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# Water Heater Guide



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# Water Heater Guide

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Produced by

Natural Resources Canada's Office of Energy Efficiency

## EnerGuide

The Heating and Cooling series is published by Natural Resources Canada's Office of Energy Efficiency. EnerGuide is the official Government of Canada mark associated with the labelling and rating of the energy consumption or energy efficiency of household appliances, heating and ventilation equipment, air conditioners, houses and vehicles. EnerGuide also helps manufacturers and dealers promote energy-efficient equipment and provides consumers with the information they need to choose energy-efficient residential equipment.

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# Introduction

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“Out of sight, out of mind” probably best describes your hot water heating system, and chances are that you never think about it until the water runs cold. This guide will help you in two ways: to select the right type of water heater and to improve the performance and efficiency of your existing water heating system.

With this guide, you will be able to take control of your hot water heating costs by making informed decisions that will save money and improve the environment at the same time. Consider the following typical situation.

It is the weekend when your water heater stops working. You need to replace it immediately. Standard water heaters are relatively inexpensive to buy, and contractors or plumbers will frequently recommend them. But if you plan ahead and ask about the energy efficiency and performance of the replacement water heater, you may save a lot of money in the future. Read on to learn everything you need to know!

Although the least expensive water heater may be the most attractive choice, you need to consider another, more significant price called the “second price tag.”

## Efficiency and the second price tag

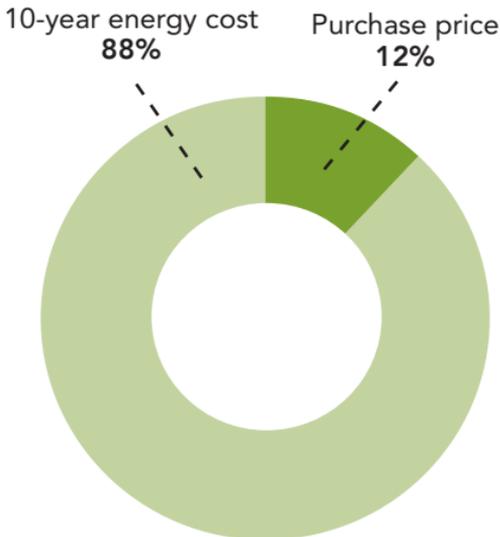
Every energy-using appliance has two price tags. We know the first – the purchase price. The second price tag is considered less in the purchasing decision, but is just as real; it is the operating cost of the appliance. The purchase price is like a down payment. You can think of the second price – the cost of energy – as a series of monthly payments that last as long as the appliance operates.

For example, consider an electric storage water heater that costs approximately \$700 to purchase and install. If electricity costs 10 cents per kilowatt-hour (kWh) and your family uses 225 litres (L) (59 gallons [gal.]) of hot water per day over a 10-year period, your energy costs in that period will be approximately seven times the cost of the equipment. See Figure 1.

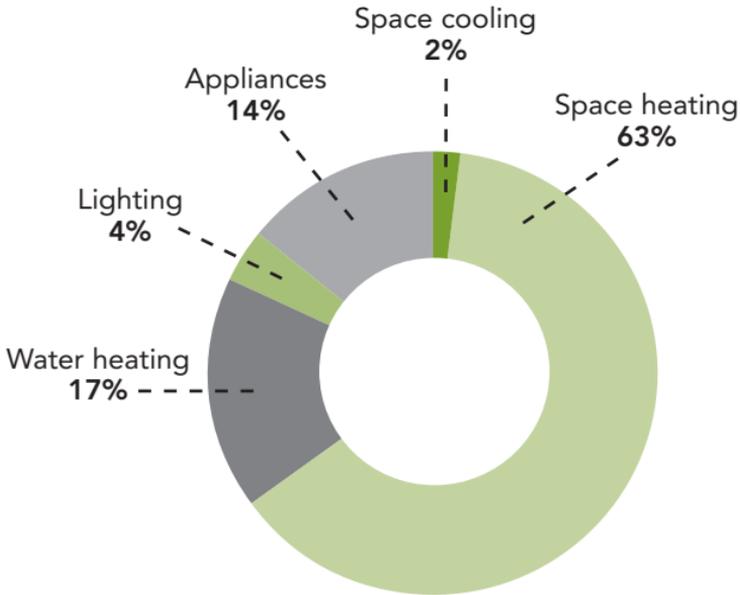
**FIGURE 1**  
**Total cost of ownership**

### Electric hot water storage tank

*Total energy costs are 7 times the initial purchase price.*



**FIGURE 2**  
**Canadian household energy use by end use**



Source: OEE *Energy End Use Data Handbook*, 2008

## Why consider water heating options?

- Hot water use is the second largest portion of energy utility costs, after home heating.
- Water heating represents 15 to 25 percent of your household energy bill and may become a larger portion if you upgrade the energy efficiency of your home and its space heating and cooling systems without upgrading your water heating system.
- You can reduce your energy bill by
  - installing a more efficient water heater
  - improving the performance of your existing water heater
  - reducing the amount of hot water that you and your family use
  - installing a drain water heat recovery (DWHR) device to reduce your water heating load

## Drain water heat recovery

The DWHR pipe is a simple technology to save on energy used to heat water. This pipe takes advantage of the warm water flowing down the drains to preheat the water going into the hot water tank. Preheating the water reduces the amount of energy needed to heat the water to the set temperature. A study by the Canadian Centre of Housing Technology stipulates that DWHR pipes are most effective when you have large “drain water events,” where a lot of warm water is being drained, mostly from the shower, sink, clothes washer and dishwasher.

Take the time now to consider options that will save you energy and money and help you make a good decision when you have to make an immediate replacement. Better yet, consider replacing your water heater close to the end of its life but before it fails, so that you can make an informed choice rather than being forced into an emergency replacement situation.

## How this guide helps

Use this guide when

- **You are considering purchasing or renting a water heater.**  
This guide will help you to consider energy and cost saving options. Your choice can save you money and reduce the impact on the environment. It is your choice to make – do not give that choice away to your rental company or plumber. Be informed and reap the benefits – you pay for the energy that heats the water.
- **You want to reduce your hot water heating costs.**  
This guide provides no- and low-cost actions (and some actions that cost a bit more) and a few maintenance tips that will help you reduce your water heating costs.

## What is in this guide?

**Chapter 1:** Describes the types of water heating systems available in the Canadian market.

**Chapter 2:** Discusses the choice of water heaters by energy source.

**Chapter 3:** Outlines how to purchase, rent or lease a storage tank water heater.

**Chapter 4:** Offers ways to reduce your water heating costs and provides some do-it-yourself maintenance tips.

**Chapter 5:** Summarizes key points for buying or renting a new water heater.

**Chapter 6:** Lists additional resources.

# 1 Choosing a water heater

This chapter provides an overview of residential water heaters. Chapter 2 expands upon the overview by comparing these water heaters by fuel type.

## How a water heater works

A water heater uses energy to raise the temperature of cold water coming in from the municipal water system or from your well. Most commonly, hot water is stored in a tank, but in the case of a tankless or on-demand water heater, the water is heated only as it is needed.

A variety of water heaters is available. Table 1 lists water heater types and the energy source available for each type.

**TABLE 1**  
**Possible energy sources by water heater type**

| Water heater type               | Electric | Gas* | Oil |
|---------------------------------|----------|------|-----|
| Storage tank                    | Yes      | Yes  | Yes |
| Tankless                        | Yes      | Yes  | –   |
| Heat pump                       | Yes      | –    | –   |
| Solar domestic hot water system | Yes      | Yes  | Yes |

\* Gas refers to either natural gas or propane.

## Measuring energy performance

The **energy factor (EF)** is used to rate the efficiency of gas-fired (natural gas) or oil-fired water heaters. It is the amount of energy supplied as hot water divided by the total amount of energy used by the water heater over a 24-hour (hr) period. The EF is determined assuming a standard hot water use profile with fixed inlet and outlet water temperatures. The calculations account for standby losses and the operating efficiency of the water heater when it is heating water (recovery efficiency). A *higher* EF indicates higher efficiency. The EF is used for both storage tank and tankless water heaters.

The energy performance of electric water heaters is rated in **standby loss** measured in watts. This indirect measure of efficiency indicates the loss of heat from the tank. Better insulation around the tank reduces heat loss. A *lower* standby loss indicates higher efficiency.

Water heaters are a regulated energy-using product in Canada. For current minimum efficiency performance levels, consult the *Guide to Canada's Energy Efficiency Regulations* at [regulations.nrcan.gc.ca](http://regulations.nrcan.gc.ca).

## ENERGY STAR®

ENERGY STAR is the international symbol of premium energy efficiency. Look for products that display the ENERGY STAR symbol. They have been tested according to prescribed procedures and meet or exceed high energy efficiency levels without compromising performance.

An ENERGY STAR label identifies the most efficient water heater models. The ENERGY STAR program recognizes the most efficient water heaters within each designated product type. Therefore, it is possible that an ENERGY STAR water heater from a particular category (e.g. gas-fired storage tank water heater) may be less efficient than a non-ENERGY STAR rated water heater from a different category (e.g. gas-fired tankless water heater). At the time of publication, the ENERGY STAR level for gas-fired storage tank water heaters was 0.67 EF and 0.82 EF for tankless gas-fired water heaters. The ENERGY STAR specifications are updated periodically. Consult the ENERGY STAR Web site for current specifications at [energystar.gc.ca](http://energystar.gc.ca).

## Storage tank water heaters

Storage tank water heaters are the most common type installed in Canadian homes. As the name implies, these systems store heated water in a tank so a quantity of hot water is stored and available. When a tap is turned on, hot water flows from the storage tank. Unheated water flows into the tank to replace that hot water. A thermostat turns on the burner or electric element to maintain the water temperature in the tank.

To protect the inside of the tank from corrosion, storage tank water heaters are usually equipped with a galvanic anode. The anode is a metal rod of magnesium or aluminium alloys that is inserted into the tank from the top. The rate at which the anode dissolves depends on the mineral content or hardness of the water as well as the integrity of the enamel or epoxy coating inside the tank.

**FIGURE 3**  
**Storage tank water heater**

---



New water heaters must have a temperature and pressure relief valve. This safety device allows water that is too hot or under too much pressure due to a faulty temperature control to escape from the tank.

Storage tank water heaters can be made more energy efficient by reducing standby loss. For gas- and oil-fired storage tank water heaters, efficiency can also be improved at the design stage by increasing the amount of heat transferred from the combustion gases to the water and by minimizing the amount of heat going out the vent or chimney.

Manufacturers incorporate design and construction features to improve the energy efficiency of storage tank water heaters. More efficient tanks have

- more tank insulation
- more efficient heat exchangers (for gas and oil tanks) so more heat is transferred from the energy source to the water
- factory-installed heat traps, which minimize unwanted convection of heat out of the tank and within the pipes, but still allow water flow. Heat traps reduce standby losses from the piping and the tank.

Routing the cold water inlet pipe to enter an electric tank near the bottom improves efficiency and saves energy compared with the usual route of through the top and internally down through a pipe called a dip tube. Gas- and oil-fired water heaters may also benefit from bottom entry of cold water. See Chapter 2 for further descriptions and diagrams of each type of electric, oil and gas storage tank water heaters.

# Tankless (on-demand) water heaters

**FIGURE 4**  
**Tankless (on-demand) water heater**



This type of water heater consists of either an electric element or a gas burner that heats flowing water and does not have a storage tank. It is also called on-demand, point-of-use, instantaneous or tankless water heater because it heats water only when it is needed, thereby eliminating continuous standby losses. A tankless water heater is usually more energy-efficient than a storage tank water heater.

For example, gas-fired tankless water heaters have EFs that range from 0.64 to 0.98, with an average of 0.85 while gas-fired storage tank water heaters have EFs that range from 0.53 to 0.70, with an average of 0.62 (based on September 2011 NRCAN on-line listings of the rated energy performance of gas-fired water heaters<sup>1</sup>).

Most electric on-demand water heaters cannot supply an entire house with hot water so they are rarely installed in Canada for that application. However, lower capacity electric on-demand water

<sup>1</sup> oee.nrcan.gc.ca/equipment/heating/806

heaters are sometimes installed close to bathroom or kitchen sinks that are located some distance from the main water heater. That type of installation is known as “point of use.” Point of use electric water heaters may also be used at a cottage where the amount of hot water required may be low, and there may be fewer fixtures than are found in a typical home.

Several on-demand gas-fired water heaters have enough delivery capacity to supply hot water for most houses. Their rated hot water flow rates are based on standard inlet and outlet water temperatures. In winter, intake cold water may be as cold as 5°C so take care when you select an on-demand water heater to account for the colder water temperature.

For example, in summer, with an inlet water temperature of 18°C, a water heater that could supply 15 L per minute (L/min) (4 U.S. gal./min) of hot water at a temperature of 58°C on a continuous basis could deliver only about 11 L/min (3 U.S. gal./min ) with an inlet temperature of 5°C.

Gas-fired on-demand water heaters have either a continuous pilot light ignition system or an electronic ignition. Water heaters that have a continuous pilot light use energy even when no hot water is required.

Gas-fired on-demand water heaters are usually mounted on an outside wall so that the flue gases can be vented to the outside through a side wall vent.

## **Combination space-water heating systems**

Combination space and water heating systems may be appropriate for houses that have lower heating requirements because they have more insulation, reduced air leakage and a more efficient use of the space. The water heater is used as the energy source for space heating as well as water heating.

In this configuration, usually a fan coil is installed with ductwork, and a small pump circulates water from the water heater through the fan coil. Hot water can also be circulated through in-floor piping for floor and radiant heating.

You must be careful when you size and choose the water heater to ensure it can meet the greater needs of the combined functions. In addition, the water heater must be specifically labelled as being suitable for combined space heating and water heating applications. If you are considering a combination system, ensure that there is a performance rating for the combo package as a system, not just the rating of the water heater.

The space heating efficiency is limited by the performance of the water heater. The operating conditions of the water heater are different when it is used for space heating in addition to heating water. Therefore, the performance ratings as a water heater are not an indicator of its performance as a space heater.

The Canadian Standards Association (CSA) published a new test method and rating standard for combination systems (CSA P.9) in 2011.

## Combination systems

A combination system requires professional design and proper sizing. The Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI) provides training to the industry based on the *Unified Canadian Guideline for Integrated (Combination) Heating Systems*. Ensure that your contractor (designer) is certified by HRAI for designing combination heating systems.

## Combination space-water systems with a hydronic boiler

Some combination space-water heating systems use hydronic boilers instead of water heaters. With a hydronic boiler, the heat is transferred through a heat exchanger to the water. This type of system is often referred to as a segregated heating system. Some jurisdictions require that a double-wall heat exchanger be used for these applications to ensure that the boiler heating loops cannot contaminate potable water.

## Integrated mechanical systems

Integrated mechanical systems (IMS) are a new family of advanced combination systems that also include a heat recovery ventilator (HRV). An IMS is performance rated to the CSA P.10 standard. Look for that rating before you purchase an IMS.

## Heat pump water heaters

FIGURE 5

Heat pump water heater



**Heat pump water heaters** (HPWHs) use electricity to transfer heat from the air instead of converting electricity directly to heat. Heat is taken from the air in the basement or utility room (or sometimes from outside) and transferred to a tank of water.

HPWHs remove heat and humidity from the air. As heat is removed from inside the home in summer, you will need less air conditioning. HPWHs are less advantageous in the winter when space heating is required.

Even considering their higher initial cost, HPWHs can be cost-effective in milder climates compared with conventional electric storage tank heaters. Some HPWHs can be added to a conventional hot water tank.

However, many ground-source (also known as earth energy) heat pumps can provide either partial or full water heating as well as space heating and cooling. These systems use the relatively constant temperature of the earth and/or ground water as a source of heat. The system reverses in the summer and provides air conditioning by moving heat from your home to the earth or ground water. Heat is supplied to the water heater when required.

## Solar domestic hot water systems

**FIGURE 6**

**Solar domestic hot water systems**

---



You can use the sun's energy to heat water. In Canada, solar domestic hot water (SDHW) systems are usually selected and sized to provide approximately 60 percent of the hot water requirements for an average home, depending on the local climate and hot water use. Solar water heater systems include collectors, a circulating pump, a storage tank or tanks, and controls. They are commonly configured to preheat water with a conventional water heater for backup. Solar preheat units typically have two tanks. One tank stores solar heat and one is connected to a conventional storage water heater that can be heated by any source (electric, gas or oil). A tankless (on-demand) water heater can also be used instead of the second tank.

# 2 Comparing water heaters by fuel type

This chapter will explore the pros and cons of common types of water heaters and the fuel options (see Table 2).

When selecting a new water heater, consider

- hot water needs (and whether they can be reduced)
- hot water delivery capacity
- storage volume
- venting requirements
- purchase and installation costs
- anticipated present and future cost of the energy needed to operate the water heater

**TABLE 2**  
**Pros and cons of various energy sources**

| Energy source | Pros   | Cons  |
|---------------|--|---|
| Electric      | <ul style="list-style-type: none"><li>• Easy to install – no venting is required for combustion air or exhaust.</li><li>• Can be located in many areas of the home.</li><li>• Range of sizes is available.</li></ul> | <ul style="list-style-type: none"><li>• Recovery of hot water takes longer, (but may be compensated for with a larger tank).</li><li>• Cannot provide hot water during power outages.</li></ul> |

| Energy source | Pros  | Cons  |
|---------------|---|---|
| Natural gas   | <ul style="list-style-type: none"> <li>• Higher input capacity (compared with electric tanks) results in faster recovery of hot water.</li> <li>• Can be vented through a chimney or through a side wall.</li> <li>• Various sizes, types and efficiencies are available.</li> <li>• Direct-vent models are sealed and do not require house air for combustion.</li> <li>• Power-vented models do not use standing pilot lights and they are resistant to combustion spillage.</li> <li>• Conventional gas-fired water heaters can provide hot water during power outages.</li> </ul> | <ul style="list-style-type: none"> <li>• A natural gas supply line must be available.</li> <li>• Installation location must be suitable to vent through the wall.</li> <li>• Must consider combustion air requirements in a well-sealed house.</li> <li>• Requires electricity to operate so it cannot provide hot water during power outages.</li> <li>• Some power vents are noisy and prone to failure.</li> </ul>   |
| Propane       | <ul style="list-style-type: none"> <li>• Essentially the same characteristics as natural gas-fired systems.</li> <li>• Fast recovery.</li> <li>• Can be vented through a chimney or through a side wall.</li> <li>• Various sizes, types and efficiencies are available.</li> <li>• Direct-vent models are sealed and do not require house air for combustion.</li> <li>• Power-vented models do not use standing pilot lights and they are resistant to combustion spillage.</li> <li>• Conventional gas-fired water heaters can provide hot water during power outages.</li> </ul>  | <ul style="list-style-type: none"> <li>• Requires a local propane storage tank.</li> <li>• Delivery of fuel must be planned.</li> <li>• Propane is more expensive than natural gas.</li> <li>• Installation location must be suitable to vent through the wall.</li> <li>• Must consider combustion air requirements in a well-sealed house.</li> <li>• Requires electricity to operate so it cannot provide hot water during power outages.</li> <li>• Some power vents are noisy and prone to failure.</li> </ul> |

| Energy source | Pros   | Cons   |
|---------------|--|--|
| Oil           | <ul style="list-style-type: none"><li>• Fastest recovery of hot water because of higher input rates than gas or electric units.</li><li>• Some water heaters can be sidewall vented.</li><li>• Some water heaters are sealed combustion and do not require house air for combustion.</li></ul> | <ul style="list-style-type: none"><li>• Requires an oil storage tank.</li><li>• Delivery of fuel must be planned.</li><li>• Limited selection of models.</li><li>• Requires combustion air.</li><li>• Requires electricity to operate so it cannot provide hot water during power outages.</li></ul> |

## Electric water heaters

FIGURE 7

### Electric water heater



The tank of an electric storage tank water heater is

- cylindrical
- steel
- lined with ceramic glass (that protects the steel tank from corrosion)
- insulated externally with foam
- covered with a thin, outer metal skin (outer jacket)

The tank has

- thermostat controls
- internal upper and lower electric elements
- cold water supply inlet
- hot water outlet

The upper element heats the water in the upper portion of the tank to quickly provide some hot water if most of the hot water has been used. After the upper portion of water is heated to the thermostat set point, the thermostat turns off the upper element and turns on the lower element. That element heats the lower portion of water.

Electric water heaters do not require air for combustion or venting of combustion by-products. They are easy to install in most locations.

The electric heating elements convert virtually all of the electricity into heat and because the elements are immersed, all of the heat is transferred to the water. The energy performance of electric water heaters is measured by standby loss in Canada.

# Gas-fired and propane water heaters

## Conventional gas-fired water heaters

FIGURE 8

### Conventional gas-fired water heater



The standard gas-fired water heater is called a conventional or naturally aspirating water heater. Its tank is

- cylindrical
- steel
- lined with glass (that protects the steel tank from corrosion)
- insulated externally with foam
- covered with a thin, outer metal skin (outer jacket)

The tank has a

- cold water supply inlet
- hot water outlet connection
- draft hood
- flue vent and pipe
- gas burner in a combustion chamber (attached externally to the bottom of the storage tank)

The gas burner uses a continuous pilot light to heat a small thermal element (a thermopile) that generates a small amount of electricity to power the control and safety circuits and ignite the main burner when required.

Conditioned house air that is used for combustion enters through openings at the bottom of the combustion chamber. The flue passes vertically through the centre of the tank to the chimney of the house for venting to the outside. Additional conditioned house air is added to and dilutes combustion gases through a draft hood at the top of the water heater.

A combined thermostat and gas valve unit controls the burner. The gas burner is activated when the water temperature in the storage tank drops below the thermostat set point. The temperature drop occurs after enough hot water is withdrawn from the tank and replaced by cold inlet water. Then hot combustion gases rise up the flue, transferring heat through the steel flue to the water. These gases exit the water heater at the top. The flue gases rise up through the chimney because they are less dense (because they are warmer) than the surrounding air (stack effect). This type of water heater does not require electricity.

Conventional gas-fired water heaters are tested and rated to the CSA P.3 standard, which determines their EF. In use, these water heaters are rather inefficient because they use naturally aspirated burners, continuous pilot lights and have constant energy losses up the chimney. They also can spill combustion gases if the house depressurizes.

## Power-vented gas-fired water heaters

FIGURE 9

### Power-vented gas-fired water heater



Power-vented gas-fired water heaters are similar in construction to conventional gas-fired water heaters. The main difference is that a fan pushes the exhaust gases through a vent out the side wall of the house. Because no chimney is required, this type of water heater is compatible with high-efficiency furnaces that are sidewall-vented. All power-vented water heaters have electronic ignition instead of a continuous pilot light, which also improves efficiency. However, the efficiency improvement over conventional water heaters is fairly small.

An advantage of power venting is that it eliminates the possibility of backdrafting and spilling combustion gases. A power-vented gas water heater may be a good option where no chimney exists or where the cost of chimney lining would be high (see Venting considerations). These water heaters require electricity, so they cannot produce hot water during a power outage. Power-vented gas-fired water heaters are also tested and rated to the CSA P.3 standard.

## Direct-vent gas-fired water heaters

Direct-vent water heaters, also referred to as “sealed combustion” water heaters, draw combustion air from outside the building directly into the combustion chamber. This means that house air is not used for combustion. Exhaust gases are vented through the wall to the outside.

Current efficiency test methods at the time of writing this publication do not calculate energy savings that result from using outside air instead of conditioned air from the house for combustion or venting. Direct-vent gas-fired water heaters are available with or without a power-vent fan. Both types are more resistant to combustion spillage than a conventional water heater.

## High-efficiency condensing gas-fired water heaters

To achieve higher efficiency, gas-fired water heaters can use a condensing heat exchanger, similar in concept to a high efficiency gas-fired furnace. More surface for heat exchange is required to condense water from the flue gases. This process captures more heat, and the heat exchanger greatly improves this water heater’s efficiency.

Condensing gas-fired water heaters are available in either storage tank or tankless configurations. Although more common in the commercial market, a high-efficiency condensing water heater may be a good choice for residential use if large quantities of hot water are required. These water heaters may also be used as part of combination space-water heating systems.

**Note:** The CSA P.3 standard applies only to gas-fired water heater tanks that have a maximum input of 22 kW and 75 000 Btu/hr. Tanks that have higher inputs (often referred to as “commercial” water heaters) are sometimes installed in residential applications. These higher input tanks are not tested and rated to the CSA P.3 standard. Their performance standard uses thermal efficiency and standby loss as performance rating metrics rather than the EF. They are also certified to a different safety certification standard that does not include the flammable vapour ignition resistance test of the CSA P.3 standard.

## Characteristics of efficient gas-fired storage tank water heaters

In general, more efficient gas-fired storage tank water heaters have some or all of the following features:

- electronic ignition, which eliminates using a continuous pilot light
- improved or extended heat exchange that increases heat transfer to the water
- sealed and power-vented combustion
- increased tank insulation
- factory-installed heat traps
- bottom inlet for the cold water

## Oil-fired water heaters

Oil-fired water heaters have an oil burner in a combustion chamber in the lower part of the storage tank. The performance of oil-fired equipment depends to a large extent on how well the air and fuel oil are mixed in the burner. Two types of burners that are commonly used are called high static and flame-retention head. The high static type has less excess air, higher flame temperature and increased efficiency compared with a standard retention head design.

A central flue provides a path for combustion gases to move up through the tank and to transfer heat to the water. The flue gas exits out the top of the tank to a conventional chimney or a sidewall vent. Chimney-vented units usually use a barometric damper to add dilution air from the house to control the chimney draft (similar to a draft hood for gas-fired equipment) but some oil-fired units are certified for use without a barometric damper.

Designs that have multiple flues increase the transfer of heat from combustion gases to the water and thereby increase efficiency. Because air continues to migrate through the water heater when the burner is not operating, some heat is carried away, and the overall efficiency is reduced.

The high static burner reduces the flow of air through the water heater during the off cycle. This burner can also be used in a sealed combustion water heater, which means that there is a dedicated air intake and exhaust, and no room air is used for combustion or dilution.

## Venting considerations

Gas- and oil-fired water heaters require proper venting to safely remove combustion gases. Two basic types of venting for gas-fired, propane or oil-fired water heaters meet most requirements of today's home designs: **traditional venting** that uses a chimney and **sidewall venting**.

The **traditional venting** method, such as a masonry chimney or a vertical metal vent, such as a B-vent, is still widely used to carry combustion gases from the water heater to the outdoors by using the natural buoyancy of the warm gases. The water heater must be located fairly close to the chimney. An evaluation by qualified service personnel is required when adding, removing, or replacing any gas-fired, propane or oil-fired equipment. Resizing and/or lining the chimney or vent may be necessary to avoid combustion gas spilling into the house and to avoid condensation forming in the venting system.

Conventional water heaters use heated air from the house for combustion and for dilution. This air enters the house through uncontrolled leaks in the building envelope. Energy-efficient, tightly sealed homes may not have enough natural leakage to supply sufficient air for combustion or supply sufficient draft for all combustion products, resulting in spillage of some combustion products into the house.

Other air-exhausting devices such as kitchen fans, bathroom fans, clothes dryers, central vacuums and fireplaces also require air and may pull air from the water heater flue. Spillage is the flow of combustion gases into the indoor air. It may occur when the water heater burner first ignites, before the flow of combustion gases up the flue is established. Spillage can be a serious problem.

If you have a newer house, or have significantly reduced the air leakage in your house with caulking, weatherstripping and new windows, you should consider installing a power-vented water heater or a sealed combustion water heater, thus eliminating the possibility of spillage and backdrafting. As a minimum, you should install a carbon monoxide sensor in the vicinity of all combustion appliances. This is required by building code in many Canadian jurisdictions.

**Sidewall venting** vents horizontally through an outside wall and may be either **direct vent** or **power vent (fan-assisted)**.

**Direct-vent water heaters** rely on natural draft for venting, while **power vents** force the combustion products outside by using a motor-driven fan. Many water heaters use extra air from the house to mix with the combustion gases to lower the temperature for the plastic vent pipe. The dilution air adds to the heating requirement for the house.

Building and combustion safety codes restrict the placement of sidewall vents. Sealed combustion water heaters and two-pipe, power-vented water heaters draw air for combustion directly from outside through sidewall piping. This eliminates the need for dilution air.

# 3 Choosing a storage tank water heater

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Now that you have read about the options for water heaters, it is time to determine which new water heater will best meet your family's needs. Though it is easy to simply replace your old water heater with the same type, a little investigation may reward you with a more cost-effective and efficient choice for your household. As with many purchase decisions, the least expensive water heater is often the most expensive to operate.

You must consider numerous factors when you choose a new hot water heater:

- Step 1: Consider your options.
- Step 2: Determine the required hot water delivery capacity.
- Step 3: Evaluate the energy efficiency.
- Step 4: Choose a supplier and an installer.

## Step 1: Consider your options.

Although storage tank water heaters are the most commonly installed water heater in Canadian households, they may not always be the most efficient choice. See Chapter 1 for a description of the different types of water heaters, including storage tank, tankless or on-demand, heat pumps and solar-assisted. Chapter 2 discusses the different types of water heaters by fuel type.

You may also want to consider changing the energy source for the water heater. The following three sections provide options for the most common conversions.

### **Changing from electricity to natural gas, propane or oil**

Changing to a gas- or oil-fired water heater from an electric model requires installing venting. This provides an ideal opportunity to install a more efficient, sealed combustion or a power-vented gas-fired water heater. Most Canadian homes heated with gas also use gas for their hot water supply because of its historically lower

operating cost and faster recovery after high use of hot water. Similarly, oil-fired water heating is common in oil-heated homes and provides an even faster recovery rate than gas.

### **Converting to a more efficient water heater that uses the same fuel**

If you have a high-efficiency condensing furnace, which does not need a chimney, and are considering replacing your fuel-fired water heater, sidewall venting may be an attractive option. Sidewall venting has become a popular method of venting more efficient water heaters instead of using the existing venting. If the original venting system had been sized for venting both a furnace and a water heater, using it for a new water heater could cause condensation to form.

Sidewall vents may allow flexibility in where you can place the gas-fired water heater because the chimney is not needed. With this increased flexibility, take a look at whether you can relocate the water heater to shorten the length of the pipes to your most-used fixtures – in the bathrooms, kitchen and laundry rooms. Shortening the pipes can result in significant energy, water and cost savings.

### **Converting from natural gas, propane or oil to electric**

A switch from gas to electric water heating may be a reasonable choice for some households. Electric water heaters are attractive where electricity rates are lower. Choosing electric water heaters with lower standby loss provides an overall efficiency improvement, and combined with lower hot water use, may make electricity more competitive. Because electric water heaters do not need dilution air, there is little interaction with the space heating and cooling system. For this reason, high-efficiency electric hot water tanks are often used with high-efficiency gas furnaces.

Without the constraint of a chimney, you may consider relocating the water tank. Look at how you can locate the water heater to shorten the length of the pipes to the taps – in the bathrooms, kitchen and laundry rooms. Shortening the pipes can result in significant energy, water and cost savings.

## Step 2: Determine the required hot water delivery capacity.

Installing a tank that is too large is not recommended for several reasons. Standby loss increases with tank size, which leads to higher energy bills. Larger tanks cost more, are more difficult to handle during installation, and take more space. Most households use much less hot water per day than their water heater is capable of producing.

The most effective method to determine the right size of tank is to consider if your existing tank meets your needs. If it does not (there are times when you run out of hot water) or if you do not have past experience to guide you, try to estimate your hot water needs. Hot water use varies depending on the number of people in your home and the types of appliances that are installed, as well as how your family uses them. Some types of appliances, such as large soaker tubs and whirlpool tubs require a lot of hot water when they are used, but they may be used only infrequently.

Check with your intended supplier, installer or water heater rental company to ensure that the water heater that you have chosen will be appropriate for the needs of your household both in terms of efficiency and supply. Energy utilities provide some recommendations on their Web sites.

Another way to determine the size of tank required is to estimate your household's peak hot water demand. For example, your household's peak hour demand for hot water usually occurs during showering. There are estimates that a typical shower is 8 min and with energy saving shower heads, the requirement for hot water will be about 30 L (8 gal.) per shower. There should be enough hot water to shower at least three people plus allow for additional hand and face washing at a sink with more hot water still available in the tank. The ability of a water heater to provide hot water in a short period of time is a measurement of its "real capacity," not just its storage capacity (physical tank size). The tank's real capacity is indicated by its **first hour rating (FHR)**.

## First hour rating

The FHR measures how much hot water the heater can supply during 1 hr, starting with a fully heated storage tank. This should match or exceed the maximum estimated hot water use in your house in 1 hr. The higher the FHR (also referred to as first hour delivery), the more hot water the water heater can deliver during the peak use time.

Avoid *over-sizing* a tank in anticipation of an infrequent high hot water need. The larger the tank, the higher the initial purchase price and the higher the standby losses, resulting in increased energy costs.

The “capacity” of a gas-fired water heater should be judged by its FHR, not its tank size. Due to larger burners, some gas water heaters with smaller tanks actually have a higher FHR than models with larger tanks.

Tankless water heaters take this concept to the extreme and eliminate the storage tank altogether. Their capacity for delivering hot water is rated by the continuous flow in gallons per minute (gpm) (L/min) of hot water that they can provide, using standard water inlet and outlet conditions, rather than the FHR. To compare the gpm (L/min) rating to the FHR, multiply the gpm by 60.

## Determining the right size for a tankless water heater

With tankless or on demand water heaters, proper sizing is also important.

Manufacturers rate the delivery of hot water in L or gpm. Consider how many users will be demanding hot water at the same time. If you expect that more than one shower or other appliance (such as a dishwasher) will be operating at one time, these demands must be added, and the water heater must be able to meet these peak loads. You may decide that operating the dishwasher can wait, and that is fine as long as everyone understands the availability of hot water.

Note that the capacities for delivering hot water that are quoted by manufacturers for both storage tank units and tankless units are based on raising the water temperature by a fixed amount. The

temperature of the incoming water varies greatly by geographical location and time of year.

The other factor relating to sizing tankless water heaters is the capacity of the energy supply. Replacing a conventional storage tank water heater with a tankless gas-fired water heater may require that the gas supply to the water heater be increased. For example, a gas-fired tankless water heater will typically require a 1.9-centimetre (cm) (¾-inch [in.]) supply compared with a 1.2-cm (½-in.) supply for a standard water heater.

### **Step 3: Evaluate the energy efficiency.**

The efficiency of gas-fired, propane and oil-fired water heaters is measured by the EF. The efficiency of electric water heaters in Canada is measured by standby loss. After you select the size, choose models with a high EF or low standby loss rating because these are the most efficient. Remember that using an oversized water heater will increase energy costs because of increased standby losses. Higher efficiency is a result of improved heat exchange and better heat retention due to increased insulation levels. Higher efficiency water heaters usually have a higher purchase cost but lower operating costs, are higher quality and have better warranties.

See Chapter 1 for more details on ENERGY STAR and regulated water heaters, as well as the EF and standby loss.

### **Step 4: Choose a supplier and an installer.**

When it comes time to replace your water heater, it is important to know that there are pros and cons to each of the options described below. Many considerations, such as fuel type, cost of service and installation, and equipment selection, will impact your decision.

Consider these options when choosing a water heater:

1. Purchase through a contractor.
2. Purchase at a retail outlet.
3. Rent from a service company or utility.

## **Option 1. Purchase through a contractor.**

To get first-hand information on the different makes and models available, consult the Internet or contact some contractors. Ask them for the manufacturers' illustrated sales literature on the water heaters they sell and install. When making your choice, remember that a higher EF indicates better energy efficiency that will reduce your energy bill. For electric water heaters, look for a lower standby loss rating.

A contractor who promotes the quality of services and products at reasonable rates rather than just low prices is usually a good choice. Having a contractor install the water heater allows you to obtain competitive bids for both purchase and installation. If you are purchasing a tankless or other non-standard water heater, make sure your contractor has a good understanding of these types of equipment and is qualified by the manufacturer.

It is important to employ a contractor who will install your equipment properly to ensure that it will operate safely and efficiently. The following tips should help you find an experienced and reliable contractor:

- Check with your utility or service company for water heater purchase, rental or lease programs as well as a list of their authorised or recommended contractors for installing and servicing water heaters.
- Ask friends, neighbours or relatives if they could recommend a contractor.
- Check the Internet and/or the Yellow Pages under "Water heaters" and related classifications such as plumbers.
- Request a list of recommended contractors at retail outlets that sell water heaters.
- If you are considering installing a less common water heater system, you may want to attend a home show to meet potential suppliers and installers or conduct research on the Internet.
- Ask about the EF and standby loss to ensure you are getting an energy-efficient water heater.

Ask contractors for specific references that include the names of homeowners for whom they have done similar work. The Better Business Bureau will know if the contractor is a member and whether any recent complaints have been filed against him or her.

Do not hesitate to ask the contractor for a clear explanation of any aspect of the work before, during or after the installation of your water heater.

### **Request a written contract**

Before you decide what to buy, obtain firm, written bids from several companies on the cost of buying and installing a water heater. You should always ask for a written contract before they begin the work. Read the contract carefully and check all terms and conditions before you sign. The contract should include

- the manufacturer, model and heating capacity of the water heater
- details of the warranty (ask about a contact number and charges for emergency service calls)
- details of the installation (venting requirements, inspections)
- additional parts required (heat traps, drain pan, chimney liner, piping, insulation, etc.)
- cost of removing the old water heater
- total cost of parts and labour, including taxes
- payment method
- dates the work begins and ends

### **Option 2. Purchase at a retail outlet.**

Most hardware and building supply stores carry water heaters, though all models may not be on display or available through them. Some manufacturers provide retailers with consumer specification sheets to help you determine which model is most appropriate for your needs, including some details about energy efficiency. Many retailers can provide this information from their in-store electronic catalogue. You may want to bring a copy of this guide along to help you make a decision.

It is easy to simply replace your existing water heater with exactly the same model and size, if it is still available, but that might not be your best choice in the long run. As noted in the “Introduction,” it is important to consider the second price tag, which is the operating cost. Usually the least expensive water heater will cost the most to operate over its lifetime. Take the time to review the energy efficiency features of the various water heaters so you can benefit from the savings. Many retailers can help you find a qualified installer.

## **Warranties**

Some manufacturers group their water heaters by levels of warranty. Warranties do guarantee longer water heater life but may not equate to lower operating costs. To clarify, a warranty provides protection against some of the cost of premature water heater failure. A warranty ranges from one year to lifetime. The warranty is not always a good measure of reliability, but manufacturers offering longer-term warranties often use improved materials and designs to achieve more reliable heaters.

For example, in areas where hard water is common, improved materials and tank designs can also extend the life of the water heater. Water quality is the single most important factor affecting the life of the water heater. Remember that the least expensive water heater to purchase may be the most expensive to own over the useful life of the water heater and the additional cost for longer warranties should be considered.

## **Option 3. Rent from a service company or utility.**

Renting a water heater from a service company or utility is often the easiest method. Many utilities and energy suppliers have a program that includes peace-of-mind service, easy and convenient installation and the equipment on a practical payment plan. There are some drawbacks, however, to renting, the most important being that, over the life of the water heater, this option will be more costly than purchasing one. Check with your utility or service company or search the Internet to see if such a service is available in your area, and find out about the rental fee and applicable terms and conditions. Ensure you understand your obligations before signing a contract.

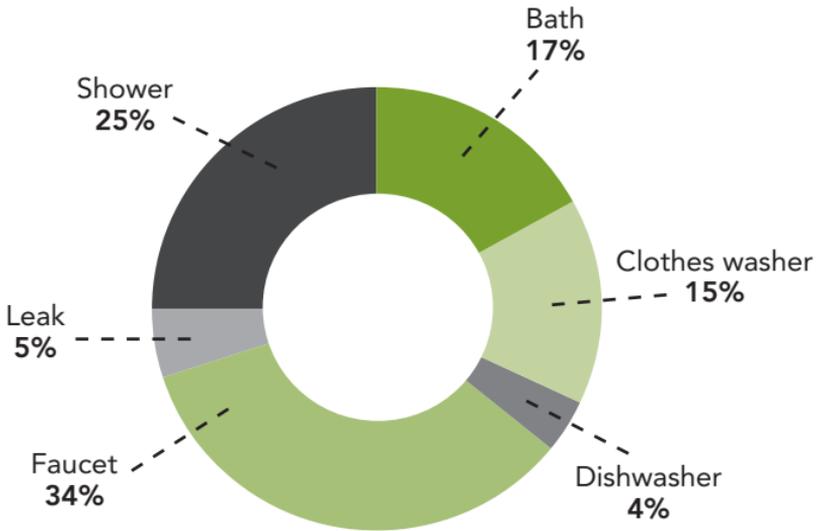
# 4 Reducing water heating bills

## Typical household hot water use

In Canada, the average person uses 75 L of hot water per day and the average Canadian household uses 225 L.

The four main uses for hot water in the home are showers, faucets (food preparation, hand washing), clothes washers and dishwashers. Figure 10 shows typical hot water use breakdown, which illustrates that showers and baths account for almost half the hot water use in your home.

**FIGURE 10**  
**Main uses for household hot water**



Source: Canadian Building Energy End-Use Data and Analysis Centre

Aside from the number of people in the house, the age of household occupants and their habits and lifestyle influence daily hot water use. For example, some people enjoy long, hot showers while others like shorter, cooler showers. The number of loads of automatic dishwashing and clothes washing must be also

considered. Last but not least, the size of the home and other hot water use activities, such as whirlpool baths, spas and hot tubs all contribute to the total hot water use.

The following section provides ideas for reducing your use of hot water. For example, did you know that some laundry detergents are now formulated to work best in cold water? Warm or hot water is no longer required to clean your clothes. Read on for more great tips.

## How to reduce hot water use

You can decrease water heating costs significantly in your home without replacing your water heater. The key is to use hot water more efficiently, so you need less of it without sacrificing comfort and convenience. Switching to water-saving fixtures and making a few simple adjustments to your existing water heater are great ways to start.

### No-cost measures

#### *TIP #1: Take a shower instead of a bath.*

A 5-min shower using a water-saving shower head uses only half the hot water that taking a bath does (see Tip #6 for an easy test to determine if your shower head is water-efficient).

#### *TIP #2: Reduce the water flow while you soap up or apply shampoo.*

Some low-flow shower heads have a “trickle” valve that reduces the flow of water (without adjusting the faucets) while you apply soap or shampoo. Save even more by turning off the shower while you apply soap or shampoo.

#### *TIP #3: Turn the hot water down or off while you shave or wash dishes.*

This apparently insignificant step, as opposed to letting the water run fully, can have significant results when practiced routinely.

***TIP #4: Wash and rinse clothes in cold water.***

About one-fifth of the hot water used in a typical house is for laundry. Most of the cost of operating washing machines is for heating the water. However, some detergents are now specifically formulated to dissolve in cold water. Cold water use may make clothes last longer. Cold water can be used for washing most laundry loads and is always sufficient for rinsing. If you do use warm water for some loads, adjust the water temperature and the water level for the size of the load.

## **EnerGuide and ENERGY STAR®**

Next time you purchase a clothes washer, consider its impact on hot water use. The EnerGuide label takes into account both the electricity used to operate the machine and the energy required to heat the water. The most efficient appliances carry the ENERGY STAR symbol as well as an EnerGuide label. ENERGY STAR qualified front and top loading clothes washers use 35 to 50 percent less water than traditional top load models.

## **Low-cost measures**

***TIP #5: Fix hot water leaks.***

A leak of one drip per second of hot water from a faucet or shower head costs about \$1 per month, yet often could be repaired in a few minutes and for a few cents with a new washer.

*TIP #6: Install water-saving shower heads.*

**FIGURE 11**

## **Install a water-saving shower head**



Low-flow shower heads can reduce hot water consumption by 30 percent, yet still provide a strong, vitalising spray. Look for a shower head that has a flow rate of less than 9.5 L/min. Many styles are available. Because personal preferences vary, consider purchasing a shower head that has an adjustable spray. Avoid low quality shower heads that may simply restrict water flow and result in poor and annoying performance.

### **Flow rate measurement test**

This quick test can help you determine if your shower head is a good candidate for replacement. Replace an existing shower head with a water-saving model if a 2-L cardboard milk carton fills in less than 10 seconds (sec) (12 L/min) when the hot and cold water taps are fully open.

### ***TIP #7: Install water-saving aerators on the kitchen and bathroom faucets.***

Check the flow rate of your faucets by the same method used for the shower head. Replace aerators on faucets that use more than 14 L/min of water. (A 2-L cardboard milk carton fills in less than 8 to 10 sec.)

Select water-saving aerators that provide flow rates necessary for different household uses. For bathroom faucets, aerators that deliver 2 to 4 L/min of water may be sufficient. Kitchen faucets require a flow rate of 8 to 12 L/min if you regularly fill the sink for washing dishes. On the other hand, if you tend to let the water run while rinsing vegetables, an aerator with a flow rate of about 7 L/min will give good performance and substantial savings. The product packaging for aerators should provide you with flow rate information. Take your old aerator with you to the store to ensure you get the correct size and threading style.

Three people living in a house can use between 110 and 450 L of hot water per day depending on their habits, lifestyle and water use devices. Installing a few simple devices and changing a few habits can really make a difference in your consumption of hot water!

## **How to increase the efficiency of your water heater**

Tips #1 through #7 dealt with how you can reduce the amount of hot water used with simple habit changes and inexpensive low-flow water devices. The remaining tips deal with increasing the efficiency of your water heating system and include some maintenance tips.

### **No-cost measures**

#### ***TIP #8: Maintain a moderate tank temperature.***

Be careful if you are thinking about changing the temperature settings of your water heater. Lowering the temperature too much may promote bacterial growth, especially in electric storage tank water heaters. Lower water temperatures would also increase the possibility of running out of hot water because more hot water will be used when you are mixing hot and cold to get warm water for some uses. There are requirements for installing tempering valves or “at-use” devices to lower the delivered water temperature to

reduce the danger of scalding, especially for small children, elderly and disabled persons. Table 4 lists the approximate time it takes for scalding to occur at different temperatures of hot water.

**TABLE 4**  
**Water temperature scalding guide**

| Temperature  | Time to scald     |
|--------------|-------------------|
| 52°C (125°F) | 1.5 to 2.0 min    |
| 54°C (130°F) | about 30.0 sec    |
| 57°C (135°F) | about 10.0 sec    |
| 60°C (140°F) | less than 5.0 sec |
| 63°C (145°F) | less than 3.0 sec |
| 66°C (150°F) | about 1.5 sec     |
| 68°C (155°F) | about 1.0 sec     |

**Gas-fired, propane and oil-fired water heaters** are easy to adjust. They have a temperature control on the outside that can be adjusted by turning it away from the “very hot” setting. Because there are usually no numbers stated on this dial, you will have to retest the water temperature several hours after the adjustment.

Adjusting the temperature of an **electric water heater** will usually be more difficult. An electric water heater has both upper and lower thermostats located behind removable panels. You may want to consider having a qualified service person make any adjustments.

## Low-cost measures

*TIP #9: Insulate water pipes.*

**FIGURE 12**

### **Insulate water pipes**

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Insulating the hot and cold water pipes within 2 to 3 m of the water heater is the most cost effective improvement that can be made to existing or new installations. Several products can do this job, but the easiest one to use is the pop-on insulating foam sleeves. They are very effective and can be mitred at bends in the pipe.

The safety guidelines for insulating gas-fired, propane and oil-fired water heaters differ from those for electric water heaters. Follow the manufacturer's instructions or keep the pipe insulation at least 15 cm (6 in.) away from the exhaust vent at the top of natural gas/propane and oil water heaters. There are no restrictions for electric water heaters.

Insulating the cold water pipes will minimize condensation on the pipes. This prevents dripping on ceiling tiles and basement floors.

***TIP #10: Install heat traps.***

Heat traps prevent unwanted circulation of water by convection within the pipes. If heat traps were not initially installed with your water heater, they can be added to existing heaters to reduce water heating energy loss. However, the cost of installing them may not be economical for an older tank that may be replaced soon. A quality installation of a new water heater should *always* include heat traps. Some tanks have heat traps installed as integral components. Do not install additional external heat traps on those tanks.

***TIP #11: Insulate an electric water heater tank.***

If your existing electric water heater storage tank is warm to the touch on the side and top, your tank will benefit from an additional insulating jacket. Even newer models of water heaters with higher levels of insulation will benefit from an added layer, especially if the water heater is located in a cooler location such as in the basement.

It is not recommended to add insulation on the outside of a gas- or oil-fired water heater. The insulation could block the airflow to the burner and vent and create a serious safety hazard.

***TIP #12: Use off-peak power to heat water (if available).***

If your electric utility offers time-of-use rates, you may be able to lower your electric bill by controlling the storage water heater during set periods. Timers or other controls may be used to shut off the water heater during utility peak demand periods. The family will not normally be aware that this is happening. This type of energy controller may be available as an option with a water heater rental arrangement.

***TIP #13: Turn off your water heater when your home is unoccupied.***

If your home will be unoccupied for an extended period, you should turn off your water heater.

# 5 Summary

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The information in this guide has been provided to help you make informed decisions about water heaters that will save you money and lower your energy consumption.

Key points for buying or renting a new water heater:

- Get the right capacity tank for your family's needs. Too much capacity will cost more to purchase and operate.
- If your water heater is approaching the end of its expected service life, research now to determine your best options.
- Remember the second price tag. The operating costs will be greater than the purchase or rental price. Use local energy prices and consider future energy prices in your analysis.
- Compare efficiency ratings. For gas-fired and propane water heaters, look for an ENERGY STAR qualified model. For electric water heaters, look for a lower standby loss.
- Ensure that heat traps and pipe insulation are installed. Where practical, locate the water heater as close to the major uses as possible.
- Consider adding a DWHR device at the same time as you replace your water heater.

Key points for reducing hot water costs:

- Install low-flow shower heads and faucet aerators.
- Think about how your family uses hot water and take steps to reduce your consumption.
- Use cold water to wash clothes.
- Choose clothes washers and dishwashers that are ENERGY STAR qualified.

# 6

## More information

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### Free publications from the OEE

The OEE of NRCan offers many publications that will help you understand home heating systems and home energy use. These publications explain what you can do to reduce your energy use and maintenance costs while increasing your comfort and helping to protect the environment.

#### **To obtain additional copies of this or other free publications on energy efficiency, contact**

Energy Publications  
Office of Energy Efficiency  
Natural Resources Canada  
c/o St. Joseph Communications  
Order Processing Unit  
1165 Kenaston Street  
PO Box 9809 Stn T  
Ottawa ON K1G 6S1  
Tel.: 1-800-387-2000 (toll-free)  
Fax: 613-740-3114  
TTY: 613-996-4397 (teletype for the hearing-impaired)

Publications can also be ordered or viewed on-line at the OEE's Energy Publications Virtual Library at [oee.nrcan.gc.ca/infosource](http://oee.nrcan.gc.ca/infosource).

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