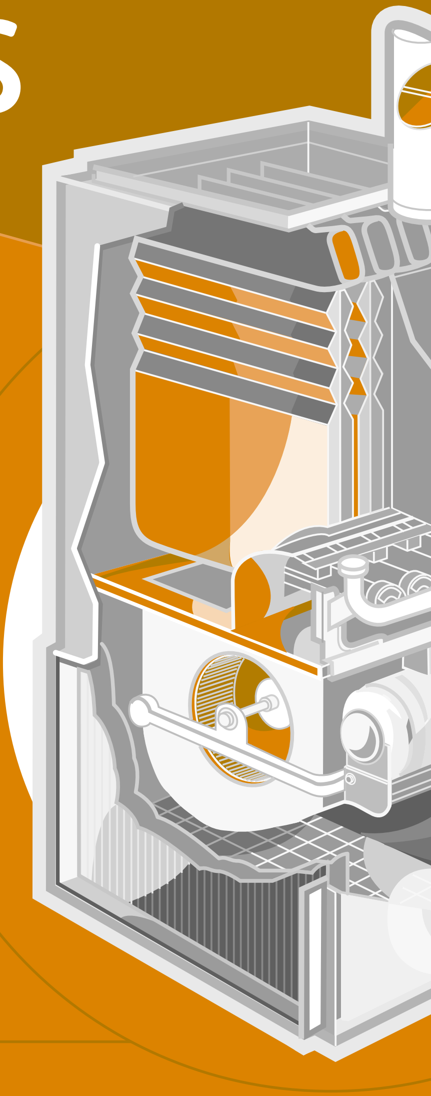
Heating With Gas



Natural Resources Canada
Ressources naturelles Canada
Canada

Heating With Gas

Produced by
Natural Resources Canada's
Office of Energy Efficiency
EnerGuide

The Heating and Cooling Series is published by EnerGuide, an energy efficiency labelling initiative of 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.

Heating With Gas

Rev. ed

Canadian Cataloguing in Publication Data
The National Library of Canada has catalogued this publication as follows:
Heating with gas
(Home Heating and Cooling Series)
ISBN 0-662-34205-4
Cat. No. M91-23/3-2003E

1. Gas-burners – Handbooks, manuals, etc.
2. Dwellings – Heating and ventilation – Handbooks, manuals, etc.
3. Dwellings – Energy conservation.
   I. Canada. Natural Resources Canada.
   II. Canada. Centre for Mineral and Energy Technology.

TH7406.H5214 1996 697.043 C95.980003-4

Revised March 2004
Aussi disponible en français sous le titre :
Le chauffage au gaz

To receive additional copies of this or other free publications on energy efficiency, please contact

Energy Publications
Office of Energy Efficiency
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c/o S.J.D.S.
Ottawa ON K1G 6S3
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HEATING WITH GAS

Introduction

If your present home-heating system is costing too much to operate or is in poor condition or if you are planning on buying a new home, you are probably considering your heating options. About 60 percent of the energy required to run the average home is used for space heating. Therefore, one of the most important projects you will undertake as a homeowner, along with insulating and air sealing, is choosing, changing or upgrading your heating system. A smart decision about heating can significantly reduce the cost of running your home and also make your home more comfortable. Some impressive improvements have been made in heating systems in recent years, and there is a wide range of good equipment on the market.

You will be using your new or improved heating system for a long time, so it is important to do your homework before you make a choice. It is worth taking the time now to ensure that you make the best choice for your situation. You should thoroughly investigate all your options first. These days, however, your options may be quite bewildering because of the wide range of equipment and energy sources available. This booklet will help you make the right buying decision. You will find it useful whether you are installing a system in a new home, replacing a system in an existing home or simply upgrading your present system.

Before proceeding any further, you should familiarize yourself with a number of basic concepts that will help you understand your options.

Heating Concepts

Energy efficiency
All fuel-burning systems (natural gas, oil, propane, wood) lose heat because of transient operation, cold start-up, incomplete combustion, heat carried away in combustion gases and warm house air drawn up the chimney. The extent of these losses determines the efficiency of the furnace or boiler, given as a percentage indicating the amount of original heat that actually warms the house.

Steady-state efficiency measures the maximum efficiency the furnace achieves after it has been running long enough to reach its peak-level operating temperature. This is an important standardized testing procedure that is used by a serviceperson to adjust the furnace, but the figure it gives is not the efficiency the furnace or boiler will achieve in actual use over the course of a heating season. This is much like the difference between the fuel consumption figures published for cars and the actual consumption of the car in day-to-day service.

Seasonal efficiency takes into consideration not only normal operating losses, but also the fact that most furnaces rarely run long enough to reach their steady-state efficiency temperature, particularly during milder weather at the beginning and end of the heating season. This figure, better known as the **Annual Fuel Utilization Efficiency (AFUE)**, is useful to homeowners because it provides a good indication of how much annual heating costs will be reduced by improving existing equipment or by replacing it with a higher-efficiency unit (see Table 3, "Typical Heating System Efficiencies and Energy Savings," on page 52).

If you are heating with natural gas or propane or you are considering one or the other, the more you understand the terminology associated with gas heating systems, the better equipped you will be to make a wise heating system choice. The text box "Gas Heating Terms" presents some of the basics.

Gas Heating Terms

Measuring up

The heating capacity of appliances may be expressed in **kilowatts (kW)**, **British thermal units per hour (Btu/h)** or **megajoules per hour (MJ/h)**.

1 kW = 3414 Btu/h = 3.6 MJ/h

Energy consumption may be measured in kilowatt hours (kWh), British thermal units (Btu) or megajoules (MJ).

1 kWh = 3414 Btu = 3.6 MJ

The gas industry still commonly uses Btu/h for rating heating appliances, but newer equipment should also be labelled with the equivalent rating in kW. The heating capacity of electric heating systems is usually expressed in kW. Most home heating appliances have capacities between 40 000 and 150 000 Btu/h (about 12 kW to 44 kW).

Natural gas

Consumption of natural gas is measured in **cubic metres (m^3)** or **cubic feet (cu. ft.)**. This is the amount that your gas meter registers and the amount that the gas utility records when a reading is taken. The unit of measurement used in billing is inconsistent across Canada. If your utility bills you in units different from those on your meter, use one of the following conversions:

- to convert cubic metres to cubic feet, multiply by 35.3
- to convert cubic feet to cubic metres, multiply by 0.028

One cubic metre of natural gas contains 37.5 MJ (35 500 Btu) of energy.

Propane

Consumption of propane is usually measured in **litres (L)**, with propane having an energy content of about 25.3 MJ/L.

In general, the same technologies and comments apply to propane as to natural gas, with slight differences in efficiencies. Propane has a lower hydrogen level than natural gas. About 3 percent less energy is tied up in the form of latent heat with propane systems than with natural gas. This means that conventional and mid-efficiency propane

Continued on page 5

...continued

furnaces can be expected to be slightly more efficient than comparable natural gas units. On the other hand, propane's lower hydrogen content makes it more difficult to condense the combustion products, so that a propane-fired condensing furnace will be less efficient than the same unit fired with natural gas.

Certification and standards

All gas-fired appliances sold in Canada are required to conform to safety standards established by the Canadian Standards Association (CSA). As proof of compliance, they are also required to be certified by an independent body accredited by the Standards Council of Canada, such as CSA International, Underwriters Laboratories Inc. (UL), Underwriters' Laboratories of Canada (ULC), Intertek Testing Services NA Ltd., or OMNI-Test Laboratories Inc. Before purchasing your heating equipment, be sure it carries a certification label from one of these agencies.

The CSA standards for gas-fired furnaces and boilers also require compliance with the efficiency levels currently prescribed in the federal *Energy Efficiency Regulations*. (See "Energy Efficiency Standards" on page 15 for more information.)

The efficiency of your heating system can be improved in many ways. Some improvements are simple enough that you may be able to do them yourself. Others require changes that can be performed only by a licensed service-person, a qualified heating contractor or, in the case of electric systems, an electrician. All improvements should pay for themselves within a reasonable time. When you are thinking about your heating system, remember to also consider your hot water heater.

1. The Five-Step Decision-Making Process for Home Heating

In this chapter, each of the five steps in the decision-making process for home heating is described in detail.

Step 1. Before Starting

Consider getting expert advice from an EnerGuide for Houses evaluation. The service includes an evaluation of your home and provides recommendations or a written report and an energy efficiency rating for your home. It will help you plan the energy upgrades that can easily be incorporated very cost-efficiently into most renovation projects, resulting in a more comfortable home that uses less energy. For additional information or to get the name of the delivery agent in your area, visit the Office of Energy Efficiency's Web site at **oee.nrcan.gc.ca/houses,** or call Natural Resources Canada toll-free at 1 800 387-2000.

Step 2. Draftproofing and Insulating

It is counter-productive to invest in a new or improved heating system only to allow much of its heat to escape because of an inefficient house envelope that needs more insulation or has many air leaks. To avoid this, take a closer look at where you can draftproof and insulate simply and effectively before having your heating system sized, installed or upgraded.

Draftproofing and insulating have many advantages. Heating the house will cost considerably less, you will be more comfortable because there will be fewer drafts, and surfaces, such as walls, will be warmer. Your house will tend to be cooler in the summer too. Another benefit to draftproofing and insulating relates to humidity levels. Dry air in a house during the winter is caused by too much outside air getting in. Although the relative humidity may be high for cold outside air, the absolute amount of moisture (water vapour) this cold air can hold is actually very low. When this air makes its way inside and is heated to house temperature, it becomes extremely dry.

If the air inside your house feels too dry, one of the easiest solutions is to add moisture using a humidifier. An even more effective way to increase humidity levels (and lower heating costs) is to reduce air leaks. In general, most houses that have been draftproofed and insulated do not need a humidifier – the moisture generated through cooking, bathing, dishwashing and other activities is more than adequate.

Making your house more airtight can cause excess humidity and affect its air quality. Unwanted fumes, odours, gases and excess humidity can be trapped inside the house envelope and may build up over time to unpleasant levels. One of the best ways to improve air quality while maintaining comfort and avoiding heat loss is to install a fresh air intake or mechanical ventilation system that brings in and circulates fresh air, without causing drafts. Your serviceperson should be able to provide you with more information.

Insulating, caulking and weatherstripping will reduce the amount of heat needed to keep your house comfortable. If your home has not been thoroughly reinsulated and draftproofed, you should consider doing this before changing or modifying the heating system. For more information about draftproofing and insulating, write for a free copy of *Keeping the Heat In* (see page 69). Whether you plan to do the work yourself or hire a contractor, this publication provides the information you need (including proper insulation levels) and can help make the whole job easier.

To ensure that you get a heating system with the right heating capacity, be sure to draftproof and insulate before you and your contractor determine what size of heating system and equipment is best. In general, oversized furnaces will waste fuel because they tend to operate in frequent, short cycles. They may also decrease comfort because of the resulting excessive temperature fluctuations.

If you are buying or building a new house, insist on the R-2000* Standard. R-2000 homes have high levels of insulation, airtight construction, heat recovery ventilators, energy-efficient windows and doors, efficient heating

* R-2000 is an official mark of Natural Resources Canada.

systems, and other design features that cut heating requirements by as much as 30 percent compared with conventional construction. For more information on R-2000 homes, see page 70 or contact your provincial/territorial R-2000 delivery agent. To get the name of the delivery agent in your area call Natural Resources Canada at 1 800 387-2000.

Step 3. Selecting Your Energy Source

The next step is to select the heating energy source that is right for you. Generally, your options include natural gas, oil, propane, electricity or wood. You may also choose a combination of these conventional energy sources or alternatives, such as solar energy.

Your decision regarding the most appropriate energy source should be based on a number of considerations, the most important of which are energy availability, cost and the environment.

Energy Availability

Not all energy sources are available in all areas of Canada. Electricity and heating oil are generally available in most places, but natural gas, which must be delivered by pipeline, is not available in much of the Atlantic region or in many rural and remote areas throughout Canada. Propane is available in most parts of Canada and may be used in rural or cottage areas as a substitute for natural gas or fuel oil, although often at a significantly higher operating cost. In many areas, wood is a cost-effective complement to your conventional heating system. Check with your local fuel supplier and gas or electrical utility to find out which energy sources are available in your area.

Cost Considerations

For most homeowners, the major factor in the home heating decision is cost. This factor will have two major components – the capital cost of the installed heating system and the annual operating cost for energy. Other factors, such as maintenance costs, cleanliness and noise of operation, should also be considered.

Installation capital costs of various heating systems, depending on whether they are new or retrofitted, include such items as the following:

- hookup to gas lines or electric power lines
- 200-amp service for electric heating
- storage tanks for oil or propane
- heating equipment (furnace, boiler, baseboard heaters, heat pump, etc.)
- chimney or venting system (if required)
- ducting system or pipes and radiators
- thermostats and controls
- trenching or drilling for earth-energy systems (ground-source heat pumps)
- labour for installation of any of the above

The capital cost of a heating system can range from as low as $1,000 for baseboard heaters in a small house to as high as $12,000 or more for a ground-source heat pump for a larger home (capable of providing heating, air conditioning and hot water). Heating contractors or utility representatives can give you an estimate of the capital cost of various systems. Always ask for a firm, detailed quotation before you authorize any work.

The **operating or fuel cost** of a heating system is determined by three major factors:

1. *Annual heating load or heating requirements of the house.* This depends on the climate, the size and style of house, the insulation levels, the airtightness, the amount of useful solar energy through windows, the amount of heat given off by lights and appliances, the thermostat setting and other operational factors. Together, these factors determine how much heat must be supplied by the heating system over the annual heating season. This number, usually expressed as MJ, kWh or Btu per year (see "Gas Heating Terms," page 4), can be estimated by a heating contractor, home builder or utility representative.

2. *Choice of energy source and its unit price.* Each energy source is measured and priced differently. Natural gas is priced in cents per cubic metre (¢/m^3), dollars per megajoule ($/MJ) or dollars per gigajoule ($/GJ); oil and propane in cents per litre (¢/L); electricity in cents per kilowatt hour (¢/kWh); and wood in dollars per cord. You must consider the heat content of the various energy sources to determine the most cost-effective energy source for your area. Check with your local utility or fuel supplier for the price of the energy sources in your area. Table 2 on page 50 gives the energy content for the various energy sources in the units in which they are commonly sold.

3. *Equipment efficiency*. The seasonal efficiency with which the appliance converts the energy source to useful heat in the home is also an important factor in the heating cost equation. For example, if a furnace has an AFUE (see "Heating Concepts," page 3) of 80 percent, then 80 percent of the heat value in the fuel is available. The other 20 percent is lost, mostly up the chimney; thus, additional fuel must be consumed to make up for these losses. Improving the efficiency of the heating equipment reduces energy use and cost.

The combination of heating load, fuel choice and equipment efficiency determines the annual cost of heating. A detailed description of how you can calculate heating costs for various energy sources and technologies is given in Chapter 5, along with typical seasonal efficiencies (or AFUEs) for a range of technologies.

When choosing a new heating system, it is important to buy a product that offers the best possible quality/price ratio within the limits of your budget. Take into account the overall cost of each system you are considering; this includes its purchase price, installation cost and operating costs. Often the optimal choice is the most efficient product. A higher initial purchase price is usually more than compensated by lower operating costs and, in some cases, a lower installation cost. The more efficient system saves you money every time you heat your home, and these savings increase as fuel prices increase over the life of the heating system.

Environment

The effects of energy production and consumption play an important role in many of today's key environmental problems. Exploration for and extraction of fossil fuels in fragile ecosystems, spills and leaks during transportation, urban smog, acid rain and climate change can all adversely affect our environment. Each form of energy has a different impact at various points in the energy cycle. No form of energy is completely harmless, although the environmental impacts of some sources, such as passive solar energy, are relatively insignificant.

Heating your home affects the environment in different ways, from gases leaving the chimney, to emissions at a coal-fired electricity-generating station, to flooding at a remote hydroelectric site. The overall environmental impact is determined by the amount and type of fuel your heating system uses. Selecting the cleanest energy source available is within your power.

The combustion of natural gas, propane or fuel oil in your furnace releases various pollutants into the local environment. Electricity is clean at the point of use, but it has environmental impacts at the point of generation. In Alberta, Saskatchewan, Ontario, New Brunswick, Newfoundland and Labrador, Nova Scotia and Prince Edward Island, coal or heavy oil is burned to meet electricity demand during the winter. In British Columbia, Manitoba and Quebec, where winter peak demand is met by hydroelectric power, the environmental impact is much less obvious. However, in some instances, emissions of methane, a greenhouse gas, can be high in hydro dam projects. Nuclear power has its own set of environmental problems.

In short, there is no easy solution; but by buying the most efficient system with the most appropriate energy source for your area, you can make a major contribution to helping the environment. Other approaches to reduce energy use and the impact on the environment include improving your home's insulation and airtightness (while ensuring proper ventilation), maintaining your heating system, installing set-back or programmable thermostats and improving your heat distribution system.

Step 4. Selecting or Improving Your Heat Distribution System

Most heating systems today are either forced-air systems or hydronic (hot water) systems. These consist of a heating unit (furnace or boiler), a distribution system (ducts and registers or pipes and radiators) and controls (such as thermostats) that regulate the system. Some houses use space heaters and may not have distribution networks.

FORCED-AIR SYSTEMS

By far, the most common type of central heating system used in Canadian homes is forced air (with a furnace as the heat source). Among its advantages are its ability to provide heat quickly, to filter and humidify household air, and to provide ventilation and central air conditioning. In addition, with an efficient circulating fan motor set, the furnace fan can be used year-round to provide continuous air circulation throughout the house while efficiently balancing the distribution of heat in colder months. It also allows for overnight thermostat set-back, a simple way to save energy.

Forced-air heating systems also have some disadvantages. The temperature of the air coming from the heating registers can vary depending on the type of system. The air can sometimes feel cool (especially with certain heat pumps), even when it is actually warmer than the room temperature. The effect is much the same as the cooling action of a fan or a summer breeze. In addition, there can be short bursts of very hot air, especially with severely oversized systems. Some people may find such characteristics uncomfortable at times. The ductwork that distributes the heat may also transmit the noise of the furnace and circulating fan to every room and can circulate dust, cooking odours and other airborne odours throughout the house. Consult your heating contractor for further information.

HYDRONIC HEATING SYSTEMS

A hydronic heating system uses a boiler to heat water. The hot water is circulated through the house before returning to the boiler to be reheated.

Gas-fired boilers for conventional hydronic heating systems typically produce hot water at approximately 82°C (180°F) and are part of a closed system.

At one time, hot-water or steam-heating systems had large boilers and used wrought-iron pipes and massive cast-iron radiators; some of these still exist in older homes. For many years now, installers have been using smaller copper piping, slim baseboard heaters, and smaller, more efficient boilers. Recently, CSA-approved plastic piping has become available as an alternative to copper piping for space heating and service hot-water distribution.

OTHER TYPES OF SYSTEMS

Apart from the more popular systems previously noted, others that can be used independently or in combination with the standard system are also available. These include **room space heaters, radiant space heaters** and **built-in radiant systems**.

Room space heaters provide heat directly to the rooms in which they are located and do not have a central heat distribution system. Obvious examples are wood stoves, vented oil-fired space heaters, and electric or gas-fired baseboard heaters.

Some space heaters can also be effective radiant heat sources, warming solid bodies (such as people) in their line of sight without necessarily having to heat up all the air. Good examples are the new direct-vent gas fireplaces, advanced combustion wood fireplaces and stoves, and portable electric infrared radiant heaters. If properly located in a major living space, a **radiant space heater** can act as an effective surrogate zoning system, lowering the overall heat demands of the house and the final heating bills while making the occupants feel more comfortable.

Built-in radiant systems are generally of two types: hot water pipes in floors and electrical cables in floors, which may also be installed in ceilings. The radiant floor type, becoming increasingly popular, consists of narrow hot water pipes embedded in the floor or laid in the joist space under the floor. Hot water at a temperature of around

40°C (104°F) is pumped slowly through the pipes and radiates heat into the house. Thick carpets can reduce effectiveness significantly by acting as insulation. Such a system may be more costly to install and does not appear to offer much in direct energy savings. However, some radiant floor installations offer benefits in terms of comfort, and result in lower thermostat settings and reduced heating bills.

Your choice of a heat distribution system may be limited if you have a warm air or hydronic system already in place. If you have electric baseboards and are faced with high heating bills, you may want to change to another type of system, even though it can be an expensive undertaking. Although a major constraint is the lack of a distribution system, many homeowners are finding that air ducts for a central forced-air system or pipes and radiators for a hydronic system can be installed at a cost that still makes the whole conversion financially attractive. Fuel-fired space heaters, wood stoves and advanced, energy-efficient wood- or gas-fired fireplaces can also be effective.

Your final choice will probably be based on the answers to one or more of the following questions:

- How much will the system cost compared with other systems?
- Will this type of system suit my lifestyle? Will I be comfortable with it? Do I want central ventilation, air conditioning or air circulation?
- Is there a contractor available to install the system?
- Is the system compatible with my energy choice?

Step 5. Selecting Your Heating Equipment

After you have selected your energy source options and your heat distribution system, you can begin to consider your alternatives regarding heating equipment and efficiency levels. At some point in your evaluation, you will have to consider whether to upgrade your existing heating equipment or to replace it entirely. A number of things can be done to improve the efficiency and general performance of an existing heating system. You also have the choice of several different replacement models with various efficiency ratings and prices.

Following are some details to consider when choosing your equipment.

Equipment Efficiency and Suitability

Refer to Chapters 2 and 3 of this booklet for a more detailed discussion of your options for gas furnaces and boilers.

Purchase, Installation, Operation and Maintenance Costs

Generally, the more efficient heating systems have a higher purchase price, but most often the initial incremental cost is quickly paid back by fuel savings, making energy efficiency a good investment.

Often, the more efficient systems require much less house air and may not even need a chimney. High-efficiency units can be vented out a side wall. This makes them safer and more compatible with airtight housing. Having high-efficiency heating equipment can be a buying incentive and can increase the resale value of your home.

Servicing and Guarantees

It is important to know the type and frequency of servicing your system requires, the price of parts, the cost of servicing, and the details of guarantees and warranties, such as the period covered and if parts and labour are included. All gas furnaces require general maintenance to ensure optimal performance.

Energy Efficiency Standards

The Government of Canada has implemented energy efficiency standards for some heating equipment and other energy-consuming appliances and products. In addition, various provincial/territorial governments have introduced energy efficiency standards. Generally, these standards establish the minimum acceptable energy efficiency level for specific types of heating equipment. After the standards are in place, models that do not comply with the standard are no longer allowed on the market where the standard applies.

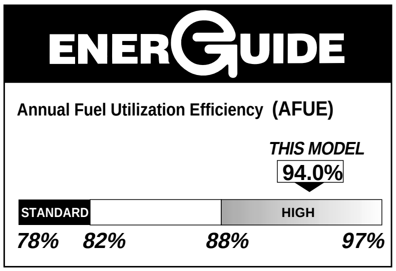
"Standard" and "Mid-Efficiency" Furnaces

Since 1995 the national minimum efficiency standard for gas furnaces has been 78 percent. Prior to that, the 78 percent efficiency level was considered to be a mid-efficiency level by the industry, and since there remain many pre-1995 low-efficiency furnaces in Canadian houses, the term mid-efficiency continues to be used by some to denote the 78–84 percent efficiency range. When considering new furnaces, it is important to remember that the 78 percent level is now the least efficient furnace available on the market, and this booklet will refer to those furnaces as standard-efficiency furnaces.

Energy Efficiency Rating System

The Government of Canada and the Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI) have established a voluntary energy efficiency rating system for residential gas and propane forced-air furnaces to help consumers compare the energy efficiency of different products. The EnerGuide label with the furnace's AFUE rating (Figure 1) is shown on the back page of manufacturers' brochures. Included on the EnerGuide label is a rating scale showing the range of efficiencies for gas and propane furnaces on the market, as well as a pointer indicating where the model is positioned compared with others in terms of efficiency. Chapter 5 shows you how to determine heating costs based on the furnace's AFUE rating.

Figure 1 An EnerGuide label for gas and propane furnaces



ENERGY STAR® Qualified Gas Furnaces and Boilers

The international ENERGY STAR symbol is a simple way for you to identify at a glance product models that are among the most energy efficient on the market. Natural Resources Canada promotes and administers the ENERGY STAR symbol in Canada. Only gas furnaces and boilers that meet the higher energy efficiency performance levels of ENERGY STAR may carry the symbol.

For a gas furnace to meet ENERGY STAR criteria, it must be a condensing unit with an AFUE of 90 percent or higher. See Chapter 3 for information on condensing furnaces.

For a gas-fired boiler, the ENERGY STAR criteria is set at an AFUE of 85 percent. ENERGY STAR qualified boilers are not necessarily condensing models. See Chapter 3 for a discussion of suitable applications for condensing boilers.

Replacing a 20-year-old furnace that has an AFUE of 60 to 65 percent can mean an annual energy savings of at least 30 percent. You are invited to use the EnerGuide Heating Cost Calculator, available on the EnerGuide Web Site at **oee.nrcan.gc.ca/equipment**.

Given that 60 percent of the energy required to run the average home is used for space heating, buying ENERGY STAR qualified products will not only save you money but help the environment. By improving the energy efficiency of your space heating, you reduce greenhouse gas emissions that contribute to climate change and significantly help in achieving Canada's climate change goals.

2. Basic Heating Equipment for Gas-Fired Systems

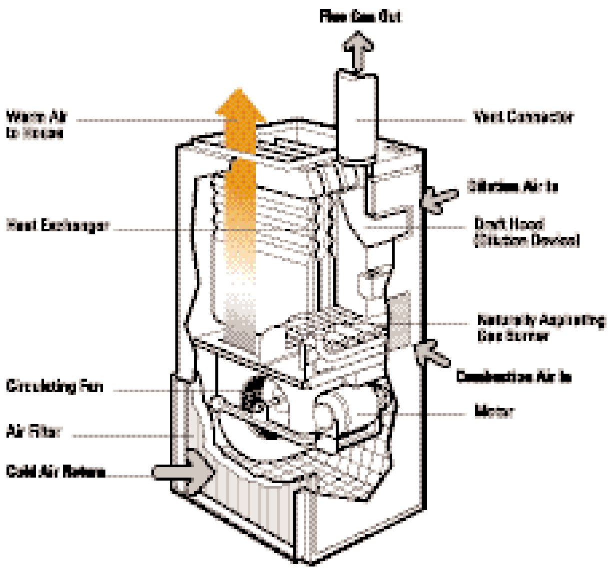
Most natural-gas-fired heating systems today are either forced-air or hydronic (hot water) systems as noted in Chapter 1. This chapter discusses the equipment that make up these two distinct systems.

Equipment for Forced-Air Systems

Conventional Gas Furnace

An old conventional natural-gas-fired, forced-air heating system is shown in Figure 2. This system consists of a furnace with a naturally aspirating gas burner. Older units were equipped with a standing (continuously lit) pilot light; the newer ones feature electric ignition. The combustion gases pass through the furnace, where they pass heat across a heat exchanger and are exhausted to the outside through a flue pipe and vent. A draft hood serves to isolate the burner from outside pressure fluctuations at the vent exit

Figure 2 A conventional gas-fired, warm-air furnace



by pulling varying quantities of heated house air into the exhaust as required. A circulating fan passes cooled house air from the return ducts over the furnace heat exchanger, where the air is warmed up and passed into the ductwork that distributes the heated air around the house.

Notice that there are two entirely separate air movement paths: the combustion path supplies air to the burner and to the draft hood and carries hot combustion gases through the burner, heat exchanger and flue pipe to the vent and out of the house; the heat distribution and cold air return path circulates and heats the air inside the house.

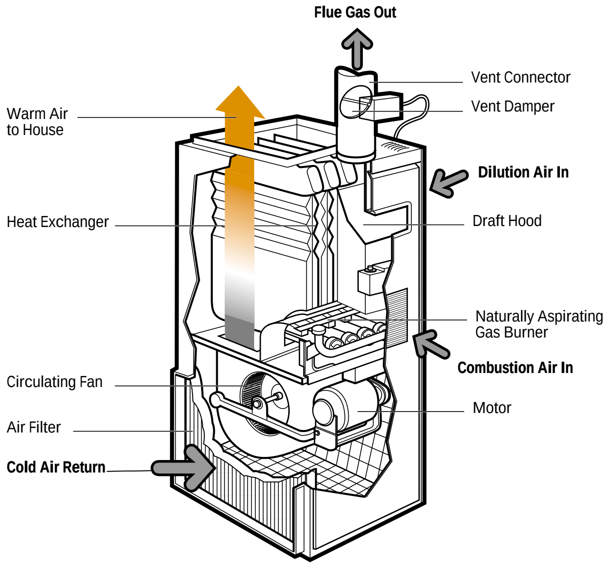
Conventional gas furnaces have a seasonal efficiency of about 60 percent. Although the majority of Canadian homes have gas furnaces similar to this type, such equipment does not meet the new seasonal efficiency standards and is no longer sold in Canada. Today, new furnaces must meet minimum energy efficiency requirements as set out in the Regulations of Canada's *Energy Efficiency Act*. The minimum seasonal efficiency, or AFUE, as of 1995 is 78 percent (see Chapter 3).

The other common type of gas-fired system is an oil-fired furnace that has been converted to natural gas, usually with either a power burner or a power-assisted burner. This type of unit has a fan with a burner to assist in the combustion process and in the development and maintenance of an adequate draft. The dilution device is a double-acting barometric damper, rather than a draft hood, but it performs a similar function.

Oil furnaces that have been converted are generally more efficient than conventional gas furnaces, with seasonal efficiencies in the range of 63 to 68 percent; however, they are not nearly as efficient as the new types of standard and high-efficiency gas furnaces.

Gas Furnace With Automatic Vent Damper

Figure 3 Vent-dampered gas furnace



A vent-dampered gas furnace has a vent damper in the flue exhaust, downstream of both the furnace heat exchanger and the draft dilution device (Figure 3). A thermostat controls the damper: when the gas burner turns off, the damper is closed automatically after a period; when the thermostat signals to start the furnace, the damper opens before the burner ignites. By closing off the vent during much of the off cycle, the damper prevents some of the warm household air from being drawn up the chimney and lost to the outdoors. These furnaces usually have an electric or electronic ignition. Fuel savings are generally in the range of 3 to 10 percent, compared with a conventional furnace. However, some of the savings can be lost if a conventional gas-fired water heater (see Chapter 8) is also connected to the same chimney. The water heater is still vented and is burdened by an increased draft, augmenting the heat lost through the water heater. The vent-dampered gas furnace does not meet the now-applicable minimum standards for energy efficiency.

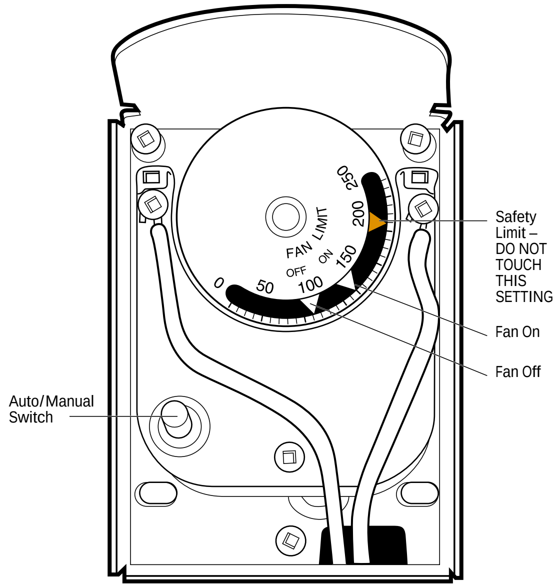
Maximizing Effectiveness in Forced-Air Heating Systems

The performance of an existing forced-air heating system can be improved by adjusting the furnace fan and getting the heat where you want it.

Adjusting the Furnace Fan

Heat output from a warm air system can often be increased by adjusting the controls that turn the fan on and off automatically. Fan controls are usually located in a metal box, often mounted on the front of the furnace, near the top. Inside the box is a temperature dial with three pointers. (To remove the cover, you must either squeeze it or remove metal screws.) The lowest setting is the fan “off” pointer; the next one is the fan “on” setting (Figure 4). The third and highest pointer is the safety limit control that shuts the burner off if the furnace gets too hot. This safety limit is normally set at the factory. **Do not adjust this safety limit setting.**

Figure 4 Circulating fan control



The "on-off" fan control pointers have usually been set for an "on" temperature of 66°C (151°F) and an "off" temperature of 49°C (120°F). To increase the amount of heat distributed by the furnace, most heating experts now recommend changing the setting to an "on" temperature of 49°C (120°F) and an "off" temperature of 32°C (90°F). These changes will cause the fan to come on sooner after the burner starts up and to stay on longer after the burner shuts down. This allows the circulating air to extract more heat from the furnace so that less heat is lost up the chimney or through the vent.

The fan control dial is spring-mounted, so it must be held firmly with one hand while you adjust the pointer with the other. Make sure the "auto/manual" switch is set to "auto" after replacing the cover of the metal box. **If you feel uncomfortable or unsure of what to do to modify these settings, ask your furnace serviceperson to make the setting changes for you during the next service call.**

These modified temperature settings may result in slightly lower air temperatures coming from the room registers at the beginning and end of the furnace cycle. If the cooler air at either end of the cycle makes you feel uncomfortable, try raising either the fan "on" setting to 54°C (130°F) or the fan "off" setting to 38°C (100°F), or try both, whichever is appropriate.

A two-speed fan will allow you to get more heat out of the furnace while providing for continuous air circulation and more even temperatures throughout the house when the furnace is off; however, your electricity bill may increase significantly.

Some of the new high-efficiency furnaces use a more efficient, variable speed, high-efficiency, brushless DC motor to run the circulating fan. For extended or continuous fan operation, such a unit can save a significant amount on your electricity bill while making the delivery of heat more even and comfortable.

Getting the Heat Where You Want It

Uneven heat distribution is sometimes a problem, which often results in the inability to heat some rooms in the house, such as upstairs bedrooms. This can be due to warm air leaking out through joints in the heating ducts or to heat loss from ductwork passing through the basement or, even worse, through unheated areas such as a crawl space, attic or garage.

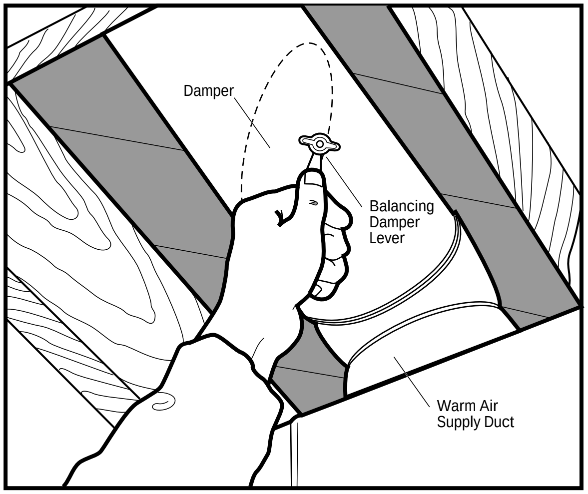
Sealing all joints in the ductwork with a special water-based duct mastic (sealant) will reduce or eliminate warm air leaks. Look in the Yellow Pages™ under "Furnaces – Heating" or "Furnaces – Supplies and Parts." (High-temperature duct tape may work, although it tends to degrade or permit air leakage over time.)

When the circulating fan is running, the house heat loss can significantly increase if leaky ducts are located in an exterior wall, an attic or a crawl space, allowing the heated air to escape. This is one more good reason to ensure that all ducts are well sealed.

Ducts passing through an unheated area such as a crawl space or an attic should first be sealed, then wrapped with batt or **duct insulation**. Do the same for long duct runs in the basement. As a minimum, it is recommended that the warm air plenum and at least the first three metres (10 feet) of warm air ducting be insulated. Better still, insulate all the warm air ducts you can access. Use batts of insulation with foil backing, or enclose the insulated ducts in the joist space. If your basement is presently heated by the heat loss from the ducts, it may be necessary to have additional registers installed in the basement after you insulate. This will help to ensure that the heat will go only where you want it, when you want it, without being lost along the way.

Rooms on upper floors or far from the furnace are sometimes difficult to heat because of the duct losses previously described and because of friction and other resistance to airflow (such as right-angle bends) in the ductwork. This can sometimes be corrected by slightly modifying the ductwork after the ducts have been sealed and insulated, and by balancing the airflow in the supply ducts (Figure 5) to redirect the flow of air from the warmer areas to cooler rooms.

Figure 5 Balancing damper in the supply duct



In some forced-air distribution systems, balancing dampers may be located in the secondary warm air ducts, close to where they branch off from the rectangular main heating duct. Often the dampers can be identified by a small lever on the outside of the duct (Figure 5). The position of this lever (or sometimes a slot in the end of the damper shaft) indicates the angle of the unseen damper inside the duct. If there are no such dampers, you will have to use the ones in the floor registers.

Start by closing the dampers in the ducts that supply heat to the warmest rooms (even if completely closed, they will probably still supply some heat to these rooms). Wait a few days to see what effect this has on the overall heat balance, then make further adjustments as necessary. Such adjustments may slightly reduce the total airflow through the furnace, but this will be balanced to some extent by a slight increase in the temperature of the delivered air.

It may be more practical to hire a service technician experienced in heat balancing to do the job. If you make too large a reduction in the airflow, you could cause an undesirable rise in the temperature of the air inside the furnace plenum. It is a good idea to have this temperature rise checked by your furnace serviceperson.

Most houses have been designed with inadequate cold air returns. The result is that there is not enough airflow through the furnace. Putting additional cold air returns in living areas, particularly in bedrooms, can improve air circulation and heating system efficiency while improving comfort and air quality in the house.

Some years ago, it was mistakenly thought that one way to get around the problem of inadequate cold air return was to open up the cold air return ductwork or plenum in the basement area near the furnace or even to take off the furnace access panel near the air filter. **This is dangerous.** The depressurization caused by the circulating fan can actually disrupt the combustion and result in spillage or backdrafting of combustion products. These combustion products can then be circulated through the house instead of going up the chimney. **In certain cases, this can cause carbon monoxide poisoning.**

For heat distribution problems that cannot be corrected by damper adjustments and other duct modifications, have a qualified serviceperson do a complete and proper balancing of your distribution system.

Programmable Thermostats

The easiest way to save heating dollars is to lower the temperature setting on your house thermostat, when possible. As a general rule, you will save 2 percent on your heating bill for every 1ºC (2ºF) you turn down the thermostat overnight.

Programmable thermostats have mechanical or electronic timers that allow you to preset household temperatures for specific periods of the day and night. In a typical application, you could program the thermostat to reduce the temperature an hour before you go to bed and to increase it before you get up in the morning. You could also program it to reduce the temperature for any period during the day when the house is unoccupied and to restore the temperature shortly before you return. For example, you could have the temperature set at 17ºC (63ºF) when

Continued on page 26

you are sleeping or not at

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home and at 20ºC (68ºF) when you are awake and at home. Experiment with the unit until you find the most comfortable and economical routine for you and your family.

ENERGY STAR qualified programmable thermostats
Programmable thermostats that are ENERGY STAR qualified are required to offer at least four possible daily temperature settings (e.g., wake, day, evening, sleep) for at least two different program periods (e.g., weekdays and weekends). A hold feature allows you to temporarily override the program for a period such as a vacation.

The thermostat will include instructions for the installer to adjust the cycle to suit your heating/cooling equipment. It will come pre-programmed with recommended temperature settings, but you may readily change them to suit your comfort and daily schedule.

Many offer additional features that allow you to

1. store and repeat additional daily settings that can be run and changed without affecting the regular settings
2. store more than four daily temperature settings
3. adjust heating and cooling turn-on times in response to outside temperature changes

When used properly, ENERGY STAR labelled thermostats can save you 10 to 15 percent on your heating bills.

Zone control thermostats
If you have a hydronic (hot water) system, you can also reduce energy use through zone control. In this system, thermostat-controlled valves on each radiator permit the control of individual room temperatures. A plumbing and heating contractor can provide more information about zone control and can install the required equipment when the heating system is installed. Zone controls are also available for forced-air heating systems, usually with dampers in main duct passages driven by separate thermostats in different areas of the house.

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Improved thermostats
More sophisticated electronic and self-tuning thermostats are also being developed. These are very sensitive and help reduce the room temperature "swing" from an average of 1.5–2.0ºC (34.7–35.6ºF) to 0.5–1.0ºC (32.9–33.8ºF), ensuring that the heating system turns on and off as close to the required temperatures as possible. Energy savings from these advanced mechanisms can vary, and comfort is usually enhanced.

Equipment for Hydronic (Hot Water) Systems

Design and Operation

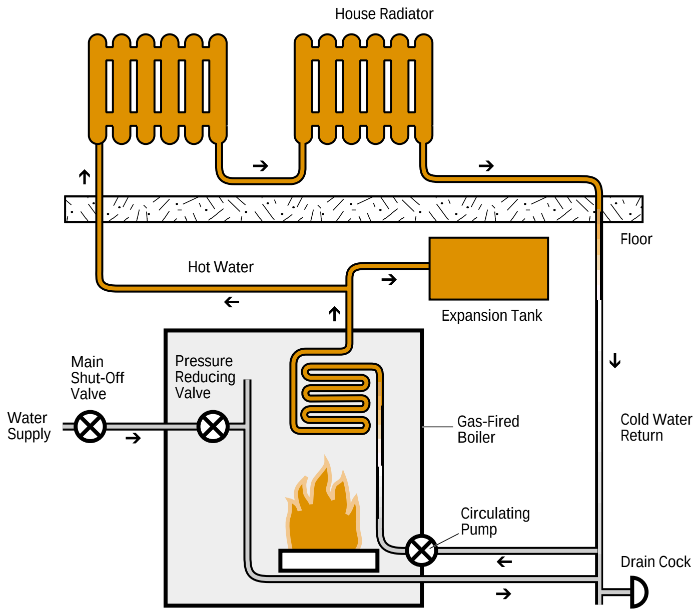
A hydronic heating system uses hot water to distribute heat around the house and has three basic components:

1. a boiler to heat the water
2. heating units in most rooms, usually baseboards or radiators, which are often located on an outside wall
3. a pump to circulate the water from the boiler to the radiators and back through a piping system

A natural-gas-fired boiler uses the same type of burner (either naturally aspirating or power) as a natural-gas-fired forced-air furnace, but a boiler is generally smaller. There is only one air path, which goes to the boiler; this is split between the burner and the dilution device, either a draft hood or a double-acting barometric damper (in the case of a power burner). A boiler does not need the fan and filter housing that makes up a large portion of a forced-air furnace.

Most boilers require a circulating pump to push heated water through the pipes and the radiator system (Figure 6). The seasonal efficiency of conventional boiler systems is similar to that of conventional furnaces, which is around 60 percent. Today, new boilers must meet minimum energy efficiency requirements as set out in the Regulations of Canada's *Energy Efficiency Act*. The minimum seasonal efficiency, or AFUE, as of 1999 is 80 percent (see Chapter 3).

Figure 6 Schematic of a hydronic (hot water) heating system



Maximizing Effectiveness

The performance of hydronic heating systems can be improved in several ways.

Improving Heat Distribution

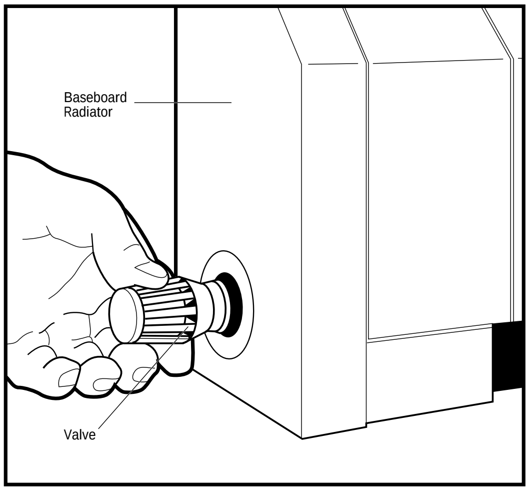
Old-fashioned gravity heating systems that circulate water by natural convection are less efficient than systems with a circulating pump. Slow heat circulation may cause house temperatures to fluctuate noticeably between firing cycles. It can also take a long time to restore the house temperature after a nighttime thermostat set-back. In addition, a gravity system cannot circulate hot water to radiators or baseboard heaters in basement living areas, where they would be below the level of the boiler. All of these problems can be overcome by adding a circulating pump and replacing the open expansion tank with a sealed and pressurized expansion tank near the boiler. If you have a gravity system, discuss the possibility of upgrading it with your plumbing and heating contractor.

Balancing the Heat

Balancing the heat delivered to different areas of the house is as important with hydronic heating as it is with a forced-air system. Radiators are often fitted with a simple manual valve that can be used to control the amount of water flowing through them. Such valves can be used to vary the heat delivered to different rooms of the house in the same way that balancing dampers are used in a forced-air system.

One device that can vary the heat output automatically is a thermostatic radiator valve (Figure 7), which can be set to control the temperature in any room. This valve, however, will not work on radiators or baseboard heaters installed on what is called a “series loop” system. In such a system, the water must pass through all the radiators, one after the other, on its way back to the boiler. If there is more than one loop in the system, some balancing of the heat output can be achieved by adjusting the valves that control the water flow through each loop. The heat output of baseboard units can also be controlled to some extent by regulating the built-in damper, which operates much like the damper in a warm air register.

Figure 7 Thermostatic radiator valve



Outdoor Reset

Most hydronic heating systems have the boiler temperature set for 82ºC (180ºF). A device that has reduced energy consumption in many hydronic heating installations is an outdoor reset controller, which controls the circulating water temperature in relation to the outside air temperature. As it gets warmer outside, the boiler water temperature is reduced. However, some boilers can be subject to thermal shock or corrosion if the return water temperature is too cold. Before applying one of these devices to your system, consult your plumbing and heating contractor to ensure that your boiler can handle it, and that the distribution system will perform effectively at the lower temperature.

Chimney Liners

The combustion of natural gas sends a great deal of water vapour up the chimney. If the chimney is too cool, the vapour will condense; the alternate freezing and thawing of the water, as well as the acidic corrosion from the condensate, can seriously damage masonry chimneys. This problem is particularly serious with outside chimneys, which are much cooler and exposed more to the elements.

If your gas heating system is vented through an existing masonry chimney, you can usually avoid these condensation problems by inserting an approved metal liner, either a double-walled B-vent or a single-walled, stainless steel Underwriters' Laboratories of Canada (ULC) liner. Approved liners reduce the size of the flue so that the chimney will match the requirements of the gas-fired appliances being vented. The reduced diameter of the flue allows gases to go up the vent faster with less chance of cooling down. At the same time, the inside surface of the metal liner is warmed more quickly by the flue gases escaping the chimney, reducing the likelihood of condensation. Metal liners should be used with natural gas furnaces and are a requirement in many provinces/territories. Contact your local utility or provincial/territorial authority for specific advice.

Converting Oil Furnaces to Gas

If you are presently heating with oil, you may be able to convert your existing furnace or boiler to gas. This involves replacing the oil burner with a gas conversion burner and modifying the venting system.

Not all types of oil furnaces can be converted. Also, a conversion is practical only if the equipment is in good enough condition to have a reasonable life expectancy after conversion. Oil furnaces converted to gas have low seasonal efficiencies in the range of 63 to 68 percent.

3. New Standard- and High-Efficiency Furnaces and Boilers

Over the last 20 years, a new generation of higher-efficiency gas furnaces and boilers has come to market. An essential difference in the design of these units is how they are vented, eliminating the need for dilution air. The combustion of natural gas produces certain by-products, including water vapour and carbon dioxide. In a conventional gas furnace, such by-products are vented through a chimney, but a considerable amount of heat (both in the combustion products and in heated room air) also escapes through the chimney at the same time. Heat is also lost up the chimney when the furnace is off. The newer designs have been modified to increase energy efficiency by reducing the amount of heated air that escapes during both the on and off cycles and by extracting more of the heat contained in the combustion by-products before they are vented.

Furnaces with these design modifications use much less energy than conventional furnaces, so consider what this means to you in dollars. Refer to the technologies and seasonal efficiencies listed in Table 3 on page 52, and compare your possible savings with the purchase cost of the equipment. This will help you decide which energy-saving features will give you the most for your heating dollar.

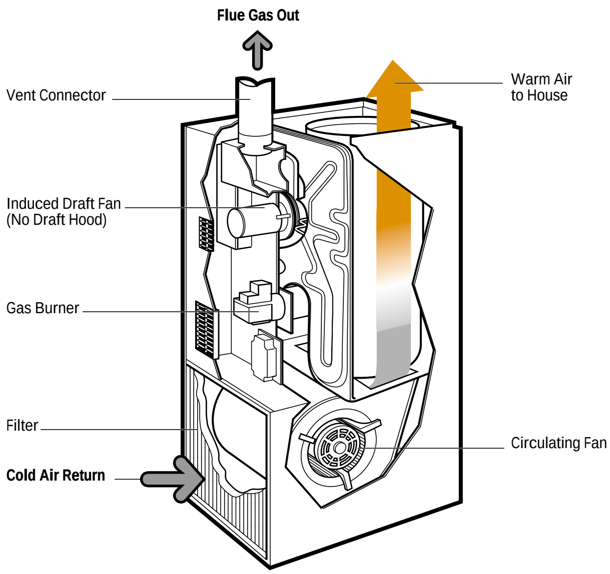
Standard-Efficiency Gas Furnaces

Standard-efficiency furnaces have a seasonal efficiency of at least 78 percent, with most having an efficiency of 80 percent. Standard-efficiency gas furnaces use mainly a naturally aspirating burner and do not have a continuously lit pilot light.

Newer furnaces have electric ignition systems, which can be spark ignition, heat source ignition or intermittent ignition systems. These systems consist of an ignition device that lights the gas and electrically operates the gas valve and controls. When the thermostat indicates that heat is required, the ignition controls open the gas valve to allow gas into the combustion chamber. The gas is then ignited. These devices can result in energy savings of 3 to 5 percent compared with a furnace with a conventional standing pilot light.

Most standard efficiency furnaces are equipped with a powered exhaust, usually consisting of a built-in induced draft fan (Figure 8). With more heat exchange, no dilution air and high resistance to flow during the off cycle, seasonal efficiency is much higher for today's standard-efficiency furnaces than for furnaces equipped with pilot lights, offering energy savings of 23 to 28 percent. These systems can be vented through a properly sized chimney or out the side wall of the house using high-grade stainless steel. However, there have been problems associated with the use of high-temperature plastic vent pipes with standard-efficiency furnaces. Regulations may forbid the use of certain vent materials in your area. You should discuss all options with your local serviceperson, approvals agency or gas utility.

Figure 8 Standard-efficiency gas furnace with induced draft fan



Note that installation codes may require a combustion air supply to be brought from outdoors to the furnace.

High-Efficiency Condensing Gas Furnaces

Condensing gas furnaces are the most energy-efficient furnaces available, with seasonal efficiencies of between 90 and 97 percent. The high-efficiency condensing gas furnace should be the new furnace of choice for most Canadians because it is

1. cost-effective for most climatic regions of Canada
2. not susceptible to some of the condensation and long-term vent degradation problems that can occur with the standard-efficiency furnace
3. better suited for the tight construction of an energy-efficient house

Figure 9 ENERGY STAR symbol

The only furnaces that qualify for ENERGY STAR labelling are high-efficiency condensing gas furnaces.

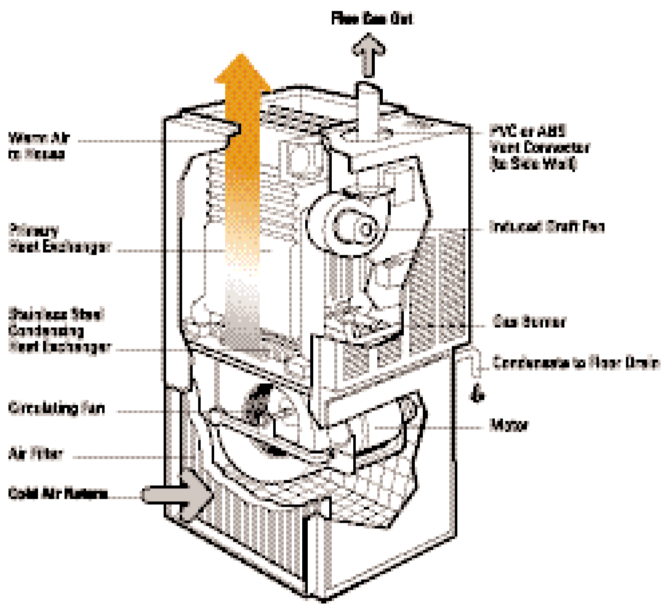
Most condensing gas furnaces have burners similar to conventional furnaces, with draft supplied by an induced draft fan (Figure 10). However, they have additional heat exchange surfaces made of corrosion-resistant materials (usually stainless steel) that extract heat from the combustion by-products before they are exhausted. In this condensing heat exchange section, the combustion gases are cooled to a point at which the water vapour condenses, thus releasing additional heat into the home. The condensate is piped to a floor drain.

A chimney is not needed, thus reducing the cost of installation. Because the flue gas temperature is low, the gases are vented through a PVC or ABS plastic pipe out the side wall of the house. Depending on the combustion and heat exchange design, fuel savings of up to 38 percent can be achieved, compared with older gas furnaces equipped with pilot lights. Furthermore, polluting emissions released into the environment are also reduced.

A second type of condensing furnace or boiler uses a pulse combustion technology to ignite small amounts of gas at frequent intervals; otherwise, it is essentially similar to the condensing gas furnace previously described.

Contrary to conventional and standard-efficiency furnaces, where efficiency decreases with furnace oversizing, condensing furnaces are actually more efficient when they are oversized and run for shorter periods. Thus, if you are choosing a new condensing furnace, you can get a furnace that is slightly larger than the house heat demand, without suffering an "efficiency penalty."

Figure 10 High-efficiency condensing gas furnace



Sealed Combustion

In a sealed combustion system, outside air is piped directly to the combustion chamber, and the furnace does not draw any air from inside the house for either combustion or vent gas dilution.

Although heating costs may be reduced slightly by decreasing the amount of heated air that is drawn from inside the house, the main advantage of sealed combustion is that it isolates the combustion air system from the house so that the furnace is not affected by the operation of other appliances in the home. The tight construction of an energy-efficient house, combined with the operation of exhaust fans (such as kitchen and bathroom fans and clothes dryers), can cause spillage of flue gas and backdrafting from fuel-burning appliances. Sealed combustion units prevent this potential safety problem.

Most high-efficiency furnaces are designed as sealed combustion systems, and so are well suited to the tight construction of a modern energy-efficient house. Those that are not sealed typically have an induced draft that is powerful enough to overcome any house depressurization. Some standard-efficiency furnaces are also available as sealed combustion systems.

Non-Condensing Gas Boilers

Residential gas boilers sold in Canada today are required to have an AFUE rating of at least 80 percent. ENERGY STAR qualified boilers must have an AFUE rating of at least 85 percent. The following are some ways manufacturers have improved efficiency levels:

- Elimination of continuous pilot lights. Most boilers on the market today use some form of intermittent ignition device, usually electronic ignition.
- Improved insulation levels. Because boilers store more heat internally than warm air furnaces do, they are subject to greater heat losses, both out through their casing (sides) and up the chimney when they are not being fired. To reduce heat lost from casings, new boilers have much better insulation to keep the boiler water hot.
- Better draft control methods to reduce flue losses. Many boilers use draft hoods. The draft hood is located downstream of the boiler proper. It draws household air into the gas vent along with the flue gases. This stabilizes the airflow through the appliance, isolating the burner from outside pressure fluctuations. But it also continuously draws heat from the boiler and warm household air up the chimney. A vent damper is now usually installed downstream of the draft hood to close off the exhaust when the burner is not operating. When the gas burner turns off, the damper is closed automatically after a short period; before the burner lights again, the damper opens.

Other boilers that use aspirating gas burners have eliminated the need for a draft hood entirely by using a powered exhaust system, usually incorporating an induced draft fan. With no dilution air, high resistance to spillage during the on cycle, and minimal flow up the stack during the off cycle, these units tend to give superior performance to those using draft hoods and vent dampers.

Today, many gas boilers have replaced the naturally aspirating gas burner with a power burner. These use a fan on the burner to improve the combustion process and ensure the development and maintenance of an adequate draft. These burners, similar to ones used in advanced oil-fired equipment, tend to have a high-pressure restriction or even close off the combustion air passage when the burner is not operating. This minimizes off-cycle heat losses without requiring a flue damper. Such units minimize dilution air, or have sealed combustion, and have performance characteristics similar to or better than the aspirating burner with a powered exhaust system.

Condensing Gas Boilers

Condensing gas boilers employ either an aspirating burner with an induced draft fan, or a power burner, similar to the units described previously. However, they have an additional heat exchanger made of corrosion resistant materials (usually stainless steel) that extracts latent heat remaining in the combustion by-products by condensing the combustion products before they are exhausted. A chimney is not needed, reducing the cost of installation. Because the flue gas temperature is low, the gases are vented through a PVC or ABS plastic pipe out the side wall of the house.

A condensing boiler can have an AFUE rating of 90 percent or higher. But in practice, condensing boilers in hydronic (hot water) heating systems can have difficulty achieving this efficiency. For the condensing boiler's heat exchanger to extract all the potential latent heat effectively, the system has to run with the lowest possible return water temperatures, preferably not exceeding 45–50°C (113–122°F). Unfortunately, most radiator systems are designed to operate at significantly higher return water temperatures, which makes it difficult for the flue gas to condense. If the return water temperature is too high, actual operating efficiency may be only slightly higher than that of the better models of non-condensing boilers.

For a condensing boiler to achieve its potential, the heating system must be designed to return water to the boiler below the temperature of the condensing flue gas. Residential applications that normally operate at sufficiently low return water temperatures include

- radiant floor heating
- pool water heating

For radiator systems, it may be possible to lower the return water temperature with techniques such as

- using an outdoor reset controller as discussed in Chapter 2 to lower the supply water temperature in the "shoulder heating seasons" (late spring and early fall) to get efficiencies up during these periods, although this method is not effective in the peak heating season

- using radiator systems that have sufficient heat exchange surface to operate effectively at lower temperatures

- using the return water to preheat service water (as shown in Figure 11 on page 40) for combined space and water heating systems

For a condensing boiler to operate efficiently, a total systems approach to design is required.

Combined Space, Water Heating and Ventilating Systems

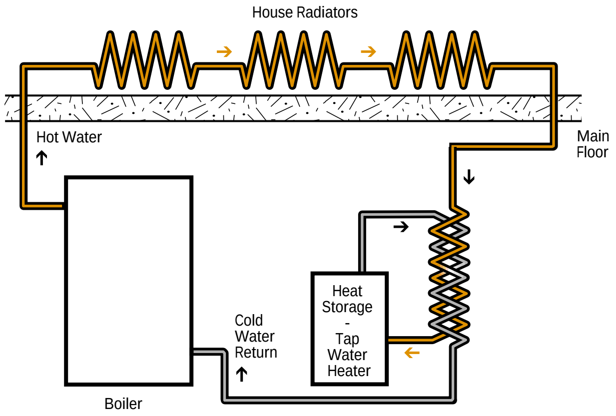
One way to potentially maximize efficiency and reduce costs is to integrate space and water heating in a single appliance.

In many cases, with new or renovated housing, improvements to the building envelope have reduced the space heating load to the point where it is sometimes difficult to justify the expense of a high-efficiency furnace solely to satisfy the heating load. To take advantage of the efficiency potential of condensing gas-fired systems, it makes sense to combine space heating with other functions, in particular, domestic water heating. Domestic hot water loads have remained fairly constant and have even increased over time, making it logical to put more effort into improving the efficiency of the hot water generator. Therefore, it would be natural to combine space and water heating systems.

An integrated, high-efficiency space and water condensing gas-fired heating system, using water from municipal mains as the driving mechanism to condense the flue gas, can have efficiencies of over 90 percent for both space and water heating. Space heating can be hydronic or forced air (through a fan coil). This type of system may entail a lower overall capital cost than individual appliances; it eliminates the need for multiple exhaust systems; and it maximizes efficient operation.

In practice, condensing gas-fired boilers in hydronic heating systems can have difficulty condensing because the return water temperature is above the dew point of the flue gases. By installing a water-to-water heat exchanger and storage tank for tap hot water upstream of the boiler, the return water temperature can be brought below the dew point, flue gases will condense and the efficiencies will be improved significantly. Such a high-efficiency combined system is shown in Figure 11.

Figure 11 Schematic of high-efficiency combined space and water heating system



Standard-efficiency gas-fired combined systems also exist, but their overall efficiency potential is lower than for condensing units. A standard-efficiency boiler coupled with an external storage tank is another efficient combined system.

Early "combo" systems used a conventional natural draft water heater and a fan coil to supply heat to the distribution air. These units suffer from low efficiency and limited life and have been supplanted by the optimized systems described above.

Condensation Problems

In the house

More efficient heating systems, combined with better draft-proofing and insulation, can result in less air infiltration, which, in turn, leads to excess humidity in the house.

Heavy condensation on the inside of windows and dampness or mould growth on walls or ceilings are indications of too much moisture. If not corrected, serious structural damage may occur; luckily, indoor condensation problems can be solved. Because most of the indoor humidity arises from regular household activities (such as showering and cooking), your first step should be to reduce the amount of mois-

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from these sources. You can do this by using lids on pots when cooking, keeping showers short and ensuring that your dryer vents to the outside. Even better, install exhaust fans in the bathroom and kitchen vented directly to the outside. You should also check the humidifier setting on your furnace if it is equipped with one. In fact, it is often not necessary to have a humidifier in an airtight house. Finally, as a last resort, you should talk to a contractor about installing a heat recovery ventilator (HRV) that will increase your home's ventilation and decrease humidity without wasting energy.

In the chimney

Condensation in the chimney is another possible problem. The lower flue temperature achieved by the improved efficiency of today's heating equipment has created the possibility of another problem – damage caused by condensation inside a chimney, particularly a masonry chimney located on an outside wall, where it is chilled by exposure to outside air. Look for a white, powdery efflorescence on the outside of the chimney, spalling or flaking of the bricks, crumbling mortar joints, wet patches on inside walls behind the chimney, pieces of tile at the bottom of the chimney, and water running out of the cleanout door or around the bottom of the chimney behind the furnace. The most common cause of all of these problems is condensation inside a cold chimney. Water vapour is produced when oil or natural gas is burned, but humid house air drawn into the chimney also contributes to problems.

Another cause of condensation is that the new, more efficient furnaces need smaller chimneys than the 200-mm^2 (8-sq.-in.) flue tile that has been standard for many years. Combustion gases, already cooled by the improved heat exchangers in the furnace, rise slowly in the cold, oversized flue and are sometimes cooled to the dew point of the water vapour they contain. The resulting condensation can then leak into the bricks and cause structural or water damage. If this is caught in time, there are simple remedies. Some solutions to these problems are described in Chapter 7.

Looking Ahead

Research and development is ongoing in the field of furnace efficiency. There have been recent developments in blower motors.

High-Efficiency Variable Speed Blower Motors

It is becoming a common design practice to run furnace blowers continuously at a low speed during the heating season, to improve both comfort level and furnace efficiency. In many parts of Canada, homeowners often install central air-conditioning systems that utilize the same furnace blower. These practices dramatically increase annual electrical consumption by the furnace, compared with the traditional demand-only mode of operation during the heating season. The standard type of alternating current (AC) motor used in most furnaces – the four-speed Permanent Split Capacitor (PSC) type – is not the most energy efficient, particularly when operated at low speeds. Some furnaces now available use high-efficiency variable speed brushless DC motors. A high-efficiency motor, when used continuously, uses less than one third of the electricity consumed by a standard motor. It will eventually pay for itself in reduced electrical bills.

The electrical savings from the high-efficiency fan-blower motor will otherwise contribute to satisfying some of the heating demand. Thus the gas savings from a furnace equipped with a high-efficiency motor will be offset somewhat by the extra heat that the furnace must supply. However, when central air conditioning is used, the high-efficiency fan-blower motor will provide additional savings since the heat from the inefficient motor no longer needs to be cooled.

4. Other Gas Heating Options

Several other gas heating options are available in addition to the forced-air systems described in Chapter 3.

Specialized Gas Heating Equipment

Installing a central natural-gas-heating system may not be practical or possible if your house is built on a concrete slab or if you live in a mobile home. Specialized gas heating equipment might be a good alternative. There are many kinds available, and you should consult your gas utility or a heating contractor for a detailed assessment. The following are some of the most common types.

Direct-Vent Wall Furnaces

Direct-vent wall furnaces are self-contained, sealed combustion heating appliances that draw in combustion air and discharge combustion products through a vent to the outside. They are permanently attached to the structure of a building, recreational vehicle or mobile home, and are not connected to ductwork. These units circulate heated air by gravity or with the help of a circulating fan. Units with a circulating fan yield higher efficiencies.

Wall furnaces are compact and less expensive than central furnaces. They come in a variety of heating capacities with efficiencies that range from that of a standard-efficiency unit with a pilot light to a high-efficiency unit with an electric ignition and induced draft. The AFUE can range from 70 to 80 percent, although generally, high-efficiency central furnaces are much more efficient.

Room Heaters

Room heaters are self-contained, free-standing heating appliances with heat outputs much lower than those of central furnaces. Often, they resemble the new free-standing wood stoves. They are not connected to ductwork, they heat only the space in which they are located, and most rooms require their own units. A vent pipe allows the combustion by-products to escape to the outdoors.

Heat is circulated by natural convection or with a circulating fan. Units are available with AFUE ratings between 60 and 82 percent.

A direct-vent, gas-fired baseboard heater has recently been developed; it resembles electric or new hydronic (hot water) baseboards. It allows the retrofit of existing electrically heated homes, without the need for a chimney or a central distribution system.

NATURAL GAS AND PROPANE FIREPLACES

Gas fireplaces are becoming popular, both for new homes and for replacement in existing dwellings. Most units are built-in, whereas others are free-standing and resemble a wood stove.

Gas fireplaces have the potential for reasonably efficient performance. However, the efficiency of models currently available on the market can range anywhere from 30 to 70 percent, when tested to the new Canadian standard (CSA P.4.1-02, "Testing Method for Measuring Annual Fireplace Efficiency"). If you are looking for a gas fireplace, ask for its CSA P.4.1-02 rating so you can properly compare different products.

ENERGUIDE RATING SYSTEM FOR GAS FIREPLACES

As of October 2003, an agreement between Natural Resources Canada and the Heating, Refrigeration and Air Conditioning Institute of Canada establishes an energy efficiency rating system for vented gas fireplaces. The EnerGuide rating system provides consumers with the assurance of a standardized method of testing, allowing them to accurately compare different makes and models. The testing provides a Fireplace Efficiency / FE rating based on products tested and certified to the Canadian Standards Association test standard P.4.1-02.

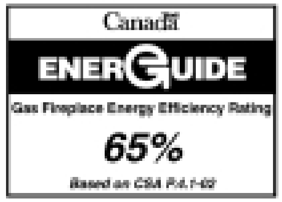
The standard assesses all gas fireplaces, whether they are decorative units or models used for space heating. It is an accurate measurement that reflects the overall operation of the fireplace, taking into account its use and performance throughout the entire heating season. The FE rating is expressed as a percentage; therefore, the higher the rating, the more efficient the unit.

In Canada, the FE rating is the only recognized measurement of the efficiency of vented gas fireplaces.

The EnerGuide Label for Gas Fireplaces

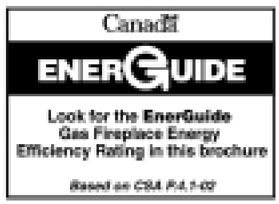
The EnerGuide Fireplace Efficiency rating will be found on manufacturers' product literature starting in the fall of 2003. The FE will be inserted in an easily identifiable EnerGuide label format and presented in one of two ways depending on whether the product literature lists only a single model or multiple models.

Figure 12 EnerGuide label for fireplaces (single model)



This EnerGuide label is found in product literature that features a single model. As noted in the rating system explanation above, the higher the percentage the more efficient the model.

Figure 13 EnerGuide label for fireplaces (multiple models)



This label is featured in product literature where multiple models with different FE ratings are shown. Each model number listed in the literature will identify the EnerGuide FE rating directly beside the model number.

Note the words "Based on CSA P.4.1-02" on both labels. This reference demonstrates that the FE rating is based on the testing method that all gas fireplaces sold in Canada must adhere to.

Energy Efficiency Consideration

If you are looking for a gas fireplace, consider the following points:

- Every make and model has an EnerGuide rating, not just the most efficient ones.
- Vented gas fireplaces can be attractive and still be energy efficient.
- The EnerGuide label provides a Fireplace Efficiency / FE number where the higher the number means the higher the efficiency.
- Higher-efficiency equipment uses less energy that results in energy savings. The actual saving depends upon location (both the regional climate and cost of fuel), the efficiency of the vented gas fireplace chosen and the efficiency of the house itself.
- Ensure you consider the particular application for the gas fireplace you are shopping for. Whether you are looking for a decorative appliance or a heating appliance, consider the right size appliance for the space. Are there supplemental ways to help move the heat to other areas of the home? Do you understand the merits of zone heating versus central heating?
- There are different ratings for "decorative" versus "heater" appliances.

For more information, talk to your product representative, or call toll-free to order your free copy of *All About Gas Fireplaces* at 1 800 387-2000 or visit Natural Resources Canada's Web site at **oee.nrcan.gc.ca/equipment**.

Web Version of EnerGuide Gas Fireplaces Directory

A Web version of the EnerGuide gas fireplaces directory will be available by fall 2004. The directory will provide a list of all models of vented gas fireplaces for sale in Canada and will enable you to compare the energy performance and operating costs of similar models.

CARBON MONOXIDE DETECTORS

Because modern houses are more airtight and have more powerful air-exhausting systems, there is a greater chance that combustion products – sometimes containing deadly carbon monoxide gas – will build up inside your house to potentially dangerous levels. A certified carbon monoxide detector located close to fuel-fired appliances (such as furnaces, fireplaces, space heaters, wood stoves and gas or propane refrigerators) will signal a potentially dangerous situation that must be corrected immediately.

Symptoms of low-level carbon monoxide poisoning are similar to those of the flu – headaches, lethargy and nausea. If your carbon monoxide detector goes off, leave your home immediately, call your gas distribution company and seek medical attention.

If you have a conventional wood-burning fireplace (which can often leak carbon monoxide) and plan to use it fairly often, install a carbon monoxide detector near the fireplace.

5. Comparing Annual Heating Costs

The combination of heating load, energy source and equipment efficiency determines the annual cost of heating.

Heating Costs When Upgrading Your Existing Gas Heating System

If you are heating with gas and are thinking of converting to a more efficient gas heating system, you may be interested in calculating the savings you could expect. Using Table 1 (on page 49) and the following formula will provide you with reasonably accurate figures. You need to know your annual fuel cost and the type of heating technology you are using. (Note: the published AFUE for propane-fired appliances is based on firing with natural gas. This rating should be adjusted in accordance with the footnotes to Table 1 to arrive at a more accurate rating for calculation purposes.)

Equation 1

$$\text{Annual \$ savings} = \frac{A - B}{A} \times C$$

Where A = Seasonal efficiency of the proposed system
B = Seasonal efficiency of the existing system
C = Present annual fuel cost for space heating

Example: How much would you save by changing from a conventional gas furnace to a high-efficiency gas furnace at 96 percent efficiency if your present annual gas cost for space heating is $800?

The seasonal efficiency of the new condensing furnace is 96 percent, and the efficiency of your present gas furnace is 60 percent. Hence, A = 96 percent, B = 60 percent and C = $800.

$$\text{Annual \$ savings} = \frac{96 - 60}{96} \times 800$$

$$= \$300$$

Thus, you would save $300 a year in energy costs by installing a high-efficiency gas furnace, and you would also eliminate the need for a chimney.

TABLE 1
Gas Heating Appliances – Features and Efficiency Ranges

Type	Features	Seasonal Efficiency (AFUE) (%)
Conventional furnace[1]	▪ chimney ▪ draft hood ▪ with continuously lit pilot light ▪ with electronic ignition and vent damper	60 62–67
Conventional boiler[1]	▪ chimney ▪ draft hood ▪ with continuously lit pilot light ▪ with electronic ignition and vent damper	55–65 60–70
Standard-efficiency furnace[1]	▪ chimney or side wall vent ▪ draft hood ▪ electric ignition ▪ powered exhaust	78–84
Standard-efficiency boiler[1]	▪ similar to mid-efficiency furnace	80–88
Condensing furnace[2]	▪ no chimney ▪ no draft hood ▪ electric ignition ▪ multi-stage heat exchanger ▪ condenses water vapour from flue gases ▪ PVC or ABS flue pipe to side wall	90–97
Condensing boiler[2,3]	▪ similar to condensing furnace	89–99[3]
Conversion burners for oil equipment[1]	▪ chimney ▪ pilot light or electric ignition ▪ special barometric damper or draft hood	63–68
Direct-vent wall furnace[1]	▪ vent ▪ sealed combustion ▪ pilot light or electric ignition	70–82
Room heaters[1]	▪ vent ▪ pilot light or electric ignition ▪ draft hood or sealed combustion	60–82

[1] *If this appliance is fired with propane rather than natural gas, add 2 percent to the efficiency.*

[2] *If a condensing appliance is fired with propane rather than natural gas, subtract 2 percent from the efficiency.*

[3] *See pages 37–38 for conditions affecting condensing boiler efficiency.*

Heating Costs With Different Energy Sources

You may be interested in calculating the cost of heating with gas compared with the cost of heating with other energy sources, such as electricity, propane, oil or wood. If this is the case, you can use the following procedure (Steps 1 to 4). You need to find out the cost of the energy sources you want to compare and the types of heating technologies you might want to use.

Step 1. Determine the Price of Energy Sources in Your Area

Call your local fuel and electricity suppliers to find out the cost of energy sources in your area. This should be the total cost delivered to your home, and it should include any basic cost that some suppliers might charge, along with necessary rentals, such as a propane tank. Be sure to get the prices for the energy sources in the same units as shown in Table 2. Write the costs in the spaces provided. If your local natural gas price is given in gigajoules (GJ), you can convert it to cubic metres (m^3) by multiplying the price per gigajoule by 0.0375. For example,

$$\$5.17/\text{GJ} \times 0.0375 = \$0.19/\text{m}^3$$

TABLE 2
Energy Content and Local Price of Various Energy Sources

Energy Source	Energy Content	Local Price
Natural Gas	37.5 MJ/m^3	$0. __________ /$m^3$
Propane	25.3 MJ/L	$0. __________ /L
Oil	38.2 MJ/L	$0. __________ /L
Electricity	3.6 MJ/kWh	$0. __________ /kWh
Hardwood[1]	30 600 MJ/cord	$ __________ /cord
Softwood[1]	18 700 MJ/cord	$ __________ /cord
Wood Pellets	19 800 MJ/tonne	$ __________ /tonne

Conversion 1000 MJ = 1 gigajoule (GJ)

[1] The figures provided for wood are for a full cord, measuring 1.2 m x 1.2 m x 2.4 m (4 ft. x 4 ft. x 8 ft.).

Step 2. Select the Type of Heating Appliance

Choose the type of equipment you want to compare from the list of appliance types in Table 3 on page 52. Note the efficiency figures in the column titled "Seasonal Efficiency." By using these figures, you can calculate the savings you can achieve by upgrading an older system to a newer, more energy-efficient one or by choosing a higher-efficiency appliance that uses an alternative energy source.

Step 3. Determine Your Home's Annual Heating Load

If you know your bill for space heating and the unit cost of your energy source, you can determine your annual heating load in gigajoules from the following equation:

Equation 2

$$\text{Annual Heating Load} = \frac{\text{Heating Bill}}{100\ 000} \times \frac{\text{Seasonal Efficiency}}{\text{Energy Cost/Unit}} \times \text{Energy Content}$$

For example, you have been able to determine that your annual bill for space heating with natural gas is $687, gas costs $0.22/$m^3$, and you have an old conventional gas furnace with a seasonal efficiency of 60 percent (see Table 3).

The energy content of natural gas is 37.5 MJ/m^3 (see Table 2).

$$\text{Annual Heating Load} = \left(\frac{687}{100\ 000}\right) \times \left(\frac{60}{0.22}\right) \times 37.5 = 70\ \text{GJ}$$

If your bills also include tap water heating and even equipment rentals, you can still calculate your annual heating load, but it will require a little more care and calculation to separate your heating-only portion.

If you cannot get your heating bills, you can estimate your annual heating load in gigajoules from Table 4 on page 53 by selecting the house type and location that is closest to you.

TABLE 3

Typical Heating System Efficiencies and Energy Savings

Energy Source	Technology	Seasonal Efficiency (AFUE) %	Energy Savings (% of Base[1])
Natural Gas	▪ Conventional furnace/ boiler	60	Base
	▪ Standard-efficiency furnace	78–84	23–28
	▪ Standard-efficiency boiler	80–88	25–32
	▪ Condensing furnace	90–97	33–38
	▪ Condensing boiler	89–99	33–39
	▪ Integrated space/ tap water condensing	90–96	33–38 space 44–48 water
Propane	▪ Conventional furnace/ boiler	62	Base
	▪ Standard-efficiency furnace	79–85	21–27
	▪ Standard-efficiency boiler	82–90	24–31
	▪ Condensing furnace	88–95	29–34
	▪ Condensing boiler	87–97	29–36
Oil	▪ Cast-iron head burner (old furnace)	60	Base
	▪ Flame-retention head replacement burner	70–78	14–23
	▪ High-static replacement burner	74–82	19–27
	▪ New standard model	78–86	23–30
	▪ Standard-efficiency	83–89	28–33
	▪ Integrated space/tap water standard-efficiency	83–89	28–33 space 40–44 water
Electricity	▪ Electric baseboards	100	N/A
	▪ Electric furnace or boiler	100	
	▪ Air-source heat pump	1.7 COP[2]	
	▪ Earth-energy system (ground-source heat pump)	2.6 COP[2]	
Wood	▪ Central furnace	45–55	N/A
	▪ Conventional stove (properly located)	55–70	
	▪ "High-tech" stove[3] (properly located)	70–80	
	▪ Advanced combustion fireplace[3]	50–70	
	▪ Pellet stove	55–80	

[1] *Base represents the energy consumed by a conventional furnace.*

[2] *COP = Coefficient of Performance, a measure of the heat delivered by a heat pump over the heating season per unit of electricity consumed.*

[3] *CSA B415 or EPA Phase II tested.*

TABLE 4

Typical Annual Heating Loads in Gigajoules (GJ) for Various Housing Types in Canadian Cities

City	Old Detached	New Detached	New Semi-Detached	New Town-house
Victoria	85	60	45	30
Prince George	150	110	80	60
Calgary	120	90	65	50
Edmonton	130	95	70	55
Fort McMurray / Prince Albert	140	105	80	60
Regina / Saskatoon / Winnipeg	130	90	70	50
Whitehorse	155	115	85	60
Yellowknife	195	145	110	80
Thunder Bay	130	95	70	55
Sudbury	120	90	65	50
Ottawa	110	75	55	40
Toronto	95	65	45	35
Windsor	80	55	40	30
Montréal	110	80	65	45
Québec	115	85	65	50
Chicoutimi	125	90	70	55
Saint John	105	75	60	45
Edmundston	120	90	65	50
Charlottetown	110	80	60	45
Halifax	100	75	55	40
St. John's	120	85	60	45

Note: ***"New"*** *means houses built in 1990 or later, and* ***"old"*** *means houses built before 1990. Due to construction practices, weatherizing and reinsulating (which can be different from house to house), these figures are meant to be used only as guidelines; they should not substitute for an accurate determination of heating requirements, as discussed in Chapter 6.*

Assumptions:
Old detached – approximately 186 m^2 (2000 sq. ft.)
New detached – approximately 186 m^2 (2000 sq. ft.)
New semi-detached – approximately 139 m^2 (1500 sq. ft.)
New townhouse – inside unit, approximately 93 m^2 (1000 sq. ft.)

Step 4. Use the Formula

The annual heating cost is calculated as follows:

Equation 3

$$\frac{\text{Energy Cost/Unit}}{\text{Energy Content}} \times \frac{\text{Heating Load}}{\text{Seasonal Efficiency}} \times 100\,000 = \text{Heating Cost (\$)}$$

1. Enter the cost per unit of energy and divide it by the energy content of the energy source – both numbers come from Table 2 on page 50.
2. Select the heating load for your type of housing and location from Table 4 on page 53, and divide it by the seasonal efficiency of the proposed heating system from Table 3 on page 52.
3. Multiply the results of these two calculations, then multiply that result by 100 000.

The result should give you an approximate heating cost for your house. If you know your actual heating costs and the type of heating system you have, you can modify the heating load originally taken from Table 4 to suit your specific house.

Sample Calculation: You have an old detached home in Edmundston, and you would like to find out what the annual heating cost would be with a high-efficiency condensing natural gas furnace at 96 percent efficiency with gas costing $\$0.18/m^3$. The house heating load is 120 GJ (see Table 4), and the energy content is 37.5 MJ/m^3 (see Table 3).

Annual cost of natural gas heating:

$$\frac{\$0.18}{37.5} \times \frac{120}{96} \times 100\,000 = \$600$$

If you would like to compare this heating cost with that of other types of heating systems or energy sources, replace the numbers in the formula with the appropriate ones for your comparison using Tables 2 and 3.

6. The Mechanics of Buying, Installing or Upgrading a System

Buying Your Equipment

You cannot shop for a furnace the way you shop for a camera or a pair of shoes. There are not many "furnace stores" where makes and models can be examined, compared and priced. To get first-hand information on the different makes and models available, you will have to contact a number of heating firms. Ask them for the manufacturers' illustrated sales literature on the furnaces they sell and install. You should also contact your local gas utility or a local contractor for assistance and information. Your utility can usually provide information on the cost of purchasing, renting or installing furnaces and the estimated seasonal heating costs of the type of equipment you plan to use.

If you have decided on a particular type of furnace, read the literature carefully to find out if it describes the features you are looking for – such as a condensing heat exchanger and a high-efficiency brushless DC motor for the circulating fan. Also, look for the EnerGuide rating. This is the seasonal efficiency (AFUE) rating, not just the steady-state efficiency. Make sure you distinguish between the two types of ratings. For more information on the EnerGuide rating system for gas and propane furnaces, refer to page 16.

Ask your contractor to calculate the heating requirement of your house. The furnace size should preferably be determined by a heat loss calculation using the method prescribed in CSA F280, "Determining the Required Capacity of Residential Space Heating and Cooling Appliances." This method requires a thorough measurement and examination of your house to determine size, insulation levels and the degree to which the house envelope is airtight. Alternatively, the contractor may arrive at a reasonably good estimate using calculations based on the fuel consumption history of your present furnace over a known period, and the known climatic history for your location over the same period.

Before settling on the size of furnace, you should ask the contractor to provide you with the calculation results, including a summary of the general design assumptions, and a statement of the calculation method(s) used. A calculation based simply on the floor area of the home, or on replacing the furnace with one of "equivalent" size, is not adequate in most cases. If the contractor does not show any interest in either a detailed assessment of the house or a review of your past heating bills, then his or her calculation of your furnace size is likely to be not much more than a "guesstimate."

It is important to hire a contractor who will install your equipment properly to ensure that it will operate efficiently. Check with your local gas utility or provincial/territorial gas regulatory office to find out how to get in touch with a fully qualified, registered or licensed contractor. If your neighbours have had similar work done recently, ask them how satisfied they were with their contractor.

Before you decide what to buy, obtain firm, written bids from several companies on the cost of buying and installing a complete new unit, along with any other fittings and adjustments required, including changes to any ductwork or piping and a final balancing of the heat supply to the house.

Home Energy Audit – EnerGuide for Houses

Before replacing your heating system, you should consider having a home energy audit carried out by a qualified EnerGuide for Houses advisor. The advisor will provide you with a thorough whole-house energy evaluation and analysis, including

- a guided tour of your house to point out areas of air leakage
- an easy-to-understand report on your home's energy performance
- a home improvement plan that will show you how to lower your energy costs
- an EnerGuide for Houses rating and label so you can compare your home with others across Canada

By following up on the recommendations of such an audit, you may be able to reduce the size of furnace required. For more information on EnerGuide for Houses, see page 69.

Checklist for Having a Natural Gas Heating System Installed

You should get several estimates on the work to be done. When you are comparing these estimates, cost will be an important factor, but there are other considerations involved. Some contractors may be better at explaining what has to be done. Some may use higher-quality components, and others may schedule the work at your convenience.

Estimates should include the following items:

- the total cost for all necessary work
- an itemized list of all material and labour costs in the bid, including those for the
  - alteration or improvement of existing heat distribution ducts
  - installation of furnace and gas supply piping and ductwork
  - installation of water heater and vent (where applicable)
  - installation of chimney liner and any attendant masonry work
  - installation of additional equipment, such as gas appliances, humidifiers, air cleaners or air conditioners
- a statement describing how much existing equipment will be used in the new system
- a rough diagram showing the layout of ductwork or water pipes and the location of supply piping and heating equipment
- a statement that clearly defines who is responsible for
  - all necessary permits and payment of related fees
  - on-site inspections by the utility
  - scheduling of all other required work by the utility, such as supply pipe installation and hookup

– removal of any existing equipment that will not be used with the new system
– all related costs, such as subcontracts with tradespeople

- a clear estimate of when the work will be completed
- a warranty for materials and labour
- a schedule and method of payment

Ask contractors for 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. Your local Chamber of Commerce or Board of Trade may also be able to provide information.

The contractor installing the heating system may be able to install additional gas-fired appliances for a favourable price at the same time as the heating system is set up. This work can often be undertaken without duplication of the inspections, permits and labour associated with such jobs.

Some utilities or dealers will also offer rental of heating equipment or lease-to-purchase plans. You may find it advantageous to participate in one of these plans rather than to purchase the equipment outright.

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 heating system.

BILLING

Billing for natural gas service is handled in different ways, with two of the most common ones being equal billing and standard billing.

Equal billing. Your gas bill is paid in regular, equal instalments, based on an estimate of your annual total consumption. Periodic adjustments are made to balance your monthly charge against your actual yearly household consumption.

Standard billing. Gas utility bills are paid on a monthly basis for gas consumed during that month. Your gas meter is read periodically and bills are adjusted accordingly.

There may be a minimum monthly charge for natural gas service, and a small monthly payment may be required in the summer months even if gas is not used. This will not be a noticeable factor in homes equipped with gas water heaters or other gas appliances. In some areas, there is an extra fixed administrative charge in addition to the minimum monthly billing.

To determine your actual gas cost, you may have to calculate the sum of the charge for distribution and the charge for gas itself.

7. Maintenance

Servicing Maintenance

Many gas utilities offer a maintenance service (often through contractors) that includes an annual furnace inspection, cleaning and adjustment, if necessary. This type of annual checkup is highly recommended for both efficiency and safety.

Some of the other tasks that should be performed by a serviceperson during regular maintenance are as follows:

- inspecting the inside and outside of the vent pipe and stack
- checking the condition of the furnace heat exchanger
- checking the safety controls for the exhaust system
- checking the other safety controls
- checking the condition of all fan wheels – circulating, exhaust (induced draft fan) or forced (burner) – and cleaning them, if necessary
- cleaning or replacing the air filter for forced-air systems

Separately, many gas utilities or dealers may also offer a parts-replacement plan, which, for an annual fee, covers repair, adjustment or replacement of controls, motors and parts. As well, they will alter appliances, equipment or piping and turn on gas service if the pilot light has been shut off.

Furthermore, most utilities offer the following services at no charge: emergency services (such as investigating suspected gas leaks or carbon monoxide spillage); estimates for repairs, replacements and alterations; verifying gas meter operation; and finding the location of buried gas lines.

If the furnace's pilot light has been shut off during the summer to conserve fuel, relighting should be done carefully and in accordance with the manufacturer's instructions, which are usually on a metal plate near the furnace burner or gas controls. Shutting off the pilot light for the summer is cost-effective only if you plan to shut it off and relight it yourself. If it fails to relight, you should contact the gas utility and have the relighting done by a qualified serviceperson. A fee is normally charged for this service. While the serviceperson is in your home, ask for instructions on properly relighting the pilot light. You could also ask for a brief inspection of the equipment.

Owner Maintenance

There are a number of maintenance tasks you can do yourself to keep your system working well. But even if you do these properly and regularly, **you should still have your system serviced annually by an expert heating contractor or gas utility.**

Routine Chimney Care

Other than the modern side wall venting furnaces and boilers, gas furnaces and boilers must be vented with one of the following:

- a double-walled, prefabricated metal B-vent with an aluminum lining
- a properly sized masonry chimney lined with a clay flue tile
- a masonry chimney lined either with a B-vent or an approved stainless steel liner

Although a gas furnace vent (chimney) rarely, if ever, needs to be cleaned, it should be checked occasionally for signs of deterioration due to condensation or corrosion. You can check it simply by inserting a mirror in the cleanout opening at the bottom of the chimney on a bright day.

Look for a broken or flaking flue liner, or rusting or bending of the metal liner. Water streaks from the cleanout door or the base vent T can also indicate chimney condensation and other potential problems.

Take a look at the outside of the chimney as well. White or yellow efflorescence on masonry chimneys or deteriorating or flaking brick or mortar can indicate condensation problems in a masonry chimney. Don't forget to look at the outside of metal chimneys as well. Rust marks could indicate the onset of serious corrosion.

The advantage of high-efficiency condensing furnaces is that they eliminate the need for a chimney and are thus vented out the side wall of the house through an effectively non-destructible PVC or ABS pipe. Make sure that the pipe always slopes upwards from the appliance to the outside and ensure that the outside vent terminal is kept free from obstructions, including ice formation.

Certain types of gas-fired systems have special needs that may require your attention. Check your owner's manual or discuss this with your installer or serviceperson.

OWNER MAINTENANCE OF FORCED-AIR HEATING SYSTEMS

Cleaning or Changing the Air Filter

IMPORTANT! Turn off the power to the furnace before opening the furnace access panel to check the filter or fan.

Few homeowners give the air filter in a furnace the attention it needs. It should be cleaned or replaced once a month. You can get permanent filters made of aluminum or plastic mesh that can be washed in a laundry tub, but these are not as fine as glass-fibre filters and do not trap as much dirt.

If you have added an electrostatic air filter to your furnace, you do not need a standard filter as well. Remember that the electrostatic filters also need to be cleaned regularly. Check your owner's manual for instructions.

Fan Care

Except for superficial vacuuming, there is no maintenance that a homeowner can perform on a direct-drive furnace fan with an internal motor. On belt-driven fans, some motors have small oiling cups over the bearings on each end of the motor, whereas others are maintenance-free. The ones requiring oiling should be given a few drops of oil once or twice during the heating season and again in the summer, if you use your fan for ventilation or air conditioning. (Check your owner's manual or ask your furnace serviceperson about the type and quantity of oil to use.)

Also, check the tension of the fan belt by pressing it firmly in the centre with your thumb. You should be able to depress it about 20 mm (3/4 in.) but no more than 25 mm (1 in.). The tension of the fan belt can be adjusted by loosening the bolts on the motor mount and moving it forward or backward. Make sure the fan and motor pulleys remain perfectly aligned. This job is best done by a qualified serviceperson.

Care of the Distribution System

Remove obstructions from ducts, warm air registers and cold air returns so that air can move freely around the system. Use a special, water-based duct mastic to seal cracks at duct joints, as described on page 23. At the same time, consider insulating as much of your warm air ducts as you can easily access.

OWNER MAINTENANCE OF HYDRONIC (HOT WATER) SYSTEMS

Here are a few things you can do with a hydronic (hot water) heating system.

- Insulate hot water pipes.
- Once or twice a year, bleed air bubbles out of radiators so that they can fill with water.
- Vacuum the radiators.
- Check to see that the level of water in the expansion tank is below flood level.
- Oil the circulating pump (according to the manufacturer's instructions).
- Allow air to flow freely around radiators: make sure that they are not covered by curtains or by ventilated wood panelling, and try to ensure that they are not directly behind furniture so that the heat generated can get into the rest of the room.

8. Gas Water Heaters and Other Equipment

If natural gas is being supplied to your home for space heating purposes, you also have the option to use gas for other household activities.

Most Canadian homes heated with natural gas also use gas for their domestic hot water supply. Domestic water heaters are the second largest individual users of energy in most Canadian houses, after the space heating system. Depending upon the house type and on the number and lifestyles of the inhabitants, hot water consumption may account for more than 20 percent of total annual energy consumption.

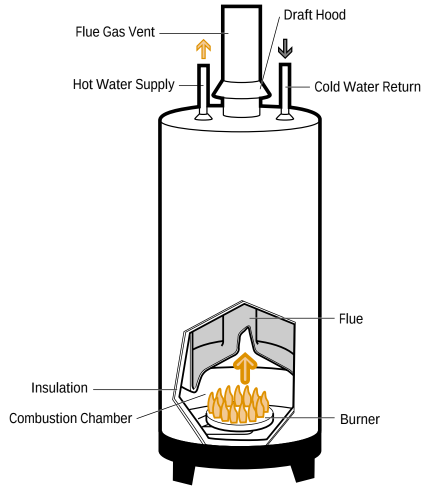
When compared with electricity, one of the principal advantages of a gas-fired water heater is its cheaper operating cost. The overall efficiency of a gas-fired water heater is measured by the energy factor, which takes into account standby losses, combustion system efficiency and recovery efficiency. Most direct heat loss from water heaters is made up of losses by air and heat flow up the flue, both when the burner is firing and when it is not; by heat conducted through the tank walls and base; and by hot water convection losses through the hot and cold water feed pipes.

Water Heater Technologies

Conventional Gas Water Heaters

Gas-fired residential water heaters typically consist of a steel cylinder storage tank. Capacities of 30, 40 and 50 gallons (114, 151 and 189 litres, respectively) are most common. They also have one or two inches (2.5 to 5.0 cm) of insulation placed between the tank lining and the outer jacket, a cold water supply inlet and a hot water outlet pipe, a draft hood, and a flue, as shown in Figure 14. The gas burner is located inside a combustion chamber at the bottom of the storage tank and has a continuously burning pilot light that is used to ignite the main burner. Air for combustion is brought in through air openings located at the bottom of the combustion chamber.

Figure 14 Conventional gas-fired water heater



A combined combustion thermostat and gas valve unit controls both the temperature of the water in the tank and the gas flow. The flue passes vertically through the centre of the tank cylinder to the outside. Its main job is to conduct the combustion products from the combustion chamber to the vent system. Approximately one-half to two-thirds of the standby losses are through the flue. Overall seasonal efficiencies are around 55 to 60 percent.

Increased Efficiency Gas Water Heaters

If you are in the market for a new gas water heater, increased tank insulation and heat traps are options that are available as part of the original equipment. There are also gas-fired boilers on the market that provide a continuous supply of domestic hot water. The boiler circulates cold water through a finned copper coil immersed in the boiler water. It is set to maintain the supply of hot water during the off-heating season. New designs for water heaters, such as the following, offer increased efficiency and performance.

Power-Vented Gas Water Heaters

To make water heaters compatible with the new standard- and high-efficiency furnaces, manufacturers have developed new free-standing gas-fired water heaters with induced draft fans that can push the exhaust gases either up the chimney vent or out the side wall of the house. Most of these units retain the draft hood with its dilution air requirement and have a continuous pilot light. Overall efficiencies are not much different from those of conventional water heaters.

Direct-Vent Gas Water Heaters

Direct-vent water heaters, also referred to as "sealed combustion" water heaters, draw combustion air from outside the building, rather than from the room, directly into the combustion chamber. Exhaust gases are vented, with the aid of a blower, to the outside. Efficiency is improved by reducing off-cycle losses. A direct-vent water heater offers energy savings of around 20 percent.

High-Efficiency Condensing Gas Water Heaters

Gas water heaters that are more efficient than before are appearing on the Canadian market. An additional heat exchanger uses the incoming cold water to cool the heat-exchange surface areas to the condensation point of the flue gases. The condensate is either collected for a later neutralizing treatment or sent down the floor drain to the sewer system. Corrosion-resistant materials must be used for the condensing part of the heat-exchange surface. These materials are more expensive than those used in conventional water heaters. Because flue gases are cooled, they can be vented through a side-wall plastic PVC or ABS vent, which is a cheaper option than a central corrosion-resistant vent. Such a unit has the potential for efficiencies above 90 percent.

Note that gas water heaters are covered by federal and provincial/territorial energy efficiency standards.

Options for improving the efficiency of the domestic hot water system by selecting and properly installing more efficient equipment are discussed below. In the past, tap water was usually set at 60°C (140°F). Today, primarily due to fears of scalding small children, the set temperature is often somewhat lower.

Reducing Energy Losses

There are three basic types of gas-fired tap water heating systems: conventional water heaters that heat the water directly in a tank; instantaneous heaters without a tank that heat the water only when it is being used; and systems that heat the water in conjunction with another energy use, usually for space heating. For the latter, it can be in the form of a "tankless coil" inside the boiler or a storage tank tied to the boiler through an efficient water-to-water heat exchanger.

The operating efficiency of a domestic hot water system can be improved significantly by carefully designing the system. Selecting equipment that generates the hot water more efficiently reduces stack and standby losses. Modifying an existing system, including piping modifications, can also reduce some of the standby losses.

Reducing Standby Losses

The term "standby loss" refers to heat lost from the water in a domestic water heater and its distribution system to the surrounding air. It is a function of the temperature difference between the water and the surrounding air, the surface area of the tank, and the amount of insulation encasing the tank.

You should consider the following options to reduce standby losses.

- Insulate the tank with an approved insulating blanket. **It is extremely important not to insulate over any controls or obstruct the vent connections or combustion air openings. Furthermore, the insulation should not come in contact with the vent connector.**
- Install a heat trap above the water heater. A heat trap is a simple piping arrangement that prevents hot water from rising in the pipes, thereby minimizing the potential for this loss.

- Insulate the hot water pipes to reduce heat loss from the pipes themselves. Pipe insulation is available in a variety of materials and thicknesses, with easy application to most hot water pipes. Use insulation with an RSI (insulation value) of at least 0.35 (R-2) over as much of the pipe as you can easily access.

Before carrying out any of the steps listed above, check with your local installer or gas utility to ensure that you will not compromise the safety or operation of the appliance.

Other Natural Gas Equipment in the Home

If you have chosen natural gas as your home heating fuel, you should consider other uses for the natural gas that is piped into your home. Examples include switching to a gas range in the kitchen or to a gas clothes dryer. Even though you may need to spend more money initially for these appliances, these changes will probably save you money in the long run because gas appliances cost less to run than their electric counterparts.

Many people enjoy using gas barbecues in the summer months. In a relatively recent development, a natural gas line can be brought to the backyard, where quick-connect fittings allow you to connect the gas line directly to a gas barbecue. A new barbecue running on natural gas costs about $20 to $40 more to purchase than a conventional propane barbecue. Hookup charges will vary by region. The costs of natural gas for a barbecue will be considerably less than the cost of propane refills for your tank. However, it is not possible to retrofit your old propane barbecue to run on natural gas.

9. Need More Information?

Order Free Publications From the OEE

The Office of Energy Efficiency (OEE) of Natural Resources Canada offers many publications that will help you understand home heating systems, home energy use and transportation efficiency. 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.

EnerGuide for Renovating Your Home

Keeping the Heat In is a guide to all aspects of home insulation and draftproofing. Whether you plan to do it yourself or hire a contractor, this 134-page book can help make it easier. Fact sheets are also available on air-leakage control, improving window energy efficiency and moisture problems. Consider getting an expert, unbiased evaluation from an EnerGuide for Houses advisor before you renovate. Our telephone operators can connect you with an advisor in your local area.

EnerGuide for Home Heating and Cooling

If you are interested in a particular energy source, the OEE has booklets on heating with electricity, gas, oil, heat pumps and wood. Other publications are available on heat recovery ventilators, wood fireplaces, gas fireplaces, air conditioning your home and comparing home heating systems.

EnerGuide for Choosing the Most Energy-Efficient Products

When shopping for household appliances, office equipment, lighting products and windows and doors, consult the OEE's series of Consumer's Guides. They will help you know what to look for when it comes to energy efficiency.

The EnerGuide label, which is affixed to all new major electrical household appliances and room air conditioners, helps you compare the energy ratings of all models sold in Canada. EnerGuide ratings are also listed in the OEE's annual directories of major electrical household appliances and room air conditioners.

Every New House Should Be This Good

R-2000 homes use about 30 percent less energy than conventionally built new homes, and they are one of the most energy-efficient new homes in Canada today. Homes built to the R-2000 Standard offer exceptional comfort and superior indoor air quality through the use of high-efficiency heating systems, high levels of insulation, state-of-the-art building techniques and whole-house ventilation systems that provide continuous fresh air to all rooms. R-2000 homes are quality assured by the Government of Canada through an independent R-2000 inspection process.

Buying, Driving and Maintaining Your Car

For information on vehicle fuel consumption, look for the EnerGuide label that appears on every new automobile, van and light-duty truck for sale in Canada. It helps you compare different vehicles' city and highway fuel consumption ratings and estimated annual fuel costs. You can also check the OEE's *Fuel Consumption Guide*, produced annually, which provides the same information for all vehicles. The OEE's EnerGuide for Vehicles Awards also recognize the vehicles with the lowest fuel consumption in different categories.

Also available is the OEE's *Car Economy Calculator*, a fuel log that helps you calculate your fuel consumption and savings.

The OEE's *Auto$mart Guide* provides detailed fuel efficiency information and offers tips on purchasing, operating and maintaining personal vehicles.

To receive any of these free publications, please write or call

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Office of Energy Efficiency
Natural Resources Canada
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Please allow three weeks for delivery.

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Leading Canadians to Energy Efficiency at Home, at Work and on the Road

The Office of Energy Efficiency of Natural Resources Canada strengthens and expands Canada's commitment to energy efficiency in order to help address the challenges of climate change.

Canada