disadvantage depends on the cost of the fuel used and annual efficiency of your space heating system.

One disadvantage of the HPWH is its slow recovery rate: 10 to 15 gallons per hour, somewhat less than the recovery rate of a typical electric water heater. To avoid hot water shortages, the size of the hot water tank should be increased to accommodate for the reduced heat input.

A good application for a HPWH in new homes is to integrate it into the mechanical ventilation system (Figure 6). In winter the HPWH recovers heat from stale air before exhausting it to the outside. In summer the ventilation airflow is reversed, and the HPWH recovers heat and removes humidity from outdoor air as it enters the house.

Ground source (Geothermal) heat pumps. For homes with an adequately sized ground-source heat pump heating system, two water heating options are available. Both systems are generally installed to pre-heat water in an extra tempering tank.

- **Desuperheater water heaters** attach to the heat pump and make use of the compressor's waste heat. A desuperheater water heater can satisfy 60% of domestic hot water requirements during the cooling season and 40% during the heating season. While it provides very economical heat during the air conditioning and heating seasons it does not contribute to heating water during spring and fall periods when the compressor is not operating.
- **Water source HPWHs** are another way to take advantage of a geothermal heating system. A small water source heat pump is tied into the ground source loop to preheat water. The water will be pre-heated year-round, without the need for the space heating compressor to be operating. Note that with this system the ground loop will need to be sized larger to serve both the space heating and water heating needs.

Solar water heaters. Solar water heaters can reduce the annual fuel cost of supplying hot water to your home by more than half. Throughout the year, the solar water heater system pre-heats the water before it reaches the conventional water heater. During the summer, the system may provide all the required heat.

Although the cost of a solar water system is higher than that of conventional water heaters (\$3,500 to \$5,000 installed), the cost may be justified if the traditional energy costs are high.

A solar water heater typically includes collectors mounted on the roof or in a clear area of the yard, a separate storage tank near the conventional heater in the home, connecting piping, and a controller. There are many types of solar water heater systems, but only two are appropriate for the Minnesota climate, the closed-loop heat exchanger and drainback systems. Both of these types have protection against winter freezing.

The Minnesota Building Code requires that solar collectors and solar water heating systems sold or installed in the state must bear a certification label from the Solar Rating and Certification Corporation (SRCC). Look for the SRCC label and compare performance by using the rating numbers. Use only quality equipment and experienced installers. Obtain competitive bids from at least three firms.

Heating water with wood. Wood is sometimes used to heat water and there are a few products on the market for this purpose. Anyone who is considering this should be cautioned that it is difficult to do safely. Installing a tempering tank in the same room, but which is not connected to the wood stove, is one safe way. Some wood-fueled boilers can provide domestic hot water needs.

It is recommended that you buy a wood boiler or water heater that has been tested and listed for heating potable water by Underwriters Laboratories or equivalent agencies.

Installing a water heating system

Installation. When installing your new hot-water heater, place it as near as possible to where the largest amount of hot water is used. (Use pipe insulation and heat traps to conserve energy.)

Pipe insulation. Water pipes extending vertically from the hot water storage tank are actually

New federal efficiency standards

The new standard will raise the Energy Factors for water heaters manufactured after January 20, 2004 as follows:

	Volume (Gallons)	Storage type water heaters New Minimum Energy Factor
Gas	30	0.61
	40	0.59
	50	0.58
Electric	30	0.93
	40	0.92
	50	0.90
	60	0.89
	70	0.88
	80	0.86

The new standard may also modify installation requirements for some units.

part of the tank itself. The lighter hot water flows up the pipe, replacing cooler and heavier water. Insulate both pipes with foam or fiberglass from the tank to the heat trap, or to the first horizontal run. Insulation should be kept at least three inches from the draft hood and flue.

Heat traps. Heat traps may be natural or mechanical and may reduce the amount of heat lost when water isn't being used by 12 percent. Some new high efficiency heaters have them installed at the factory. The natural trap is a piece of tubing bent in the form of a "U." Mechanical traps are available with a ball type check valve.

Water heaters without heat traps and with vertical pipes should have the traps installed on both the inlet and outlet pipes. The heat trap should be as close to the tank as possible.

Tempering tanks. A tempering tank pre-heats water by absorbing heat from household air and is worth considering if an inexpensive source of space heat is available, such as a wood stove. These may also be used seasonally by using warm outdoor air to preheat the incoming water. Tempering tanks may be made

Tip

Keep household items such as water softener salt, kitty litter, clothes dryer fabric softeners away from the water heater. These items are corrosive and may shorten the life of the appliance.

from an old water heater with insulation removed, or a simple water storage tank. Make sure the tank is clean and free of any toxic materials.

Using less hot water

Avoiding waste in using hot water is an effective and low cost way to reduce energy costs.

Turn down water temperature. You don't need the water to be any hotter than 120 or 125 degrees. Temperatures over 125 degrees increase the risk of scalding. Many new dishwashers feature a temperature boost setting which allows for a lower water heater temperature.

Fix leaky faucets. A hot water faucet leaking one drop per second will waste about 60 gallons of hot water a week. This could cost you up to \$35 or more a year. Leaks can usually be fixed by replacing the tap washer. Turn off the water below the sink or tub (or at the main supply if you don't have a shut-off valve below the fixture), take the faucet apart, replace the bad washers, and put the faucet back together.

Install flow restrictors on faucets. Flow restrictors will save money on both the water bill and water heating costs. They reduce the amount of water used for tasks that require flowing water without greatly changing the feel of the flow. Restrictors cost anywhere from less than a dollar to about \$3. To install, simply unscrew the aerator at the end of the faucet and push the restrictor in. If you don't have aerators on your faucets, consider installing them. If you can do it yourself, it will be worth it in water and energy savings.

Install a water-saving showerhead. A typical showerhead uses between four and nine gallons of water a minute. A water-saving showerhead uses between two and three gallons per minute, which means it can save you one to seven gallons per minute; and most of the water is hot. If your water heater is set at 120°, and if your family takes two five-minute showers a day, you can lower your yearly gas bill by over \$20 or your electric bill by about \$40 (based on sav-

ing two gallons of water per minute during a shower). If more than two gallons per minute are saved, the savings will increase.

Purchase ENERGY STAR appliances. When replacing water consuming appliances such as clothes and dishwashers, choose energy efficient models that use less hot water. The best way to assure efficiency is to purchase ENERGY STAR qualified models. (See "Appliances" Home Energy Guide).

Gravity-Film Heat Exchanger (GFX). The GFX is a vertical, counterflow heat exchanger that extracts heat out of drain water and uses that heat to preheat the cold water before it enters your water heater. It will preheat cold water by as much as 20 to 30 degrees, and by some estimates, can achieve 25% to 40% savings on residential water heating costs.

The GFX replaces about five feet of vertical drain line and can be installed where drains are piped, including inside stud walls. This is a great opportunity in a new home or remodeling project to significantly improve energy performance at a modest cost of approximately \$350.

Other easy hot water savings tips.

- Wash only full loads of laundry or adjust the water level for smaller loads. Use cold water whenever possible.
- Run the dishwasher with full loads only.
- Use cold water to flush away food in your garbage disposal.
- Turn off your water heater, or place it on its lowest setting, if you are going to be gone for a few days or more.
- Don't let the hot water run when you are shaving, washing dishes by hand, or doing similar tasks.

Summary

- When looking at a new water heater, be sure to compare the energy efficiency of different models by checking the Energy Guide label. Choose an EF of at least .64 for natural gas and propane, and an EF of at least .93 for electric.
- Buy the smallest size you can. Don't try to buy a water heater so you can shower, and wash clothes and dishes all at the same time without running out. Instead, plan your hot water use. This is especially important if you have a large family.
- Locate the water heater as close as possible to where the largest volume of hot water is used. Since heat is constantly lost through hot water pipes, the shorter the pipe runs the lower the heat loss.
- Insulate the water pipes and install heat traps if your water heater does not have one.
- Take easy, low-cost or no-cost measures to avoid waste in using hot water.

Typical household hot water flow rates

Faucets
.75 gallons to 2.5 gallons per minute
Low-flow showerheads
1.2 gallons to 2 gallons per minute
Standard showerheads
.5 gallons to 3.5 gallons per minute
Clothes washers and dishwashers
1 to 2 gallons per minute

Additional web resources

Minnesota Department of Commerce: www.commerce.state.mn.us

- Additional Home Energy Guides: (Energy Info Center > Home Energy Guides)
- Research paper: Ventilation and Depressurization Information for Houses Undergoing Remodeling (Consumer Info and Services > Buildings and Builders > Residential Buildings)

Gas Appliance Manufacturers Association (GAMA): www.gamanet.org

- Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment (Publications > Product directories)

American Council for an Energy Efficient Economy (ACE3): www.aceee.org

- Information on finding and using energy efficient appliances (Consumer Resources)

U.S. Department of Energy, Energy Efficiency and Renewable Energy: www.eere.energy.gov

- Lots of information about energy conservation and renewable technologies including water heating (Information for consumers > shortcuts to technology, water heating)

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This information will be made available, upon request, in alternative formats such as large print, Braille, cassette tape, CD-ROM.

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Minnesota Home Energy Guides

This guide is one in a series of publications designed to help Minnesotans save energy in their homes. Copies of the titles listed below are available by calling or contacting the Minnesota Department of Commerce.

CD-ROM contains all of the Home Energy Guides as well as several other publications of interest to homeowners, builders and contractors.

Appliances advises consumers on what to look for in energy efficient appliances and includes information on efficient operation and maintenance of refrigerators, freezers, washers, dryers, dishwashers, cooktops, ovens, and home office equipment.

Attic Bypasses explains how to find those "hidden air passageways" and fix them to prevent costly heat loss and damage to roofs, ceilings, walls, and insulation.

Basement Insulation discusses options to improving basement comfort, many not even involving insulation. It also provides details on exterior basement insulation, special foundation products and recommendations on interior insulation.

Caulking and Weatherstripping describes how to identify sources of air leaks, lists various types of caulk and weatherstripping, and provides illustrated how-to-apply instructions.

Combustion & Makeup Air describes the causes of dangerous combustion air problems and tells how to install an outside combustion makeup air supply. It also tells how to test your home for combustion air problems.

Energy Saving Landscapes describes how to use trees and shrubs for long-term energy savings, and lists trees appropriate for energy-savings.

Home Cooling tells you how to cool without air conditioning, and provides information on buying and operating energy efficient air conditioners.

Home Heating describes proper maintenance techniques and helps you become an educated shopper if you are buying a new heating system.

Home Insulation helps the homeowner evaluate the benefit of added insulation, providing information on buying and installing insulation.

Home Lighting looks at new technologies for residential lighting, identifying four basic strategies and providing examples for putting them into practice.

Home Moisture describes symptoms of moisture problems, lists common indoor and outdoor causes, and discusses preventive and corrective measures.

Indoor Ventilation describes the types of home mechanical ventilation systems that are available, the amount of ventilation air needed, and how best to operate and maintain the system.

Low Cost/No Cost addresses the often overlooked energy saving tips for all areas of your home.

New Homes discusses a wide range of options for increasing energy efficiency beyond the normal building code requirements. Subjects covered include insulation, ventilation, air-vapor controls, heating and cooling, windows, doors, and appliances.

Water Heaters helps you determine whether to buy a new water heater or improve the old one. It explains the efficiency of different types of water heaters and provides installation tips.

Windows and Doors helps you decide whether to replace or repair windows or doors and gives a good summa-