The Science of Home Heating

– Furnaces, Boilers, Heat Pumps, and More

How will you stay warm this winter? As temperatures dip, Canadians need fires, furnaces, heat pumps, or radiators to keep us cozy.

Which heating system is best? That depends on many factors, such as cost, efficiency, and environmental impact.

About 45 percent of Canada's carbon emissions – the greenhouse gases responsible for climate change – come from burning fossil fuels to make energy, including heat and electricity. Half of that is produced by industries, but the other half comes from houses, shops, schools, and so on.

We worry when we leave a car idling for ten minutes. But "your house is basically idling all day," says Green Buildings Engineer Brady Faught.

Reliable furnaces

About six in ten Canadian homes use forced-air furnaces for heat. These are usually powered by propane, natural gas, or electricity. Some older models rely on oil.

Here's how they work. Heat produced inside the furnace's **combustion** chamber warms the air above it. A fan then circulates the air through ducts and releases it in vents to warm the rooms. Waste gases from the combustion chamber escape through a chimney.

Furnaces heat homes quickly and evenly. Modern, high-efficiency ones claim to be 90 percent efficient or better. That means 90 percent of the fuel you put in is used for heating. It isn't lost through chimneys as waste gas.

A furnace can last 15 to 30 years or even longer. Where there's central air conditioning, the ductwork can also circulate cold air in the summer. But furnaces can be noisy – and, of course, most burn fossil fuels.

The boiling point

Boilers work in a similar way. The heat source can be natural gas, propane, oil, or electricity. Water inside the central boiler is heated until it, well, boils. This hot water travels through the house via pipes. They reach floor heating grids or radiators, or both.

Boilers are the most effective heating systems because they heat the floor and objects in a home, not just air. But they are no longer popular because they heat slowly and the heat is hard to control. Repairs can be tricky and expensive, too. A leak means water damage, and the pipes are sometimes hard to get at.

The electric option

Electric baseboard heaters rely on natural **convection** currents.

DEFINITIONS

COMBUSTION: the process of burning something

CONVECTION: the movement caused within a fluid by the tendency of hotter and therefore less dense material to rise, and colder, denser material to sink under the influence of gravity, which consequently results in transfer of heat

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Cold air enters the heater at the bottom. As a series of electric coils warm it, the air rises. The air nearest the heater is hottest. But heat naturally wants to move from a high-heat-energy to a low-heat-energy area. So warmth **disperses** throughout the room.

Electric baseboards are not as cost-effective as some other forms of heat. "They're just like having a toaster running in your house all day," says Mr. Faught. But they are cheap to install and can last 20-plus years.

Electric baseboard heaters are popular in provinces with a lot of hydro power. In Newfoundland and Labrador, 60 percent of homes use them. In Quebec, 58 percent do.

When electricity is generated with hydro, baseboards are environmentally friendly. When power is generated using fossil fuels, they are less so.

A Fire Inside

Fires used to be the main heating source in Canada. Some homes today still use a wood stove or a fireplace for heating.

If wood is readily available, fires can be an inexpensive way to heat a home. However, they release carbon into the atmosphere, and come with other dangers. Just as with furnaces, a chimney or flue is necessary to get rid of poisonous gases such as carbon monoxide.

Why Heat Pumps Rock

Finally, what about heat pumps? Using heat pumps could "reduce global greenhouse gas emissions by more than 500 million tonnes" by 2030, according to Efficiency Canada. What's more, the pumps can both warm *and* cool a home.

This relatively new technology runs on electricity. In winter, heat pumps pull air in over an outdoor coil that contains liquid refrigerant. A small amount of heat boils the refrigerant, turning it into vapour. The vapour is then compressed until it becomes a hot gas. The hot gas goes to an indoor coil. The air over the coil warms up, and fans blow it into the house.

When the refrigerant exits the coil, it moves through an expansion device. As it cools, it returns to liquid. The liquid then goes back to the outdoor heat exchanger, so the cycle can continue. In summer, the process happens in reverse.

Heat pumps are the most energy-efficient heating source because they don't rely on combustion. So why aren't they more popular? Cost is one factor. Although heat pumps are economical to run, they can be expensive to install. Also, older heat pumps didn't work well below 0 degrees Celsius. But new technology allows some units to function at as low as -25 degrees Celsius. And on very cold days, other heating systems can be used to kick in and help.

"To suggest that we cannot heat a home without natural gas or oil is false," said Mr. Luymes. "Really, every household in the country should be at least contemplating purchasing a heat pump." ★

Staying Warm

In 2023, just seven percent of Canadian households reported using heat pumps. In the highest-income group, the number was nine percent. In the lowest-income group, it was closer to five percent.

About 56 percent of the highest income households rely on oil and natural gas for heating. Electric heating is most common in lower-income households, at 47 percent. Renters (52 percent) are more likely to use electric heating than homeowners (27 percent).

DEFINITIONS

disperse: distribute or spread over a wide area

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COMPREHENSION QUESTIONS

1. Where do almost half of Canada's carbon emissions come from?

2. How did people who lived in Canada many decades ago heat their homes?

3. How are most Canadian homes heated nowadays? How are these units usually powered?

4. Describe how a furnace works.

5. How efficient are modern furnaces?

6. How does a boiler heating system work? How do boilers make the heat they use to warm the water?

7. Explain how an electric baseboard heater works.

8. Why are modern heat pumps the most energy-efficient type of home heating?

9. How are most heat pumps powered?

10. Describe how a heat pump works.

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ORGANIZER

A. There are a variety of home heating systems available. Add point form notes to the organizer below to compare and contrast how they work, and the pros and cons of each type of system.

Type of Heating System	How does it work?	Pros	Cons
Forced Air Furnace			
Boiler			
Electric baseboard heaters			
Wood stove			
Heat pump			

B. After gathering and considering the information in the above table, ***I believe that the best type of home heating system is*** _____ ***because*** _____

Some considerations might be: _____

_____

_____

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QUESTIONS FOR FURTHER THOUGHT

1. The article quotes Brady Faught, a green buildings engineer in Vancouver, who points out that people worry about leaving a car idling for ten minutes—but "your house is basically idling all day." What does he mean by this statement? Give examples to explain your thinking.

2. Martin Luymes, a vice-president with the Heating, Refrigeration, and Air Conditioning Institute, believes that heat pumps are an effective replacement for any other source of heating. "Really, every household in the country should be at least contemplating purchasing a heat pump." As you see it, what might be some of the reasons that all Canadian households have not already purchased a heat pump?

3. What are some simple ways that anyone could cut down on their home energy use in the winter? Provide examples.

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PUTTING IT ALL TOGETHER

A. Write the letter that corresponds to the best answer on the line beside each question:

_____ 1. **What type of home heating system is most common in Canada?**

a) wood stoves
b) forced-air furnaces
c) baseboard heaters
d) heat pumps

_____ 2. **How many Canadian homes use heat pumps?**

a) 7 percent
b) 14 percent
c) 26 percent
d) 42 percent

_____ 3. **Heat pumps are powered by:**

a) natural gas
b) oil
c) propane
d) electricity

B. Mark the statements T (True) or F (False). If a statement is True, write one important fact to support it on the line below. If a statement is False, write the words that make it true on the line below.

_____ 4. **True** or **False?** Modern furnaces can be 90 percent efficient.

_____

_____ 5. **True** or **False?** Heat pumps transfer heat rather than produce it.

_____

_____ 6. **True** or **False?** Modern heat pumps stop working at about 0 degrees Celsius.

_____

C. Fill in the blanks to complete each sentence.

7. Almost half of Canada's carbon emissions come from burning _____ fuels to make energy.

8. A boiler heating system transfers hot water to a floor heating grid or a _____ .

9. Baseboard heaters rely on natural _____ currents to heat a room.

D. Respond to the following question in paragraph form. ***(Use a separate sheet of paper if necessary.)***

10. Provide an overview of how one of the home heating systems described in the article works, then summarize its pros and cons.

_____

_____

_____

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