CEMR-19

Heating with Electricity

Energy, Mines and Resources Canada
Hon. Marcel Masse, Minister

Énergie, Mines et Ressources Canada
L'Hon. Marcel Masse, Ministre

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If your home's heating system needs to be replaced, or if you are exploring the heating options for a new house, you may be considering electric heating.

Choosing a heating system is a major decision. In most cases it will be a large investment that will be used for many years. That's why it's important to choose a system that can best meet your family's present and future requirements. **Becoming fully informed about all aspects of home heating before making your final decision is the key to making the right choice.**

Clearly, **choice of fuel** is fundamental to any decision on home heating. You'll need to determine what fuel or energy sources are available and at what price.

Cost is also an important consideration when it comes to choosing equipment. If you're replacing or updating your heating system, you'll want to determine if any of the existing equipment can still be used. How much work is required to install the new system will also affect the cost. If you are now using a fuel for cooking or water heating, some of the work required to set up a heating system using the same fuel might already be done. In addition, you'll want to compare the higher purchase cost of high-efficiency equipment with the probable savings in fuel costs that this equipment will give you.

The **convenience** of operating a system, both day to day and in the long term, is another factor to look at. How much space will the heating equipment take up in your basement or elsewhere? Will your supply of energy be interrupted on occasion? If so, how often? How much servicing will the system need and what will it cost? Are central humidification, air cleaning and air conditioning compatible with the system?

No matter what kind of heating system you decide to use, it makes good sense to make the most of your investment by draftproofing and insulating first. A well sealed and insulated house requires less heat to be comfortable. Why buy a large furnace when a smaller one can do the job?

This booklet will help you to examine all of the factors involved in choosing and installing an electric heating system. After your examination you should be able to make a home heating decision that you will be comfortable with, and which will keep you comfortable, for many years.

Coming to Terms with Electricity

Here are some common terms you'll come across while exploring the option of heating with electricity.

watt (W)	The **watt** is the basic unit of measurement of electric power. The heating capacity of electric heating systems is usually expressed in **kilowatts** (kW). One kW equals 1000 watts.
kilowatt hour (kW.h)	One kW.h is the amount of electric energy supplied by 1 kW over a one-hour period.
ampere (A)	Electric flow is called **current** and is expressed in **amperes**. The short form is **A** although **amp** is sometimes used.
volt (V)	A **volt** is the basic unit of measurement for **voltage**, which is electric pressure. Voltage causes an electric current to flow.

Putting it all together. A **watt** is the power you get when one **volt** of pressure pushes one **ampere** of current.

Heating with Electricity — What Are Your Options?

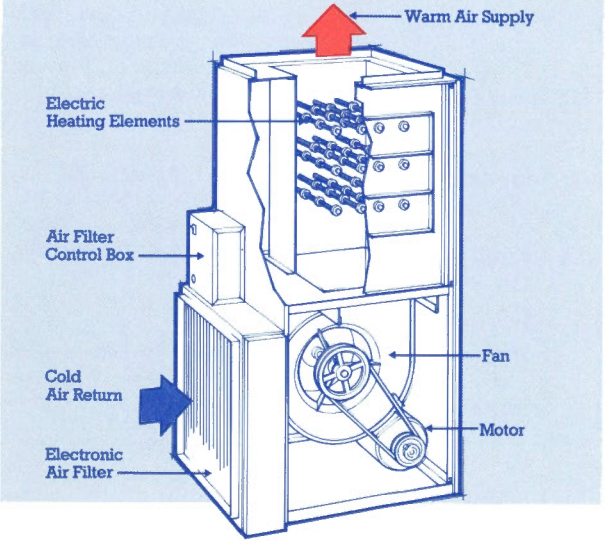
Electricity can be used as the sole energy source or in combination with other sources in a home heating system.

The five basic types of electric heating systems available in Canada are:

- forced-air systems
- room heaters
- hot water systems
- radiant systems
- combination systems

Forced-Air Systems

When an electric furnace delivers heated air blown by a fan through a network of ducts, the arrangement is known as a forced-air system. Because the fan is literally forcing air through the ductwork to the rooms, this type of system does not depend on natural convection to distribute



heated air evenly throughout your house. Forced-air systems are most suitable if central air conditioning, humidification and air cleaning are desired.

The central furnaces for forced-air systems come in a wide range of capacities — generally from 10kW to 30kW. The heating elements, circulation fan, air filter and control devices are contained in a compact cabinet.

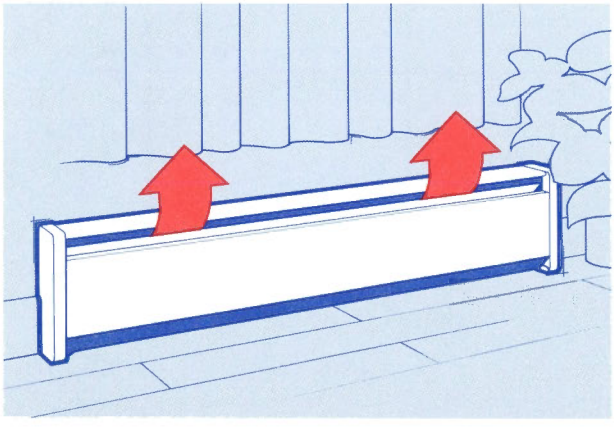
If a new electric furnace is replacing another modern forced-air furnace, the ductwork from the existing system can generally be used in the new system with very few changes. If electricity will be your only energy source, unused chimney flues can be insulated, closed off and sealed.

To accommodate different types of houses, there are three main furnace designs for use with forced-air systems. The designs are named according to the way air travels from the furnace.

- **Upflow** furnaces are best for basement floor locations.
- **Horizontal flow** furnaces are particularly suited for crawl space installations.
- **Downflow** furnaces are best for installations in mobile homes or on the main floor of houses on concrete slabs.

Room Heaters

Because room heaters are installed in each room in your house, they permit individual room temperature control.

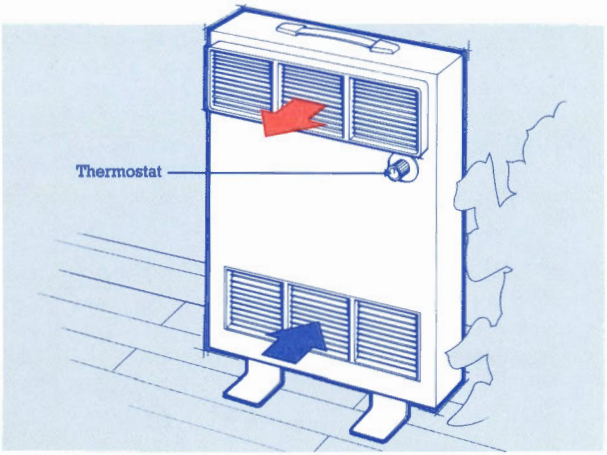


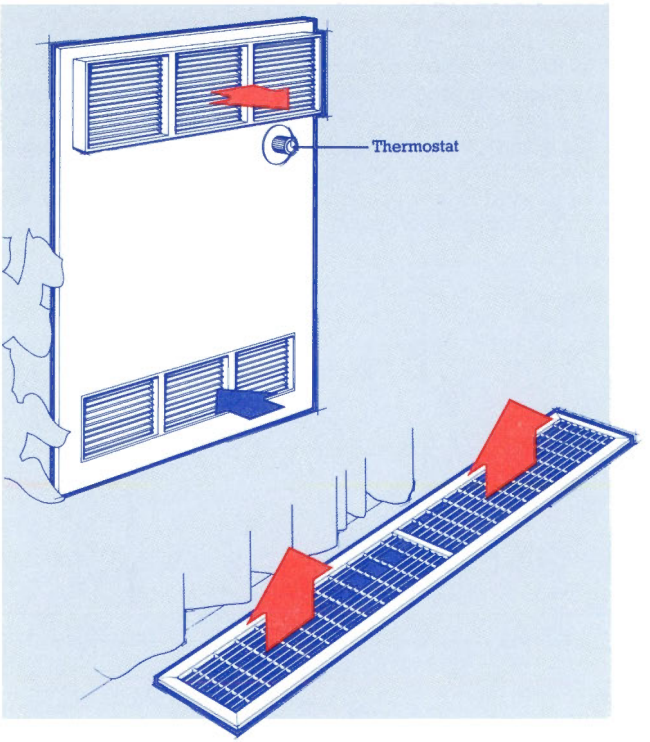
Thermostat controls are located in the unit itself or mounted on a nearby wall. All room heaters have built-in controls to prevent overheating if airflow is restricted. A wide variety of room heaters is available at moderate cost.

The most common type of room heater is the permanently mounted and wired **baseboard heater**. Ideally, they should be installed unobstructed under windows on outside walls. Baseboard heaters rely on the natural convection of heated air to circulate heat. They are available in different lengths, so they are easy to match to the heating requirements of a room.

Individual heating units such as electric baseboard heaters require a lot of power to operate. Additional electric circuits will be required for each unit. How easily this wiring can be installed will be a significant factor in the cost of the system.

If a baseboard installation is difficult or impossible, other types of room heaters can do the job. Portable convection and fan-assisted units range from 500- to 1500-watt capacity and are available in many types, shapes, colours and sizes. Although they are small enough to plug into regular house circuits, make sure that house wiring can handle the additional electric load. These units are most convenient where added or temporary warmth is needed.

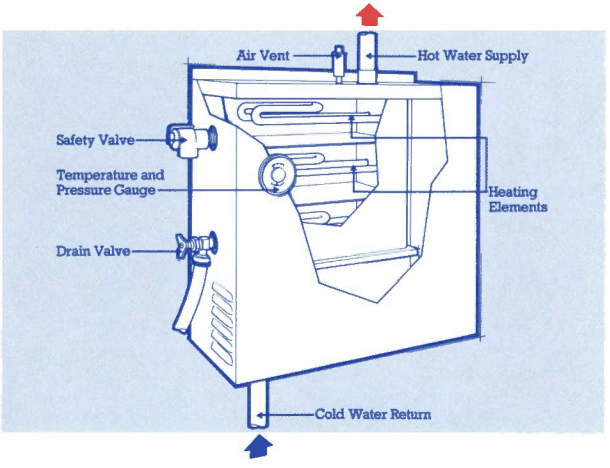




Cabinet model convection heaters can be mounted onto a wall or recessed into it. **Wall insert units** are similar, but are designed only to be recessed into the wall. Both cabinet and wall units are suitable for confined areas such as hallways, entranceways, porches, landings and bathrooms. They can be used as either a primary or supplementary heat source. Some have a small fan to distribute heat more quickly. **Drop-in** or **floor insert units** are designed for use in front of stairways, floor-level windows or sliding glass doors.

Hot Water Systems

Electric hot water or hydronic systems deliver heat to living areas through pipes and radiators instead of through the ducts that a forced-air system uses. The central boiler uses electric elements to heat water, which is circulated by a pump through the pipes and then through the radiators located in each room. Radiators are usually installed along outside walls under windows.



The central boiler in an electric hot water heating system is compact. Its heating elements are immersed directly in the water that is being heated (like an electric kettle). Where space is limited, the boiler can be installed on a basement wall, in a closet, under a kitchen cabinet; it can even be hung from basement ceiling joists.

If you are replacing a boiler in an existing hydronic system with a new electric boiler, you can probably use the existing heat distribution pipes.

The heat distribution pipes in a hot water heating system will freeze as quickly as any other pipe containing water. If the pipes freeze, they will burst and can cause serious damage to the house and its contents. It is important to take a few precautions. By adding an antifreeze solution containing glycol (or ethylene-glycol or propylene-glycol) to the water in your heating system pipes, you can prevent them from freezing. Also, insulating the pipes will help them to retain heat longer. In any case, it is always important to keep the heating system operating at a level that will keep the water within the pipes from freezing.

If you are planning to be away from your home for an extended period, arrange to have a neighbour check your house every day to ensure that the heating system is operating. If the system fails, a heating contractor must be notified immediately.

Radiant Systems

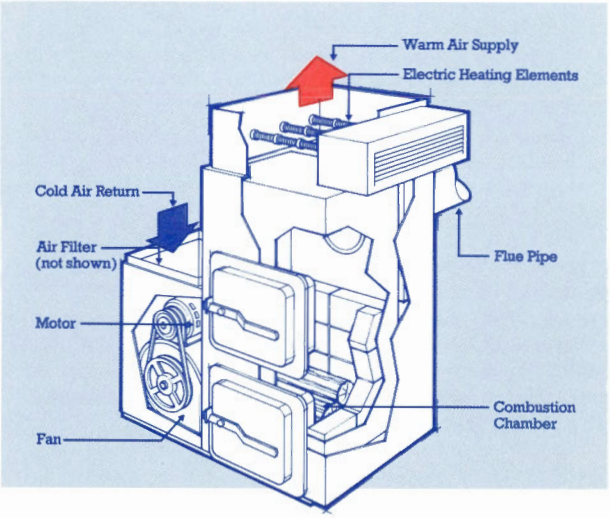
Radiant heating systems work the way the sun does: they transfer heat directly without the need of a heat transfer medium. The systems can be used for room heating, spot heating or even outdoor heating, and permit temperature control of individual areas.

There are two types of radiant-heating systems: cables imbedded in plaster ceilings, and recessed or surface-mounted heating panels. Both systems are virtually maintenance free. The ceiling cable system is most practical for new houses or additions; radiant panels can be used for most applications.

Combination Systems

Wood-Electric

Wood-electric combination furnaces are a relatively new development. They are similar in design to standard wood furnaces but contain built-in electric elements. These

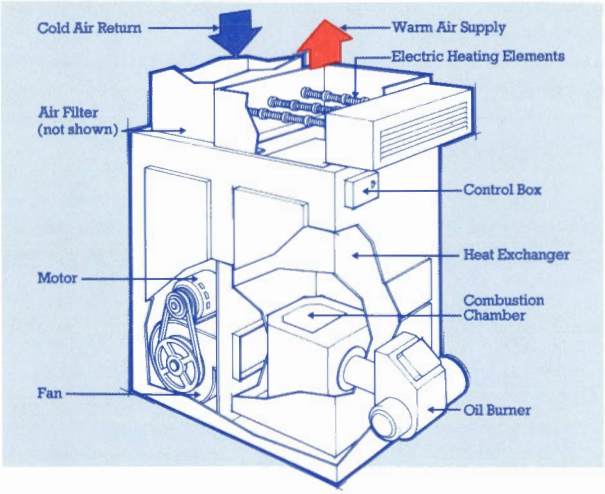


elements are activated only if the wood furnace cannot meet the heating requirements of the home. Electric baseboard heaters can also be used to supplement a central wood furnace or wood-oil combination furnace.

Note: electric plenum heaters *cannot* be added on to a forced-air wood furnace.

Oil-Electric

Oil-electric combination systems consist of an oil furnace with factory-installed electric heating elements. The electric elements will usually supply enough heat for most of the heating season and the oil burner will supply heat during only the coldest periods.



Another oil-electric combination option is to add an electric plenum heater to an existing forced-air oil heating system. The plenum heater, consisting of one or more heating coils, is inserted into the hot air plenum of the oil heating system (the plenum is part of the ductwork). The furnace's fan blows unheated air through these coils on the way to the warm air registers.

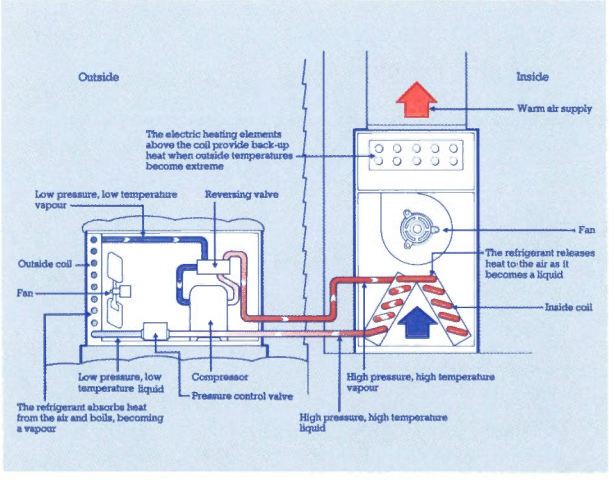
Heat Pumps

Heat pumps do not produce heat. They merely transfer or pump heat from place to place. Since it normally takes less energy to transfer heat than to generate it, heat pumps are often very energy efficient.

Although a heat pump is technically a refrigeration system, it can be used for both heating and cooling. In the summer, it removes heat from the air within the house and expels it outside much like a conventional air conditioner. In the winter, the heat pump operates in reverse, removing heat from the cold outside air and depositing it within the house.

Even very cold air contains heat. For example, at -20°C dry air contains roughly 80 per cent of the heat available at 35°C. Because heat is absent only at absolute zero (-273°C), heat pumps can operate even during the coldest Canadian winter.

Most heat pumps being sold today are air-to-air systems that operate directly between the air inside and outside the home. However, water-to-air, ground-to-air, water-to-water and ground-to-water systems are also available.



Related Equipment

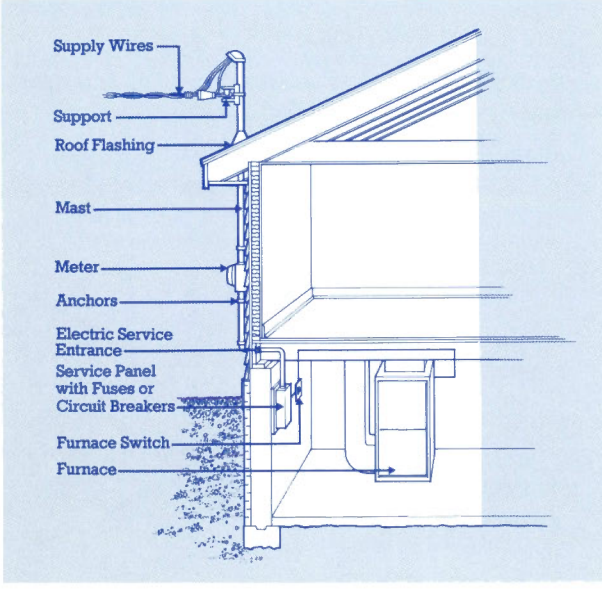
Service Panels

If you're not heating with electricity at present, your home probably has a 60A or 100A electric service. If you decide to change to electric heat you may have to upgrade your home's electric service to 200A or more.

Upgrading an electric service involves replacement of

- the electric service panel (fuse box or breaker panel)
- the three heavy wires that supply electricity to your home and their housing
- the meter base and receptacle

If you are building a new house, consider installing a 200A service no matter what type of heating system you are considering; this could avoid costly service upgrading in the future. Your utility can assess consumption of electricity and future needs and it normally has the final authority in determining a home's service capacity.



A central electric furnace will require its own switch, sized in accordance with the furnace output and usually mounted beside the main service panel.

Your local electrical utility should be consulted before any work begins. You or your electrical contractor must obtain a permit from the appropriate authority before any alteration to electric wiring can be undertaken. Some utilities are also able to provide precise information on cost and installation.

Load Management Devices

Equipment is now available to manage the extra load placed on a standard (100A) electric service when an electric heating system is added to a household. These load management devices can be applied to any electric heating system but are used primarily with electric plenum heaters added on to an oil system. Sensors on the wires supplying electricity to the house monitor the amount of electricity used. Electricity passing through these wires sets off a low-level electric current in the sensor. As house demand rises and falls, this current will fluctuate accordingly.

For instance, if the amount of electricity used in a house is heavy, say when the water heater, stove and dryer are all in operation at the same time, the device restricts the amount of current allowed to reach the heating elements of the heating system. This prevents an overloaded demand on the house's supply of electricity. (In a system using a plenum heater, the load monitor compensates for an increased household demand for electricity by temporarily switching off one or more of the plenum heater's heating elements.) Then, as appliances are turned off, the sensor responds by allowing more electricity to flow to the heating system (or by switching the plenum heater's elements back on) up to the full capacity required. Most household electric appliances produce heat as a byproduct; this will compensate somewhat for a slightly lower output by the heating system.

Load monitors may eliminate the need for upgrading to a 200A service. In some provinces, however, electrical utilities may find these devices unacceptable. Be sure to check with your electrical utility if you're considering using this kind of equipment.

Automatic Setback Thermostats

The easiest way to save heating dollars is to lower the temperature setting on your thermostat whenever possible. The surest and easiest way to accomplish this with a maximum of comfort is to install an automatic setback thermostat containing a timer that will adjust your home's temperature automatically at preset times.

For example, you could program the thermostat to reduce the temperature an hour before you go to bed and to raise it again before you get up in the morning. You could also program it to reduce the temperature during the day when the house is unoccupied and to restore the temperature shortly before you return.

Experiment with the unit after it is installed until you find the most comfortable and economical routine for you and your family.

Having an Electric Heating System Installed

If you decide to use an electric heating system, you will have to hire a contractor to install it. The first step is to ask local electrical or heating contractors for estimates. Estimates should include the following items:

- the total cost for **all** necessary work;
- an itemized listing of all work included in the bid, such as removal of existing heating equipment, and alteration or replacement of the main service panel and service entrance; the customer portion of alterations to service wires above or below grade to the transformer pole, and transformer pole replacement (sometimes the responsibility of the customer in rural areas) should also be included;
- a rough diagram showing the layout of any new wiring and the location of 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,
  - alterations to the transformer or related outside equipment that has to be done by the utility, and
  - all related costs such as subcontracts with tradespeople;
- a statement that includes when electric service will be interrupted and for how long, how much of the existing equipment will be used and when the job will be completed; and
- a schedule and method of payment.

Consider additional upgrading or improvements to house wiring while this work is being done. The provision of split receptacles to kitchen counter areas, of an electric stove receptacle or of outside lighting, or draftproofing of receptacles in outside walls, may be possible and relatively economical while the work on the heating system is being completed.

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. Some contractors may be more cooperative, and consequently, better at explaining what has to be done, may use higher quality components, or may schedule the work to your convenience.

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. Your Chamber of Commerce or Board of Trade may also be able to help. Don't hesitate to ask for a clear explanation of any aspect of the work before, during or after installation of your heating system.

In most provinces, if wiring has been upgraded, a service panel replaced, heating equipment added or load management devices installed, the work must be inspected by the utility, municipality or province. The contractor should have these inspections done before the circuits are energized or wiring is hidden behind walls.

Draftproof and Insulate First

It makes no sense to invest in a new heating system, then allow much of its heat to escape to the outdoors. To avoid this, you should draftproof (caulk and weatherstrip) and insulate, preferably **before** having your new heating system installed.

There are many advantages to draftproofing and insulating. Heating the house will cost less, and you'll be more comfortable because of fewer drafts, cold walls and cold spots. Your house will be cooler in the summer too.

Insulation, caulking and weatherstripping will alter the amount of heat needed to keep your house comfortable. To ensure that you get a heating system with the right heating capacity, do the draftproofing and insulating **before** you and your contractor determine what size of heating system is best.

Draftproofing

You can find specific spots where air is leaking by using simple procedures and common household materials. Turn off your furnace and move a piece of tissue or an incense stick slowly around the outside walls of your house. A flutter of the tissue or smoke indicates an air leak. (A downward draft along the glass surface of windows indicates air movement caused by convection, not by air leakage.)

Air leaks into the attic can be easily detected from within the attic, especially before it is insulated: Switch on all the lights in the floor below and turn off the light in the attic — air is leaking through all of the cracks showing light.

Here are some other areas where air leakage is common:

- where the walls meet the foundation (called the sill plate);
- where electric service entrances and plumbing holes have punctured the house's shell;

- where attic hatches and recessed lighting fixtures have been cut;
- around and through 'holes' in a home such as fireplaces and exhaust fans and vents;
- through electric outlets on exterior walls;
- around windows and their frames and exterior doors and their frames;
- along interior trim such as baseboards; and
- at the seams in heating and cooling ducts.

All of these areas should be sealed. Generally **caulking** is used where two surfaces meet but do not move relative to one another, such as at the sill plate. **Weatherstripping** is used wherever one surface moves relative to another, such as around windows and doors.

Insulating

Insulation wraps your house in a layer of material that slows the rate of heat escape. A popular myth is that because heat rises heat loss is greater through the attic. But heat travels in all directions and can be lost through walls and the basement as much as through the attic.

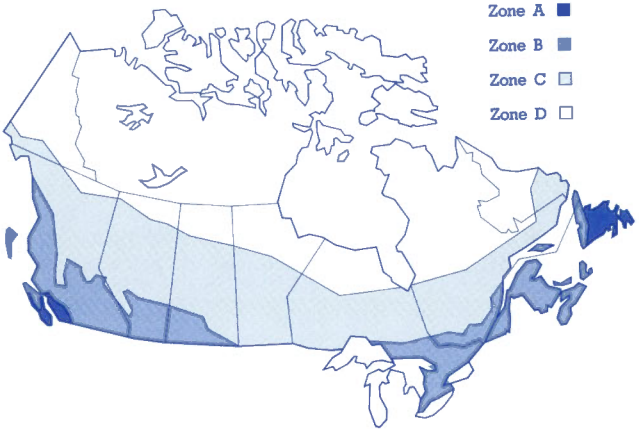
Insulation works best when used with an air-vapour barrier. A continuous sheet of 0.15-mm (6-mil) plastic is usually the best. Be sure to install it on the warm side of the insulation and to seal all its edges and any holes in it.

Where interior finishes cannot be disturbed, a vapour barrier paint, two coats of oil-based paint, or vinyl wallpaper will help prevent vapour flow. All cracks and holes in the exterior finish must be sealed; including, those found along baseboards and around door and window frames.

Another common insulation myth is that the thicker the insulation, the better it insulates. Insulation is manufactured and sold by its **thermal resistance value**, a measurement of the insulation's resistance to heat flow. This measurement is called the **RSI value** (metric) or the **R value** (imperial). The higher the RSI or R value, the better the material will insulate. One brand of insulation may be thicker than another, but if they both have the same RSI or R value they will insulate equally well.

How Much Insulation Should You Install??

The standards on this chart are based on those described in a supplement to the National Building Code (*Measures for Energy Conservation in New Buildings, 1983*). Although the code applies specifically to new buildings, these RSI (R) values reflect recent thoughts on how much insulation is practical. You may not be able to insulate an existing house to these levels because of the way it is built.



		ZONE			
		A	**B**	**C**	**D**
Walls	**RSI**	3.0	3.6	4.1	4.5
	R	17	20	23	26
Basement	**RSI**	2.2	2.2	2.2	2.2
walls	**R**	13	13	13	13
Roof or	**RSI**	4.5	5.6	6.4	7.1
ceiling	**R**	26	32	36	40
Floor (over	**RSI**	4.7	4.7	4.7	4.7
unheated areas)	**R**	27	27	27	27

Each zone on the map represents an area with similar heating requirements.

Your Final Heating Decision

Make sure you do your homework before choosing your heating system. Thoroughly investigate each of the following areas first.

Draftproofing and Insulation. Is your home ready for a new heating system?

Availability. What fuel and energy sources do you have access to?

Convenience. What systems best suit your lifestyle?

Costs. What are the costs of the fuel or energy source, equipment and installation?

You'll be using your new heating system for a long time. It's worth taking the time now to ensure you choose the right one.

Need More Information and Advice?

Free Home Energy Publications

Energy, Mines and Resources Canada has many publications that can help you understand home heating systems, how your house uses energy, and what you can do to reduce your energy costs while increasing your comfort.

Want to Draftproof and Insulate?

Keeping the Heat In is a guide to all aspects of home insulation and draftproofing. Whether you plan to do it yourself or have someone else do the work, this book can help make it easier.

Enerfacts is a series of informative, easy-to-read fact sheets. Many of the *Enerfacts* fact sheets look at specific aspects of draftproofing and insulating. They can help you sort out the materials and procedures involved in determining where your house loses energy and what to do about it.

How About Home Heating Systems?

The Billpayer's Guide to Heating Systems will show you how heating systems work. It discusses the major energy sources available to most Canadians, including oil, electricity, natural gas, wood and propane.

If you are interested in a particular energy source, you may find EMR's booklets on heating with wood, heating with electricity, heating with natural gas, or solar hot water heat helpful.

In addition, *Enerfacts* fact sheets are available on energy-efficient oil and gas furnaces and heat pumps. If you are thinking about buying any of this equipment, you'll appreciate the information these fact sheets contain.

For more specific advice on **your** home's energy efficiency

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