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Heating with Gas

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Heating with Gas

Produced by
Natural Resources Canada's Office of Energy Efficiency

EnerGuide

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

ENERGY STAR®

Natural Resources Canada's Office of Energy Efficiency promotes the international ENERGY STAR symbol in Canada and monitors its use. Major manufacturers and retailers of energy-efficient products, utilities and energy retailers, and interest groups from Australia to Europe recognize the benefits of ENERGY STAR to consumers and have joined in promoting the symbol.

ENERGY STAR is the international symbol of premium energy efficiency. Products that display the ENERGY STAR symbol have been tested according to prescribed procedures and have been found to meet or exceed higher energy efficiency levels without compromising performance.

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Introduction

Approximately 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 is choosing, changing or upgrading your heating system. A smart decision about heating can significantly reduce the cost of running your home and make your home more comfortable.

You will be using your new or improved heating system for a long time, so it is worth taking the time now to investigate your options, to ensure that you make the best choice for your situation.

A wide range of efficient equipment is available, and comparing options can be rather complex. This document will help you make the right decision, whether you are selecting a system for a new home, replacing a system in an existing home or upgrading your present system.

Before proceeding, familiarize yourself with basic concepts to help you understand your options.

Heating concepts

Energy efficiency is a measure of how much of the energy contained in a fuel is transformed into heat. All fuel-burning systems (natural gas, oil, propane, wood) lose heat because of transient operation (cycling on and off), cold start-up, incomplete combustion of the fuel, heat lost in combustion gases and warm house air drawn up the chimney.

Steady-state efficiency measures the efficiency the heating system achieves after it has been running long enough to reach its peak-level operating temperature. This is an important standardized measurement that is used for setting up the system. However, that level of efficiency will not be achieved in actual use over the heating season.

Heating concepts (continued)

Seasonal efficiency takes into consideration normal operating losses and the fact that most heating systems rarely run long enough to reach their steady-state efficiency, particularly during milder weather at the beginning and end of the heating season.

The **Annual Fuel Utilization Efficiency (AFUE)** is the metric used to express seasonal efficiency.

If you use natural gas or propane for heating or are considering doing so, 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 titled Gas heating terms presents basic terminology.

Gas heating terms

Measuring up
The heating capacity of appliances is measured in **kilowatts (kW)**, **British thermal units per hour (Btu/h)** or **megajoules per hour (MJ/h)**.

1 kW = 3413 Btu/h = 3.6 MJ/h

Annual heating loads and energy consumption are measured in kilowatt hours (kWh), British thermal units or megajoules.

1 kWh = 3413 Btu = 3.6 MJ

The gas industry commonly rates heating appliances in Btu/h, but newer equipment may also be labelled with the equivalent rating in kW. The capacity of most home heating appliances is between 40 000 and 90 000 Btu/h (12 to 26 kW). Smaller and larger systems are available.

Gas heating terms (continued)

Natural gas
Consumption of natural gas is measured in **cubic metres (m^3)** or **cubic feet (cu. ft.)**. This is the unit that your gas meter registers. If your utility bills use different units than those on your meter, you can convert the units:

- multiply cubic metres by 35.3 to get cubic feet
- multiply cubic feet by 0.028 to get cubic metres

One cubic metre of natural gas contains approximately 37.5 MJ (35 500 Btu/m^3) of energy.

Propane
Consumption of propane is usually measured in **litres (L)**. One litre of propane contains approximately 25.3 MJ (91 000 Btu/US gallon) of energy.

In general, the same technologies and comments apply to propane as to natural gas, with small differences in system efficiencies. Propane has a lower hydrogen content. Consequently, less energy is contained in water vapour in a propane system than in a natural gas system. The lower hydrogen content in propane makes it a bit more difficult to start condensing the combustion products.

Certification and standards
All gas-fired appliances sold in Canada must conform to safety standards established by the Canadian Standards Association (CSA). To prove compliance, they must 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. Ensure the equipment you buy has a certification label from one of these agencies.

Gas-fired furnaces and boilers must meet the efficiency levels prescribed in the federal *Energy Efficiency Regulations* (the Regulations). (See the Energy efficiency standards section in Chapter 1 for more information.)

The efficiency of your heating system can be improved in many ways. You can do some improvements yourself but others must be performed only by a licensed serviceperson, a qualified heating contractor or an electrician (for electric components). All improvements usually pay for themselves within a reasonable time. When you are thinking about your heating system, remember to also consider your water heater.

1 Five-step decision-making process for home heating

Improving or modifying your home heating system can be financially and environmentally beneficial. But because every household has its own unique heating requirements and options, it is important to understand which options are both available and provide the optimal benefits for your situation. In this chapter, the five steps in the decision-making process for home heating are described in detail, and they will help you select the heating system that is right for you.

Step 1. Getting started

Consider getting an ecoENERGY evaluation of your home. This detailed evaluation produces an energy efficiency rating and recommendations for improving your home's energy performance. This information can help you plan and prioritize energy upgrades that can be incorporated cost-effectively into renovation projects, resulting in a more comfortable home that uses less energy.

To find an ecoENERGY delivery agent in your area, visit the Office of Energy Efficiency (OEE) Web site at **oee.nrcan.gc.ca/retrofit/search** or call Natural Resources Canada (NRCan) toll-free at 1-800-387-2000.

Step 2. Draftproofing and insulating

A new, improved heating system will not reduce heating costs if much of its heat escapes because your house envelope needs more insulation or has air leaks. So take a close look at where you can reduce the heating losses by draftproofing and insulating before you change the heating system.

For more information, see *Keeping the Heat In* at **oee.nrcan.gc.ca/infosource**. Whether you do the work yourself or hire a contractor, this publication provides information that you need (including recommended insulation levels), and it can help make the whole job easier.

Draftproofing and insulating have many advantages:

- Heating the house will cost less.
- You will be more comfortable because there will be fewer drafts and surfaces, such as walls, will be warmer.
- The house will tend to be cooler in the summer.
- Humidity levels will improve year-round.

Dry air in a house during the winter is caused by too much outdoor air leaking in. Although the relative humidity of cold outdoor air may be high, the absolute amount of moisture in the cold air is actually very low, and the relative humidity of that air is also very low after it has been heated to the indoor temperature of the home.

If the air inside your house feels too dry, one common solution is to add moisture by using a humidifier but a more effective solution is to reduce the number of air leaks. Most houses that have been draftproofed and insulated do not need a humidifier – the moisture generated by cooking, bathing, dishwashing and other activities is sufficient.

For more information on insulation, consult the Canadian Mortgage and Housing Corporation Web site at **www.cmhc-schl.gc.ca/en/co/maho/enefcosa/index.cfm**.

Caution: Making your house extremely airtight can cause excess humidity and poor air quality. One of the best ways to improve air quality while maintaining comfort and avoiding heat loss is to install a fresh air intake or a mechanical ventilation system to circulate fresh air. For more information, contact your serviceperson.

If you are buying or building a new house, investigate whether you can purchase one that will be built to the R-2000* Standard or the ENERGY STAR® for New Homes standard. Homes that are built to those standards will have high levels of insulation and airtight construction, and they will include heat-recovery ventilators, energy-efficient windows and doors, efficient heating systems and other design features that cut heating requirements by as much as 30 percent compared with homes that just satisfy building codes.

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

For more information on R-2000 homes, contact your provincial/territorial R-2000 delivery agent. To find a delivery agent in your area, visit the NRCan Web site or call NRCan at 1-800-387-2000.

Step 3. Selecting your energy source

The next step is to select the heating energy source. Your options may include natural gas, propane, fuel oil and electricity (including GeoExchange and air-source heat pumps). You may also choose a mix of these conventional energy sources and renewable energy sources, such as solar energy.

This document focuses on gas-fired equipment (natural gas or propane). If you are considering a different fuel source, check NRCan's Web site for information about equipment that uses that fuel.

Natural gas is a logical choice rather than propane because it costs less and does not require local fuel storage tanks.

Environment

The effects of producing and consuming energy 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 small.

Heating your home affects the environment in several ways, such as gases leaving the chimney, emissions at an electricity-generating station and flooding at a remote hydroelectric site. The overall environmental impact is determined by the amount and type of fuel your heating system uses, as well as the time of day that it is used. Selecting the cleanest energy source available as well as the highest-efficiency equipment are two things that you can do to minimize the environmental impact of heating your home.

Burning natural gas, propane or fuel oil in your furnace releases pollutants into the local environment. Generating electricity impacts the environment as well, even though it is clean at the point of use. Coal or heavy oil may be burned to meet electricity demand during the winter in Alberta, Saskatchewan, Ontario, New Brunswick, Newfoundland and Labrador, Nova Scotia and Prince Edward Island. Where winter peak demand is met by hydroelectric power (British Columbia, Manitoba, Quebec), the environmental impact is much less obvious. However, in some instances, emissions of methane (a greenhouse gas [GHG]) can be high in hydro dam projects. Nuclear-generated power has its own set of environmental issues.

In summary, there may be no easy solution, but by buying the most efficient heating system with the most appropriate energy source for your area, you can make a real 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, 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 gas-fired heating systems are forced-air furnace systems, but some are hydronic (hot water) systems. These consist of a heating unit (furnace or boiler), a distribution system (ducts and registers or pipes and radiators) and thermostat controls to regulate the system.

Forced-air systems

The most common type of central heating system used in Canadian homes is forced air (using a furnace as the heat source). Among its advantages are its ability to provide heat quickly, to filter and humidify household air, to distribute fresh air provided from a ventilation system and to add central air conditioning. With an efficient circulating fan and motor set, the furnace fan can be used year-round to provide continuous air circulation throughout the house. Because furnace systems recover quickly, it is possible to set the thermostat to a lower temperature overnight, which is a simple way to save energy.

Forced-air heating systems 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 even though 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 hot air, especially from oversized systems. The ductwork that distributes the hot air may also transmit noise from the furnace and its circulating fan, and the ductwork can circulate dust, cooking odours and other airborne odours through the house. Consult your heating contractor for more information on how to minimize these issues.

Hydronic heating systems

A hydronic heating system uses a boiler or an approved combination water heater as a heat source. It distributes heat by circulating hot water through pipes installed in the house and returning the water to the boiler or water heater to be reheated.

In the past, hot-water or steam-heating systems had large boilers and used heavy wrought-iron pipes and cast-iron radiators; some of these may still exist in older homes. Newer systems have smaller, copper or specialized plastic piping; slim baseboard heaters or in-floor heating pipes; and smaller, more efficient boilers. CSA-approved plastic piping is now the most commonly used piping material for space heating and is becoming widely accepted for distributing potable hot water.

Other types of systems

Other types of gas-fired heaters that can be used independently or in combination with the standard system include **room space heaters**, **radiant space heaters** and **built-in radiant systems**.

Room space heaters heat the room they are in and do not use a heat distribution system. For example, a gas fireplace acts as a **radiant space heater**. It can provide localized heating to a single room or zone of the house. That can potentially lower the overall heating demand of the house and lower the final heating bills while also providing a decorative function and making the occupants feel more comfortable.

Built-in radiant systems generally consist of narrow hot water pipes embedded in the floor or laid in the joist space under the floor. Hot water at a temperature of approximately 40°C (104°F) is slowly circulated through the pipes and releases heat into the house. Thick carpets can reduce effectiveness by acting as insulation. Such a system may be costly to install and does not offer much in direct energy savings. However, some radiant floor installations offer benefits in terms of comfort, and they may allow you to lower thermostat settings and reduce heating bills.

Retrofit options for houses with electric baseboards

If your home has electric baseboards, 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 retrofitted at a cost that makes the conversion financially attractive. Fuel-fired space heaters and advanced, energy-efficient, gas-fired fireplaces may 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?
- Is the system compatible with my energy choice?
- 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 and service the system?

Step 5. Selecting your heating equipment

After you select the energy source and heat distribution system, consider the alternatives in heating equipment and efficiency levels. You must decide whether to upgrade your existing heating equipment or to replace it entirely. There are many ways to improve the efficiency and general performance.

Equipment efficiency and suitability

See Chapters 2 and 3 for a more detailed discussion of your options for gas furnaces and boilers.

Purchase, installation, operation and maintenance costs

Generally, more efficient heating systems cost more to buy, but the initial cost may be quickly recuperated by fuel savings, making higher energy efficiency a good investment.

High-efficiency units can generally be vented out a side wall and do not use air from the home for combustion. This makes these units safer and more compatible with airtight housing. Having high-efficiency heating equipment 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.

Energy efficiency standards

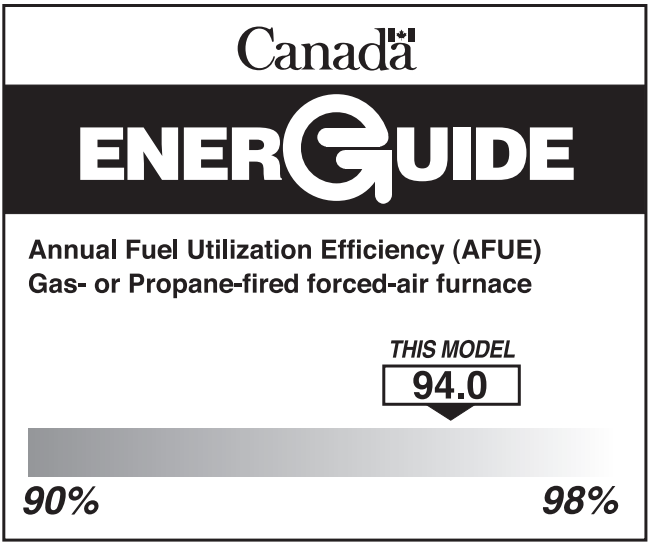
The Regulations apply to most types of gas-fired heating equipment as well as to other products that are imported into Canada or shipped across provincial borders. In addition, provincial and territorial governments have their own energy efficiency standards. Generally, these standards are harmonized with the Regulations, and they establish the minimum acceptable energy efficiency levels for specific types of heating equipment.

Energy efficiency rating system

The Government of Canada and the Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI) have established a voluntary system for energy efficiency labelling 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 usually shown on the back page of manufacturers' brochures. Included on the EnerGuide label is a rating scale that shows the range of efficiencies for gas and propane furnaces on the market, as well as a pointer that indicates how this model's efficiency compares with other models. Chapter 5 shows how to estimate heating costs based on the furnace's AFUE rating.

FIGURE 1
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. NRCan 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, have an AFUE of 95 percent or higher and have a fan efficiency of two percent or less. See Chapter 3 for information on condensing furnaces.

For a gas-fired boiler, the ENERGY STAR criterion 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 78 percent with one that has an AFUE of 95 percent will reduce annual energy costs by 18 percent. For more detailed comparisons, use the EnerGuide Heating Cost Calculator on the EnerGuide Web site at **oee.nrcan.gc.ca**.

Because 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 also help the environment. By improving the energy efficiency of your space heating, you reduce GHG and air pollution emissions that contribute to climate change and poor air quality, and you help significantly in achieving Canada's climate change goals.

2 Basic heating equipment for gas-fired systems

Most gas-fired heating systems are either forced-air or hydronic (hot water) systems, as noted in Chapter 1. This chapter discusses how to improve the effectiveness of each type of heat distribution system.

Maximizing the effectiveness of forced-air heating systems

A two-speed fan will provide continuous air circulation and more even temperatures throughout the house; however, your electricity bill may increase if your furnace does not have an efficient fan motor.

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

Getting the heat where you want it

Uneven heat distribution can make it difficult to heat some rooms in the house, such as upstairs bedrooms. This problem can be caused by

- warm air leaking out through joints in the heating ducts
- heat loss from ductwork that passes through the basement or through unheated areas such as a crawl space, an attic or a garage

Sealing all joints in the ductwork with a water-based duct mastic (sealant) will reduce or eliminate warm air leaks. Check the Internet or Yellow Pages™ to find suppliers of duct-sealing materials and licensed local contractors who specialize in duct sealing. (High-temperature duct tape may work for a short time, but it tends to degrade and detach over time.)

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

Seal and insulate ducts in unheated areas such as crawl spaces or attics first. Do the same for long duct runs in the basement. It is recommended that you insulate at least the warm air plenum and the first 3 m (10 ft.) of warm air ducting. Better still, insulate all the warm air ducts you can access.

Use foil-backed insulation 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 adjust dampers to rebalance the heat or to have additional registers installed in the basement after you insulate. This will help to ensure that the heat will go 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. These problems 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 3) to redirect the flow of air from the warmer areas to cooler rooms.

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 3). 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 partially closing the dampers in the ducts that supply heat to the warmest rooms. Wait a few days to see what effect this has on the overall heat balance, and 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 to balance the heat. If you reduce the airflow too much, you could raise the air temperature inside the furnace plenum too much. It is a good idea to have this temperature rise checked by your furnace serviceperson.

The ductwork in many houses has been badly designed and has poor cold air returns. The result is that not enough air flows through the furnace. Putting additional cold air returns in living areas, particularly in bedrooms, may be difficult, but it can improve air circulation and heating system efficiency while improving comfort and air quality in the house.

CAUTION An old misconception is that one way to solve inadequate cold air return is to open the cold air return ductwork or plenum in the basement area near the furnace or to remove a furnace access panel near the air filter. **This is dangerous.** The depressurization that could be caused by the circulating fan can disrupt the combustion process and spill or backdraft combustion products. These combustion products can then be circulated through the house instead of going up the chimney. **In extreme cases, this could 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 assessment and balancing of your distribution system or consider setting the fan control on the thermostat to program fan mode, ventilation mode (if available) or continuous circulation mode.

Programmable thermostats

One easy way to save heating costs is to lower the temperature setting on your house thermostat, when possible. As a general rule, you will save about 2 percent of your annual heating bill for every 1°C (2°F) you lower the thermostat overnight.

Programmable thermostats have electronic timers that allow you to preset household temperatures for specific periods of the day and night. The installer can adjust the thermostat to suit your heating/cooling equipment. All electronic thermostats are designed to be used by homeowners.

Programmable thermostats (continued)

In a typical application, you can 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 can 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 set the temperature at 17°C (63°F) when you are sleeping or not at home and at 20°C (68°F) when you are at home and awake. Experiment with the unit until you find the most comfortable and economical routine for you and your family.

Many programmable thermostats allow you to

- store and repeat additional daily settings that can be run and changed without affecting the regular settings
- store more than four daily temperature settings
- program the fan to operate continuously during specified time intervals. Some thermostats have a "ventilation mode" that operates the fan for a minimum period during each hour if the fan has not operated for heating or cooling during that hour.
- temporarily override the programmed settings

Zone control

If you have a hydronic (hot water) system, you can 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. Zone controls are also available for a few forced-air heating systems, using zone dampers in main duct passages controlled by separate thermostats in different areas of the house.

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° to 2.0°C (34.7° to 35.6°F) to 0.5° to 1.0°C (32.9° to 33.8°F), 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, but comfort is usually enhanced.

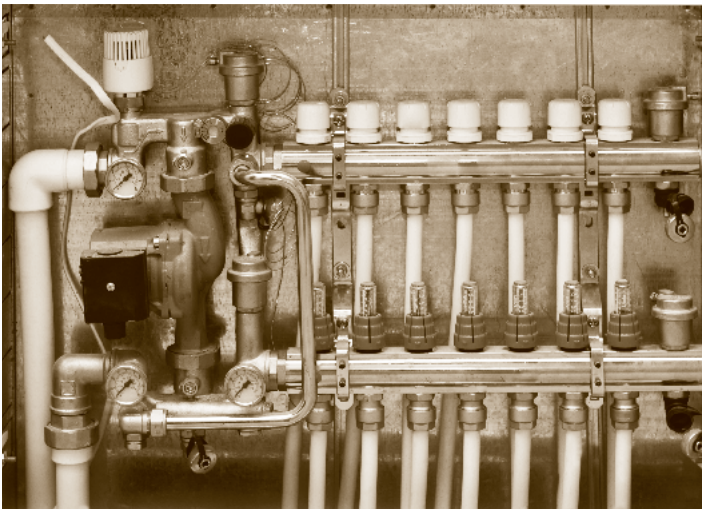
Equipment for hydronic (hot water) systems

Design and operation

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

- a heat generator such as a gas-fired boiler
- heating units in most rooms, such as baseboards or radiators, often installed against an outside wall
- a small pump to circulate water through a piping system from the heat source to the heating units

FIGURE 2
Hydronic (hot water) heating system



Maximizing effectiveness

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

Improving heat distribution

Gravity heating systems that circulate air or water by natural convection are less efficient than systems that have a blower or 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 setback. In addition, a gravity system cannot circulate hot water to radiators or baseboard heaters in basement living areas, where they are below the level of the boiler. All of these problems can be overcome by using a more modern system that includes a circulating pump and replacing an 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 at least as important with hydronic heating as it is with forced-air systems. Radiators and baseboard heaters are usually fitted with a 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.

A thermostatic radiator valve can vary the heat output automatically. 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 3
Thermostatic radiator valve

Outdoor reset

Many hydronic heating systems are designed to operate with their hot water temperature set for 60°C (140°F) or higher. An outdoor reset controller, which controls the supply water temperature in relation to the outside air temperature, will reduce the amount of energy used by the boiler and improve thermal comfort as well. As it gets warmer outside, the boiler water temperature is automatically reduced. Some boilers can be subject to thermal shock or corrosion if the return water temperature is less than their design temperature. Before applying one of these devices to your system, consult your plumbing and heating contractor to ensure that your boiler and distribution system is designed to handle lower temperature settings.

Venting of combustion products

Products of combustion must be safely vented from the home. The combustion of natural gas and any other fuel that contains hydrogen produces water vapour. If water vapour is vented through a cold chimney, some of it may condense. This can seriously damage masonry chimneys, and the problem may be particularly serious if the chimney is installed outdoors, because an outdoor chimney will be much cooler than an indoor chimney during the heating season. Specific venting and combustion air supply requirements for gas-fired heating equipment are spelled out in the appliance installation instructions and the national or local gas installation codes that are in effect in the jurisdiction where the equipment is installed. You should ensure that your installation complies with those requirements. One way to do that is to have the installation inspected by the gas utility that supplies your fuel whenever any gas-fired appliance is installed and ensure that any maintenance is performed by a qualified and licensed contractor.

Many older furnaces and water heaters use a common chimney to vent their combustion products. If you want to continue to vent a gas-fired water heater by using an existing chimney after you replace your furnace, you may need to have a licensed professional install an approved metal liner, either a double-walled B-vent or a single-walled, stainless steel Underwriters' Laboratories of Canada (ULC) liner. This is especially important if you have a masonry chimney. 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, reducing the likelihood of condensation. Contact your local utility or provincial/territorial authority for specific advice. A better alternative may be to replace both your heating system and water heater with more efficient equipment that does not rely on a chimney for venting. This is discussed in Chapter 3.

3 High-efficiency furnaces and boilers

Over the past 20 years, higher-efficiency gas furnaces and boilers have taken over the market. This section will highlight some of the advantages that these heating systems offer.

FIGURE 4
Standard-efficiency gas furnace with an induced draft fan

Furnaces

Condensing gas furnaces are the most energy-efficient furnaces available, with AFUE ratings of between 90 and 98 percent. The Regulations require a minimum efficiency of 90 percent. In addition, condensing furnaces are

- not susceptible to the condensation and long-term vent degradation problems that can occur with older furnaces
- better suited for the tight construction of energy-efficient houses

FIGURE 5
ENERGY STAR® symbol

The only furnaces that qualify for ENERGY STAR labelling are high-efficiency condensing gas furnaces with an AFUE rating of at least 95 percent.

Condensing gas furnaces 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 the condensing heat exchange section, combustion gases are cooled to a point at which the water vapour condenses, thus releasing additional heat into the furnace. The condensate is piped to a floor drain or condensate pump.

A chimney is not needed because the flue gas temperature is so low that the gases are vented out of the house through an approved plastic pipe. Fuel savings of 38 percent can be achieved with a new furnace with an AFUE of 95 percent, compared with an old gas furnace with an AFUE of 60 percent. Furthermore, emissions released into the environment are also reduced by the same amount.

FIGURE 6
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. This is desirable because it eliminates any potential for depressurization and drawing corrosive vapours inside a house, such as bleaches from a laundry zone, into the furnace combustion chamber. The majority of condensing furnaces are certified for installation that uses a "two-pipe," sealed combustion configuration. However, some condensing furnaces can be installed by using a "one-pipe" configuration that draws combustion air from inside the home.

The main advantage of two-pipe, sealed combustion is that it isolates the combustion air system from the house. Consequently, the furnace is not affected by the operation of other appliances or exhaust fans in the home and does not cause depressurization of other appliances. 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. Also, heating costs may be reduced slightly by decreasing the amount of heated air that is drawn from inside the house.

As noted above, most high-efficiency furnaces are designed and certified as two-pipe, sealed combustion systems, so they are well-suited to the tight construction of modern energy-efficient houses.

Gas boilers

Residential gas boilers sold in Canada must have an AFUE rating of at least 82 percent. ENERGY STAR qualified boilers must have an AFUE rating of at least 85 percent.

Condensing gas boilers

Condensing gas boilers employ a power burner, similar to the furnaces described previously. Like condensing furnaces, they have an additional heat exchanger made of corrosion-resistant materials (usually stainless steel) that extracts latent heat from the combustion products by condensing some of the water vapour. A chimney is not needed, reducing the cost of installation. Because the flue gas temperature is low, the gases can be vented through an approved plastic pipe, similar to condensing furnaces.

A condensing boiler can have an AFUE rating of 90 percent or higher. But in practice, condensing boilers in hydronic (hot water) heating systems may not achieve this efficiency. For the condensing boiler's heat exchanger to effectively extract all the potential latent heat, the system has to run with the lowest possible return water temperatures, preferably not exceeding 45° to 50°C (113° to 122°F). Unfortunately, older hydronic heating systems were often designed to operate with higher water temperatures, which make it difficult for the flue gas to condense. If the return water temperature is too high to permit condensation, the actual operating efficiency may be similar to non-condensing boilers, which typically have AFUE ratings of 82 to 89 percent.

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 low return water temperatures include

- in-floor 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. The heating system does not have to provide 100 percent of its design load for many hours during a typical heating season. Therefore, an outdoor reset control produces savings during the majority of the heating season. It uses advanced radiator systems that are designed with sufficient heat exchange surface to operate effectively at lower temperatures.

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

Combined space and water heating 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 that it may be 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 may make sense to combine space heating with other functions, in particular, domestic water heating. Domestic hot water loads have remained fairly level over time, making it logical to put more effort into improving the efficiency of the hot water generator. Therefore, it may be financially attractive to consider combined space and water heating systems.

A space and water heating system can have a rated component efficiency of over 90 percent for *water heating* if it

- is integrated
- is high-efficiency
- is a condensing gas-fired system
- uses water from the municipal supply as the driving mechanism to condense the flue gas

However, the system efficiency as a *space heater* may be quite different. Space heating can be hydronic or forced air (through a fan coil). This type of system may have a lower overall capital cost than individual appliances, and it eliminates the need for multiple exhaust systems. Reliable efficiency ratings for combined heating systems have only recently become available. In 2011, the Canadian Standards Association published a new standard for rating the performance of combination heating system packages. If you are considering installing a combination system, insist on getting performance ratings that have been determined using the CSA P.11 standard.

Note: In practice, condensing gas-fired water heaters and boilers in hydronic heating systems may not condense if the return water temperature is above the dew point of the flue gases.

FIGURE 7
High-efficiency combined space and water heating system

Some early "combination" systems used conventional, natural draft water heaters and a fan coil to supply space heating. These units have low efficiency that makes them unsuitable alternatives to current code-compliant systems.

Some gas-fired boilers provide domestic hot water by passing cold water through a finned copper coil that is immersed directly in the boiler water. These systems are known as tankless coil boilers. Although some manufacturers and distributors claim that hot water is essentially free, the boiler must be kept hot at all times to provide hot water, even during the summer. Standby losses from the boiler all year make these systems an inefficient means of providing hot water.

Condensation problems

In the house

More efficient heating systems, combined with better draftproofing and insulation, can result in less air infiltration, which, in turn, may lead to higher humidity in the house.

Heavy condensation on the inside of windows and dampness or mould growth on walls or ceilings are indications of excessive humidity. This can cause structural damage but, luckily, indoor condensation problems can be solved. Because most of the indoor humidity comes from regular household activities (such as showering and cooking), your first step should be to reduce the amount of moisture 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. Install exhaust fans in the bathroom and kitchen. You should also check the humidifier setting on your furnace if it is equipped with one. It is often not necessary to have a humidifier in a well-sealed house. Finally, you should talk to a contractor about installing a balanced ventilation system or a heat recovery ventilator (HRV) to increase your home's ventilation and decrease humidity without wasting energy.

High efficiency blower motors

Furnace manufacturers now offer high efficiency motor options for residential furnaces. Their blower motors, and in some cases their induced-draft motors, have an electronically commutated, brushless, DC motor option (high-efficiency). These high-efficiency motors may be called EC, ECM, BLDC, VS or DC motors, depending on the manufacturer. They are more efficient than standard multi-tap permanent split capacitor (PSC) motors, particularly when they are operated at less than their maximum speed.

If you are purchasing a new furnace, you should consider buying one that has a high-efficiency motor. In homes where the fan is run continuously or for extended periods, such a motor can significantly reduce electricity consumption while providing better air circulation. A brushless DC motor can reduce furnace electrical energy consumption by more than 70 percent, when used for continuous circulation. During the summer months, an efficient fan motor saves even more energy by reducing the load on your air-conditioning system by not adding as much heat to the cooling air as a less efficient motor would. The actual electricity cost savings that you see will depend on how often you use the central air-circulation fan and air-conditioning system.

If your furnace currently has a PSC motor, you may be able to retrofit an efficient brushless DC motor at a reasonable cost to reduce electricity consumption. Retrofit DC motors that are designed as “drop-in replacements” that connect to existing PSC motor tap connections are available from several motor manufacturers. Talk to your local installer or service technician to see if a retrofit of a high-efficiency motor is an option, especially if your motor needs to be replaced anyway. If your furnace is nearing the end of its service life, investing in an efficient retrofit motor is probably not a wise choice.

Two-stage and variable capacity furnaces

Furnace manufacturers now offer multi-stage furnaces that can operate for most of the heating season with reduced heat output and lowered air flow. This leads to lower costs for operation of the circulating blower, better air circulation, quieter operation, and improved comfort and efficiency. While there are a few two-stage gas furnaces that use PSC blower motors, the majority use high-efficiency, brushless DC motors.

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

Retrofitting a central forced-air, natural-gas-heating system may be difficult if you do not have access to install ductwork (e.g. your house is built on a concrete slab or you live in a mobile home). Specialized gas heating equipment might be a good alternative. Many kinds are 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.

Room heaters

Room heaters are self-contained, free-standing heating appliances with heat outputs lower than those of central furnaces. Some resemble 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.

Gas-fired fireplaces

Gas fireplaces are popular in new homes and for replacement in existing dwellings. Most units are built-in, whereas others are free-standing and resemble a wood stove. Many are used only occasionally as supplemental heating systems, supplying heat for a single room or zone. Those can be considered as decorative appliances rather than central heating systems.

Gas fireplaces have the potential for reasonably efficient performance. However, the efficiency of models currently available on the market is much lower than that of a furnace.

EnerGuide rating system for gas fireplaces

NRCan and the Hearth, Patio and Barbecue Association of Canada (HPBAC) administer an energy efficiency labelling system for gas fireplaces. The EnerGuide rating system provides consumers with performance information for gas fireplaces. Performance is based on a fireplace efficiency (FE) rating from the Canadian Standards Association test standard P.4.1. It is similar to an AFUE rating.

Energy efficiency considerations

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 an FE rating in which a higher number indicates higher efficiency.
- Higher-efficiency equipment uses less energy. The actual saving depends upon location (both the regional climate and cost of fuel), the efficiency of the vented gas fireplace chosen and how often you use the fireplace.
- Whether you are looking for a decorative appliance or a heating appliance, consider the right size for the space. Are there supplemental ways to help move excess heat to other areas of the home? Do you understand the merits of zone heating versus central heating?

For more information, talk to your product representative or visit the NRCan Web site at **oee.nrcan.gc.ca**.

Carbon monoxide detectors

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

situation that must be corrected immediately. CO detectors (as well as smoke detectors) are required by local codes in certain Canadian jurisdictions, but even where they are not mandated, they are a good idea.

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

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 can estimate the savings you can expect. Using Table 1 and Equation 1 will provide you with reasonably accurate estimates. 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 using 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

Annual $ savings = [(A − B) / A] × 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.

Equation 1 (continued)

Annual $ savings = [(96 − 60)/96)] × 800

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

TABLE 1

Gas heating appliances – Features and efficiency ranges

(Note that many of the systems do not satisfy the current *Energy Efficiency Regulations*)

Type	Features	Seasonal efficiency (AFUE) (%)
Naturally aspirated furnace[1]	• chimney • draft hood • with continuously lit pilot light • with electronic ignition and vent damper	60 62–67
Naturally aspirated boiler[1]	• chimney • draft hood • with continuously lit pilot light • with electronic ignition and vent damper	55–65 60–70
Power-vented furnace[1]	• chimney or side wall vent • draft hood • electric ignition • powered exhaust	78–84
Power-vented boiler[1]	• similar to mid-efficiency furnace	78–84
Condensing furnace[2,3]	• no chimney • no draft hood	90–98
Electric ignition	• multi-stage heat exchanger • condenses water vapour from flue gases • plastic flue pipe to side wall	
Condensing boiler[2,3]	• similar to condensing furnace	

(Continued on page 36)

TABLE 1

Gas heating appliances – Features and efficiency ranges (continued)

Type	Features	Seasonal efficiency (AFUE) (%)
Conversion burners for oil equipment[1]	• chimney • pilot light or electric ignition • special barometric damper or draft hood	60–65
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 Chapter 3 for conditions affecting condensing boiler efficiency.

Heating costs with different energy sources

You may want to compare the cost of heating with natural gas with the cost of heating with other energy sources, such as electricity, propane, oil or wood. You can use the following procedure (Steps 1 to 4). You need to know 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 cost 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 by multiplying the price per gigajoule by 0.0375. For example, \$5.17/GJ × 0.0375 = \$0.19/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 GJ

[1] The figures provided for wood are for a full cord, measuring 1.2 m × 1.2 m × 2.4 m (4 ft. × 4 ft. × 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. 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 by using Equation 2.

Equation 2

Annual heating load = (heating cost / 100 000) × (seasonal efficiency / energy cost per unit) × energy content

For example, your annual bill for space heating with natural gas is $687, gas costs $0.22/m^3, and you have an old 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).

If your bills also include water heating and 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.

TABLE 3
Typical heating system efficiencies and energy savings

Energy source	Technology	Seasonal efficiency (AFUE) %	Energy savings (% of base[1])
Natural gas	• obsolete furnace/boiler circa 1970	60	base
	• furnace circa 1985	78–84	23–28
	• boiler circa 1985	80–88	25–32
	• condensing furnace	90–97	33–38
	• condensing boiler	89–99	33–39
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

(Continued on page 39)

TABLE 3

Typical heating system efficiencies and energy savings (continued)

Energy source	Technology	Seasonal efficiency (AFUE) %	Energy savings (% of base[1])
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.

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

TABLE 4

Typical annual heating loads in gigajoules for various housing types in Canadian cities

City	Old detached	New detached	New semi-detached	New townhouse
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 re-insulating (which can be different from house to house), these figures are only 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.)

COP = Coefficient of performance, a measure of the heat delivered by a new townhouse – inside unit, approximately 93 m^2 (1000 sq. ft.), heat pump over the heating season per unit of electricity consumed

CSA B415 or EPA Phase II tested

Step 4. Use the formula.

The annual heating cost is calculated by using Equation 3.

Equation 3

(energy cost per unit / energy content) × (heating load / seasonal efficiency) × 100 000 = 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.
2. Select the heating load for your type of housing and location from Table 4, then divide it by the seasonal efficiency of the proposed heating system from Table 3.
3. Multiply the results of these two calculations, then multiply that result by 100 000.

The result gives 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, New Brunswick, 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).

Equation 2 (continued)

Annual cost of natural gas heating:

($0.18 / 37.5) × (120 / 96) × 100 000 = $600

If you want 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.

NRCan's CanmetENERGY has produced software called HOT2000 that can be used for evaluating the energy performance of houses and multi-unit residential buildings. For more information, consult **canmetenergy.nrcan.gc.ca**.

6 Buying, installing or upgrading a system

Buying your equipment

There are not many "furnace stores" where makes and models can be examined, compared and priced, and furnace wholesalers do not sell directly to the public. You will have to do your own research. To get information on the different makes and models available, you can

- research using the Internet
- contact heating firms. Ask them for references to manufacturers' illustrated sales literature on the furnaces they sell and install.
- contact your local gas utility or contractor for assistance and information. Your utility can usually provide information on the cost of purchasing, renting and installing furnaces as well as estimated annual heating costs for the type of equipment you plan to use.

After you decide on a particular type of furnace, review the literature carefully to find out if it provides the features you are looking for, such as two-stage heating and a high-efficiency, brushless DC motor for the circulating fan and draft inducer. Also, look for the certified EnerGuide AFUE rating. For more information on the EnerGuide rating system for gas and propane furnaces, see the Energy efficiency rating system section in Chapter 1.

Ask your contractor to calculate the heating requirement of your house. The furnace size should be determined by using a heat loss calculation that is based on the CSA standard F280, Determining the Required Capacity of Residential Space Heating and Cooling Appliances. This method requires detailed examination of your house to determine size, insulation levels and the degree to which the house envelope is airtight. Alternatively, you can arrange for a full energy evaluation for your home by contacting an approved energy evaluator. An evaluation will provide prioritized recommendations for energy efficiency upgrades, and it is a prerequisite for some energy efficiency retrofit grant programs.

Before you settle on the size of furnace, ask the contractor to provide the calculation results, including a summary of the general design assumptions and a statement of the calculation method(s) used. A calculation based only 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 buy from 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 contact a fully qualified and 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 quotes from several companies on the cost of buying and installing a complete new unit, including all fittings and adjustments required, such as upgrades to ductwork or piping, balancing of the heat supply to the house and disposal of the old equipment.

Home energy evaluation – EnerGuide for Houses

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

- a tour of your house to point out areas of air leakage
- a 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 (EGH) rating so you can compare the energy efficiency of your home with that of other homes

By following the recommendations of such an evaluation, you may be able to reduce the size of furnace required.

Checklist for having a natural gas heating system installed

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 the water heater and vent (where applicable)
  - installation of the 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 changed 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 purchasing 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.

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.

Tasks that should be performed by a serviceperson during regular maintenance include

- inspecting the combustion and vent systems
- 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 adjust appliances, equipment or piping and turn on the gas service if the pilot light has been shut off.

Most utilities offer the following services at no charge: emergency services (such as investigating suspected gas leaks or CO spillage); estimates for repairs, replacements and alterations; verifying gas meter operation; and locating buried gas pipes.

Owner maintenance

You can do a few maintenance tasks yourself to keep your system working well. But even if you do these properly and regularly, **you should still have your system serviced as required by an expert heating contractor or gas utility.**

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 approved plastic 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. Look at the vent piping and call a service person if you see any evidence of cracking or shifting of the pipes.

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.

Care of the distribution system

Remove obstructions from ducts, warm air registers and cold air returns so that air can move freely through the system. Use a water-based duct mastic to seal cracks at accessible duct joints, as described in the section Getting the heat where you want it, in Chapter 2. At the same time, consider insulating as much of your warm air ducts as you can easily access.

Owner maintenance of a forced-air heating system

Cleaning or changing the air filter

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

The air filter in a furnace should be cleaned or replaced regularly. Permanent filters made of aluminum or plastic mesh can be washed and reused.

If you have added an electrostatic air filter to your furnace, you do not need a standard filter as well. Remember that 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 that has an internal motor. On belt-driven fans that were used in some older furnaces, motors may have small oiling ports over the bearings at each end of the motor. The ones requiring oiling should be given a few drops of oil once or twice a year (check your owner's manual or ask your furnace serviceperson about the type and quantity of oil to use).

Owner maintenance of a hydronic (hot water) system

You can do the following maintenance tasks yourself for a hydronic (hot water) heating system:

- Insulate the hot water pipes.
- Bleed air from the radiators once or twice a year so that they can fill with water.
- Vacuum the radiators.
- Ensure that the level of water in the expansion tank is correct.
- Oil the circulating pump, if required (check the manufacturer's instructions).
- Allow air to flow freely around radiators. Ensure that they are not covered by curtains or by 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

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

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 occupants, hot water consumption may account for about 20 percent of total annual energy consumption.

FIGURE 8
Conventional gas-fired water heater

When compared with electricity, one of the principal advantages of a gas-fired water heater is its lower 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.

For more information on gas-fired water heaters and to order your free copy of *Water Heater Guide*, see Chapter 9 or visit the NRCan Web site at **oee.nrcan.gc.ca**.

9 More information

Free publications from the OEE

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

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

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