



Office of
Energy
Conservation

Choosing a High-Efficiency Natural Gas or Propane Fuelled Forced Air Furnace

When winter approaches people start to think about repairing or replacing the heating system in their home. Read this article to find out more about natural gas or propane-fuelled high-efficiency forced air furnaces (recommended choice for forced air heating systems) and about two rating programs for furnaces, considerations when purchasing a new furnace, maintenance issues, and financial assistance programs to assist you in purchasing a new furnace.



Choosing a High-Efficiency Natural Gas or Propane Fuelled Forced Air Furnace

When purchasing a high-efficiency natural gas or propane-fuelled forced air furnace, it is recommended to:

- Purchase an EnergyStar® rated furnace,
- It is important that each quote you receive includes the items from the checklist provided in this article,
- Ensure that the furnace is sized to be 30-40% larger than the calculated heating requirements of the home, **but no larger!**
- Read and understand the quoted warranty details,
- Comparison shop (obtain quotes from more than one place),
- Make sure that the disposal of the old furnace is included in the quote,
- Find out the details and features of the thermostat that is included with the furnace (if a thermostat is included),
- Question the heating contractor on the size of blower fan motor,
- Purchase a furnace with a direct current (DC) blower fan motor,
- Request that provided quotes include the cost of any ductwork modifications and electrical work,
- Ensure that the cost of resizing the chimney to allow other combustion appliances to operate safely and efficiently is included in the quote,
- Have the cost of all permits and inspections included in the price,
- Have a damper installed on the combustion air supply if there are no other combustion appliances in the home,
- Advise heating contractor if you have central air conditioning,
- Confirm that the furnace blower fan will provide enough air flow to prevent a central air conditioning unit's heat exchanger from freezing up,
- Ask if a condensate pump will be required,
- Select a furnace with a two-stage or multi-stage burner,
- Purchase a furnace with a variable speed, direct current motor,
- Clean or replace the furnace filters at least four times per year, and
- Have the furnace inspected at least every two years.

Introduction to High-Efficiency Furnaces:

High-efficiency natural gas or propane fuelled forced air furnaces have two heat exchangers built into them (labelled as primary and secondary in Figure 1) allowing them to extract more useful heat from the burning of natural gas or propane than either conventional or mid-efficiency furnaces which only have one heat exchanger (primary). This removal of additional heat causes condensation to occur in the exhaust air flow of the furnace, which is why this style of furnace is often referred to as a “condensing furnace”. The liquid that condenses (called condensate) is then drained from the furnace to the house sewer either by flowing down to a floor drain or by being pumped to a drain system nearby. The extraction of the additional heat, compared to conventional and mid-efficiency furnaces, cools the exhaust air flow of a high-efficiency furnace enough to be safely vented out the side of the building through a plastic pipe rather than being exhausted through a conventional chimney. High-efficiency furnaces use an induced draft fan to draw air through the combustion chamber and heat exchangers before venting it outside.

Using the two heat exchangers, high-efficiency furnaces can extract between ninety-two and ninety-six per cent of the heat generated during the burning of natural gas or propane. In other terms, for every dollar spent on natural gas or propane that is burned in the furnace, ninety-two to ninety-six cents worth of heat is delivered to the house. In comparison, mid-efficiency furnaces often have efficiencies in the seventy-eight to eighty-seven percent range, and conventional furnaces are often around sixty percent efficient. In a home with a conventional furnace that currently spends one thousand dollars per year for space heating, upgrading to a high-efficiency furnace would save approximately three hundred sixty dollars per year.

Besides saving energy, and corresponding money, high-efficiency furnaces have other advantages over mid-efficiency furnaces. Since, the exhaust products from a high-efficiency furnace have a lower temperature, they can be exhausted out the side of the house. This provides the opportunity to downsize (or remove if no other combustion devices require it) the chimney. Reducing or removing the chimney improves the air tightness of the home and reduces the amount of heat required to keep the house warm during cold weather. Conventional furnaces continually allow warm house air to escape up the chimney during cold weather, which increases the amount of heat required in the home.

Another advantage of most high-efficiency furnaces is that they draw in outside air to use in the burning of the natural gas or propane, rather than using the warm inside air. With less warm air being exhausted from the house, less heating is required.

There are a couple of possible difficulties to be considered when upgrading to a high-efficiency furnace. First, in extremely air tight houses it is possible to cause humidity problems when installing a high-efficiency furnace if the old chimney is removed. In this situation humidity problems occur due to the reduced amount of air changes in the home. If this occurs it can be remedied by bringing more outside air into the home. Although additional outside air can be brought into the house by installing a continuously running low noise bathroom fan and a fresh air intake, it is recommended that the fresh air be provided using a heat recovery ventilator.

Another possible problem when upgrading to a high-efficiency furnace is noise from air movement. A high-efficiency furnace blows more air through the duct work of a house than a conventional furnace of the same size to help increase the furnace efficiency. In many cases this will not be a problem as long as the furnace has been sized properly for the house. Most existing furnaces are oversized for the house and a smaller (properly sized) furnace will produce less noise.

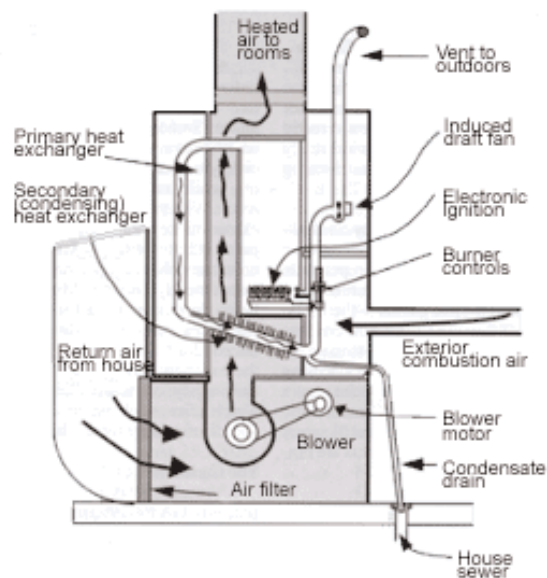


Figure 1: High-Efficiency Furnace Schematic

(reprinted with permission from the Manitoba R-2000 New Home Program)

The EnerGuide and EnergyStar® Rating Systems:

The EnerGuide program is run by the Office of Energy Efficiency (OEE), a division of Natural Resources Canada (NRCAN). The program rates the energy consumption and efficiency of household appliances, heating and ventilation equipment, air conditioners, houses, and vehicles. Using this rating system consumers can shop around for the most energy efficient choices.

While EnerGuide provides buyers with the ability to shop and compare energy ratings, EnergyStar® identifies products that meet prescribed higher levels of energy efficiency. **Therefore, it is recommended that an EnergyStar® furnace be installed.**

To learn more about these programs visit the following Office of Energy Efficiency websites:

EnerGuide: <http://www.oee.nrcan.gc.ca/energuide/>

EnergyStar®: <http://oee.nrcan.gc.ca/energystar/>

Considerations When Buying:

There are many considerations when purchasing a new high-efficiency forced air furnace that burns natural gas or propane. The following is a list of items that should be included in each quote that you receive, followed by a brief description of each item.

- Furnace efficiency
- Calculated furnace size
- Warranty details
- Brand name and model number of the quoted furnace
- Disposal of the existing furnace
- Thermostat included
- Blower fan motor size
- Direct current (DC) or alternating current (AC) blower fan motor
- Ductwork modifications
- Electrical work
- Modifications to the existing chimney
- Permits and inspections
- Modifications to the combustion air supply
- Sufficient air flow for central air conditioning
- Condensate pump
- Two-stage or Multi-stage burner
- Variable speed blower fan motor

Furnace Efficiency:

As mentioned previously, high-efficiency furnaces have efficiencies in the ninety-two to ninety-six per cent range. The higher the efficiency the less natural gas or propane required to provide the same amount of heat to the home. Therefore, look for furnaces with efficiencies of at least ninety-four per cent. **It is recommended to have an EnergyStar® furnace installed as they are the most energy efficient furnaces in their class (see the previous EnergyStar® discussion).**

Calculated Furnace Size:

In most situations in Canada, the forced air furnaces currently installed in houses are dramatically oversized. It is important to make sure that the size of the new furnace has been determined based on heating calculations and not simply on the size of the currently installed heating system. The heating calculations will indicate the amount of heat required in the home. According to the CAN/CSA standard F-280-M90 titled “*Determining the Required Capacity of Residential Space Heating and Cooling Appliances*” the size of the heating system should not exceed the heat required in the building by more than forty per cent. For high-efficiency furnaces, shorter “on” times allow the furnace to operate more efficiently, therefore, **high-efficiency furnaces should be sized to be thirty to forty percent larger than the calculated heating requirements of the home, but no larger.**

The Office of Energy Efficiency, as part of their EnerGuide program has developed a Heating Cost Calculator to assist home owners in selecting a new heating system for their home. This tool can be found on the internet at:

<http://www.oeec.nrcan.gc.ca/equipment/>

This tool allows you to *estimate the heat required in your home* based on the current consumption.

Warranty Details:

When comparing high-efficiency furnaces with similar performance specifications the differences in warranty details can be the deciding factor. **Read the quoted warranty details carefully to make sure that you understand what is covered by the warranty and what is not.**

Brand Name and Model Number of the Quoted Furnace:

The EnerGuide Heating Cost Calculator mentioned in the furnace sizing section can be used to estimate the heat required in your home, and to compare the expected energy use of up to five heating systems. This tool is very handy if you are considering heating systems that use different fuel sources. To compare forced air furnaces that will all be using the same fuel it will be necessary to be able to look up some additional specifications on the furnace either at the manufacturer's web-site or preferably in the "Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment" found at <http://gamanet.org> in the consumer information section. **It is important to obtain the brand name and model number as they will be required to look up further information on the furnace.**

Many furnace suppliers are not as familiar with the electrical consumption of the furnaces that they carry as they are with the efficiency of the furnaces. Having the brand name and model number will allow you to find out how much total energy the furnace is expected to use (natural gas or propane and electricity). The manual from the gamanet.org website provides detailed instructions on how to compare the operating costs of two furnaces, but it requires knowledge of the heat required by the building (see the Calculated Furnace Size section earlier in this document).

Disposal of the Existing Furnace:

If this is not explicitly stated in the quote, the contractor may charge you extra to remove the old furnace from your home.

Thermostat Included:

Many furnaces come with new thermostats. In the same way that there are multiple furnaces on the market there are also multiple thermostats on the market. To make it easier to find out the details about the thermostat that will be supplied with your furnace, it is recommended to make sure that the quote includes the brand name and model number of any thermostat that will be provided.

The thermostat installed should have an adjustable run time setting (sometimes called dead band, or span), and be able to control the central air conditioning unit if one is installed. The adjustable run time setting allows adjustments to be made to the length of time that the furnace runs when it comes on, which can improve the efficiency of the furnace and the comfort in the home. For more information on this topic please refer to the article on Furnace Oversizing found at the OEC website (www.oec.ca) in the residential section. **It is recommended that a programmable thermostat be installed which can be programmed to perform temperature setback over night and when the house will be unoccupied for more than four hours.** By reducing the temperature setting during the winter (increasing it during the summer) over night and during unoccupied periods energy savings of approximately 3% per degree Celsius setback can be achieved. **For energy efficiency reasons set the temperature back five degrees Celsius or more, unless there are young children in the home or it is found to be uncomfortable, in which case set the temperature back three degrees Celsius.**

Blower Fan Motor Size:

One detail that is often overlooked when purchasing a high-efficiency furnace is the amount of electricity that the furnace will consume. In a high-efficiency furnace the largest consumer of electricity is almost always the blower fan motor. This motor drives the fan which distributes the air throughout the house. If this motor is over-sized it could end up costing a fair amount more money to operate the furnace than is necessary, especially if the furnace blower fan is used with a central air-conditioning system or to continuously circulate the air in the home.

The following is an example of the costs that can be incurred by having an over-sized furnace blower fan motor. Looking at the gamanet.org appliance listing and selecting two furnaces made by the same manufacturer with the same input capacity (29.3 kW – 100,000 British Thermal Units per hour) provided the following average annual energy consumption values for the two furnaces: 376 kWh per year and 1,488 kWh per year. Therefore, if the 29.3 kW furnace that you purchased for your home was the second of those two furnaces it would cost you an extra [1,488 kWh per year – 376 kWh per year] * \$0.0859/kWh = **\$95.52 per year** and this assumes that the furnace is only being run during the heating season. If the furnace blower fan is used to provide central air conditioning or circulate the house air continuously this cost difference can be as much as three times higher.

As there is no easy method to determine if the blower fan motor installed in the quoted furnace is oversized or not, it is recommended to ask the supplier why they are suggesting the quoted blower fan motor size.

Direct Current (DC) or Alternating Current (AC) Blower Fan Motor:

Even if the blower fan motor is not oversized (see previous item) it may be consuming more electricity than is necessary. Variable speed DC motors (sometimes referred to as electronically commutated motors) can use dramatically less energy than AC motors of the same size. Although DC motors usually cost \$500 to \$800 more, their return on payback is quite attractive. For example SaskEnergy estimates that the savings achievable by purchasing a furnace with a variable speed DC motor can be as much as \$145 per year. If the average increase in cost to get a furnace with a variable speed DC motor instead of an AC motor is \$700, the rate of return on upgrading to the DC motor is 20.7%. **It is strongly recommended that a variable speed DC motor be included in the installed furnace.**

Ductwork Modifications:

As not all furnaces are the same size and shape, some modification may be required to make the new furnace connect properly to the existing ductwork. **If the quote does not mention this, make sure to ask as there may be an additional charge for the changes to the ductwork.**

Electrical Work:

Sometimes, when replacing an old furnace, the wiring running to the furnace will need to be upgraded or modified. **If the quote does not make mention of the costs to modify the existing wiring make sure to ask as there may be additional charges.**

Modifications to the Existing Chimney:

Since high-efficiency furnaces vent out the side wall of the house the existing chimney will need to be reduced in size or removed depending on if there are other combustion appliances that vent up the chimney, water heaters for example. If there are no other combustion appliances using the chimney, the chimney should be removed or capped and sealed to prevent warm house air from escaping up the chimney during the cooler months. **If there are other combustion appliances using the chimney, the chimney will need to be resized to ensure that they continue operating safely and effectively.**

Permits and Inspections:

The cost of permits and inspections is almost always included in quotes. **It is recommended that you confirm that the cost of all permits and inspections are included in the price to prevent any later surprises.**

Modifications to the Combustion Air Supply:

In most cases, when installing a high-efficiency furnace the combustion air supply can be reduced in size or removed depending if other combustion appliances are in use in the home. **After installing a high-efficiency furnace that draws air directly from outside for use during the burning process it is recommended to install a damper in the combustion air supply if there are no other combustion appliances in the home.** If other combustion appliances exist in the home (water heaters, natural gas clothes dryers, etc.) it may be necessary to keep the combustion air supply.

Sufficient Air Flow for Central Air Conditioning:

Furnaces that are also used for central air conditioning need to circulate more air than those used solely for heating. The additional air flow is required to ensure that the air conditioning heat exchanger in the furnace does not freeze up. **If you have a central air conditioning unit it is important that everyone providing you with quotes knows before they submit their quotes.**

Condensate Pump:

In some situations the furnace is not located in a convenient location to drain the condensate into the house's sewer lines. In these cases a small electric pump is installed with the furnace to pump the condensate to the house's sewer. **Make sure to ask if a condensate pump will be required as it may increase the cost of the quote.**

Two-stage or Multi-stage Burner:

Furnaces with two or more burner stages are recommended for the majority of houses in Saskatchewan. Furnaces with two-stage burners can burn natural gas (or propane) at two different rates when providing heat to the home. When on low-fire the furnace burns less natural gas (or propane) and provides less heat to the home. This is sufficient to keep the house warm during the majority of weather while also allowing the furnace to run for a longer period of time distributing the heat more evenly throughout the home. During extremely cold weather or when recovering from a temperature setback period the furnace can burn on high-fire, burning more natural gas (or propane), to provide the heat required. **As they will use less energy during the milder weather it is recommended to install a furnace with a two-stage or multi-stage burner.**

Variable Speed Blower Fan Motor:

Variable speed blower fan motors, either AC or DC (preferred), will save considerable energy over a fixed speed motor. It is preferable to install a DC variable speed motor to minimize the electrical consumption of the furnace. **If the furnace has a two-stage or multi-stage burner than a variable speed blower fan motor is very strongly recommended. If the furnace blower fan is going to be used to continuously circulate air in the house it is strongly recommended that a variable speed blower fan motor be installed.**

Maintenance Considerations:

As with all types of furnaces, high-efficiency furnaces operate most effectively if they are well maintained and serviced. This maintenance and servicing should include periodic cleaning or replacement of the furnace filter (**at least four times per year**), inspection of the furnace to check for build up on the burners and cracks in the heat exchangers (**at least every two years**), and ensuring that registers and cold air returns are not blocked (refer to the article on Blocking Forced Air Furnace Registers found at the Office of Energy Conservation's website (www.oec.ca) in the residential section).

Financial Assistance Programs:

The Federal Government of Canada announced in the summer of 2003 a home energy efficiency improvement program called the EnerGuide for Houses Grant Program. This program provides financial incentives to home owners who improve the energy efficiency of their homes. To qualify for the program home owners contact the representatives of the program (contact the OEC Hotline at 1-800-668-4636 to find out who is currently providing the program in Saskatchewan) and arrange to have an audit performed on their home. At the end of the audit the home owner receives a report providing them with a rating for their home. The home owner then performs retrofits at their own cost. The program's representatives then return to the home and perform a second audit to determine how much the house has been improved. Based on the amount that the house has improved the home owner receives a financial incentive from the federal government. To find out more about this grant program see the following website: <http://oee.nrcan.gc.ca/houses-maisons/english/homeowners/grant/grant.cfm>

Another source of possible assistance is SaskEnergy. SaskEnergy has a program in place that encourages home owners to install high-efficiency natural gas equipment including high-efficiency forced air furnaces. The current program runs until March 31, 2005 and requires that the furnace being installed is EnergyStar® certified. Although the program does not provide grant money it does provide home owners with a low interest rate loan option when purchasing a new furnace. Check with your local SaskEnergy office to see if there is an incentive program running this season, or check out their website at www.saskenergy.com

Other articles of interest:

For information on the effects of furnace over-sizing and some tips on what you can do to reduce these effects check out the "Effects of Furnace Over-sizing in Residential Situations" article found on the OEC web-page (www.oec.ca) in the residential section.

For information on the effects of blocking a furnace's warm air supply registers or cold air return registers refer to the "Effects of Blocking Forced Air Furnace Registers" article found on the OEC web-page (www.oec.ca) in the residential subsection of the programs section.