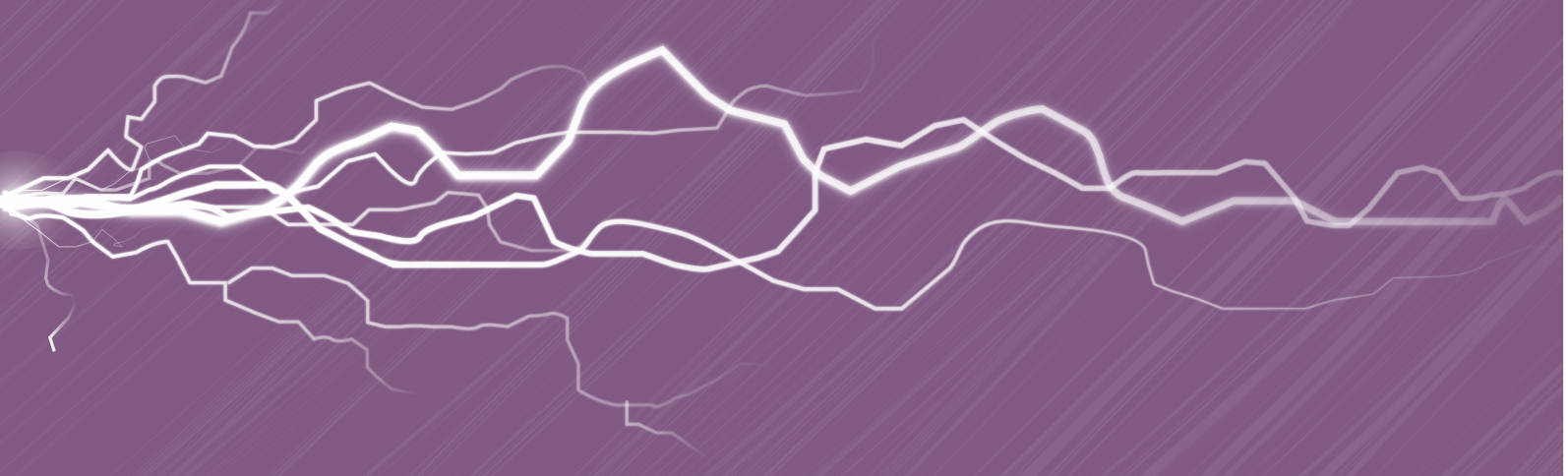
Skeena Watershed
Conservation Coalition

UPPER SKEENA HOME HEATING SOLUTIONS

A Practical Decision-Making Guide

August 2025



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SKEENA ENERGY SOLUTIONS

S W C C

EMPOWERED ENERGY SOLUTIONS TEAM

Skeena Watershed Conservation Coalition (SWCC) work focuses on the conditions for change at a community level in our watershed. Each year, SWCC delivers an ongoing schedule of activities that support the development of future leaders, conduct innovative science and research expeditions, collaborates with knowledge holders, regional experts, elected and Hereditary leaders, community economic development practitioners and create sustainable employment opportunities. Renewable energy and energy use are very important topics in the Upper Skeena as a key component to a healthy ecosystem, economy and community in the future. This approach earned SWCC the recognition as one of the top ten most effective and innovative organizations in Canada – twice!

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PROJECT OBJECTIVE

In October of 2021, we at the Skeena Watershed Conservation Coalition (SWCC) started a deep dive to understand where the Upper Skeena was in the energy security and sovereignty conversation. The Upper Skeena Regional Energy Plan came from this work. This plan gives us a thorough baseline of the energy issues the region was faced with and the start of solutions to address them.

WHAT IS ENERGY SECURITY?

The International Energy Agency (IEA) defines **energy security** as the uninterrupted availability of energy sources at an affordable price to users.

The four pillars of energy security are:

ENERGY

AFFORDABILITY | AVAILABILITY | RELIABILITY | SUSTAINABILITY

In our work with the Upper Skeena community, we found many households struggle with the payment of utility bills for heat and power, the amounts of power black and brown outs, the costs of not having dependable power (i.e., loss of fridges and freezers), and the lack of backup options for when power is lost. The volume of power outages in the Upper Skeena is higher than in other regions of BC.

Another important realization that came from creating the Upper Skeena Regional Energy Plan was that a large component of residents struggled with energy loss due to inefficient homes. These issues came from aged out, old housing infrastructure like doors and windows, poor ventilation, insufficient insulation (R-value), and heating systems that were not working well, not the right size, and/or expensive to operate.

As an added benefit of our Empowered Energy Solutions work, we have developed a decision-making matrix for region-specific heating options and renewable energy technologies to start the transition to a low carbon energy future.

For the heating decision-making matrix, we did an honest and fulsome appraisal of heating systems and fuels – including natural gas. Although there is no Liquified Natural Gas (LNG) supply line to the area, we felt we needed to discuss the option nonetheless.

RESIDENTIAL HOME HEATING

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 your costs and make your home more comfortable.

You will be using your new or improved heating system for a long time, so take the time now to investigate your options and ensure 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.

In this time of endless choices and ever-expanding markets, including such products as heating technologies, renewable energy infrastructure, and home retrofitting options, this guide helps to simplify your decision making.

Our goal is to concentrate and distill up-to-date energy-related information to make informed decisions easier for the residents, businesses, and local governments of the Upper Skeena region. We've developed a Decision-Making Matrix to simplify the process of selecting home heating systems, exploring renewable energy alternatives, and starting your journey towards energy retrofiitting your home.

HOW DOES THE UPPER SKEENA HEATING DECISION-MAKING MATRIX WORK?

In this decision-making matrix, you will find the best option between alternative heat sources based on a number of factors and their relative importance, while employing the following steps:

STEP 1: Finding the alternatives

The Decision-making matrix is a tool that will help you pinpoint the best options from a set of available choices that are suitable to our climate and location. Therefore, identifying the options is the first step before building the decision matrices.

STEP 2: Identifying crucial points

Next, you must identify considerations and criteria that are most important to you to ensure your getting the solutions that will be the most relevant and specific to your needs. The criteria and definitions for the heating decision-making matrix is outlined on the following page.

For residential heating decisions the following criteria is used:

CRITERIA	HOW THE GUIDE APPLIES THE CRITERIA
Energy Security	Heating choices directly impact energy security by determining how reliant a household or region is on specific energy sources, with options like renewable energy sources promoting greater energy security by diversifying fuel options and reducing dependence on volatile fossil fuels, while relying heavily on fossil fuels can leave communities vulnerable to price fluctuations and supply disruptions. (Google AI). *The score will reflect how the chosen system will help with energy security.*
Energy Efficiency	Energy-efficient heating systems help you reduce your energy consumption significantly which translate into savings on utility bills as well as leaving a smaller carbon footprint behind. Energy efficient heating systems also improve comfort levels in your home by minimizing wasted heat without compromising warmth. *The score will reflect how energy efficient the chosen system is.*
Enviro Impact	The environmental impact of home heating systems is the release of greenhouse gases, primarily carbon dioxide, due to the burning of firewood and fossil fuels like propane, oil, and natural gas which are commonly used to power furnaces and boilers, which significantly contribute to climate change. (Google AI) The extraction processes and transportation of these fuels can lead to air pollution and habitat destruction depending on the method used. You can mitigate these environmental impacts through choices of heating system, regular maintenance, and improving your homes efficiency through Upgrade insulation, seal air leaks, and install smart thermostats to minimize heat loss and optimize energy usage. *The score will reflect how the chosen system impacts the environment.*
Equipment Cost	Heating systems are usually one of the most expensive components of building a home as well as a large part of your budget when renovating or doing energy efficiency upgrades. An important factor in the decision making of purchasing a new heating system is how the upfront cost will ultimately save you money in the long-term and meet your goals of having an energy efficient home. *The score will reflect how expensive the system in comparison to others.*
Average Fuel Cost	It is important to know the average fuel cost for your home heating system and how much fluctuation of costing can happen and how that effects the affordability of heating your home. Fluctuations in home heating fuel costs are primarily driven by changes in supply and demand, with factors like weather extremes (especially cold winters), global oil market trends, geopolitical events, and seasonal variations significantly impacting prices, particularly for heating oil, where demand spikes during cold weather, leading to price increases. (Google AI). *The score will reflect how expensive and volatile the fuel cost is for chosen system.*
Equipment Reliability	Heating system reliability depends on the type of system, maintenance, and age. Knowing the heating system maintenance schedules will lengthen the life of your heating system and its overall efficiency. *The score will reflect the overall reliability of chosen system.*
Comfort	Home heating comfort means keeping a steady, pleasant temperature indoors. This is usually done with a heating system set to a comfortable range, ensuring warmth that's neither too hot nor too cold. It's not just about the temperature but also factors like consistent airflow and humidity levels that contribute to overall comfort in a home environment. (Google AI) *The score will reflect the comfort level relative to other systems.*

STEP 3: Creating a decision matrix

To prepare a matrix grid for comparing important factors requires you to list all of your options as the row labels on the table. Include the list of factors as the column headings.

STEP 4: Filling out the decision matrix (scoring)

The next step in building a decision matrix is to rate every consideration on a predetermined scale.

Upper Skeena *Heating* Decision-Making Matrix Scoring

Scoring will be done though 1 to 5 for given factor:

1 Point – Lowest Score. Does not meet any of your selected heating needs.
2 Points – Low score. Does not meet most of your selected heating needs.
3 Points – Moderate score. Meets some of your selected heating needs.
4 Points – High score. Meets most of your selected heating needs.
5 Points – Perfect score. Meets all of your selected heating needs.

USING THE *HEATING* DECISION-MAKING MATRIX:

1. **Examine the matrix grid of heating options and their given criteria for heating options for the Upper Skeena.**
2. **Choose the option you want to learn more about for each section/option. There is a summarized version of the decision options and supplemental information if you want to have a comprehensive look at the technologies.**

The higher the total score, the more aligned the choice is based on your criteria.

Upper Skeena Renewable Energy Decision-Making Matrix
SCORING SUMMARY

For heating option decisions the following criteria is used:

Heating Option	Options	Fuel	Energy Security	Energy Efficiency % Range	Enviro Impact	Equip Cost	Avg Fuel Cost	Equip Reliable	Comfort	Fuel Avail-ability	Health Impact	Self Sustain-ability	Total
Nat Gas Boiler	Hydronic	NG	3	4	3	3	5	4	5	1	4	5	37
Propane Boiler	Hydronic	LPG	3	3	2	2	1	4	4	3	4	4	30
Electric Boiler	Hydronic	ELEC	4	5	4	3	2	4	5	4	5	5	41
Wood/Pellet Boiler	Hydronic	BIO	4	2	2	2	4	3	3	5	3	1	29
Natural Gas Furnace	Forced Air	NG	3	4	3	4	5	4	5	1	4	5	38
Propane Furnace	Forced Air	LPG	3	3	2	3	1	4	5	3	3	4	30
Electric Furnace	Forced Air	ELEC	4	5	4	4	2	5	5	4	5	5	43
Wood/Pellet Furnace	Forced Air	BIO	4	2	2	2	4	3	3	5	3	1	29
Heat Pump	Zone	ELEC	4	5	4	4	5	4	5	4	5	5	45
Gas Space/ Wall Heater	Zone	NP/ LPG	3	3	2	4	4	3	3	2	3	4	31
Gas Fireplace	Zone	NP/ LPG	3	3	2	4	4	3	4	2	3	4	31
Wood Stove Firerplace	Zone	BIO	4	2	2	3	3	5	4	5	3	1	34
Pellet Stove Fireplace	Zone	BIO	4	2	2	3	3	3	3	3	3	2	28
Electric Baseboard	Zone	ELEC	4	5	4	5	2	4	4	4	4	5	40
Ground Source HP	Special	ELEC	4	5	3	2	4	4	4	4	5	5	40
Oil Furnace	Special	Oil	2	1	1	3	1	3	3	2	1	3	20

1 2 3 4 5

Does not meet heating needs → Meets all heating needs

***See Appendix for further explanation of Fuel Availability Scoring, Health Impact Scoring and Self Sufficient Scoring*

OUR RESEARCH APPROACH

We worked with a heating and HVAC specialist who gave us current information of the heating technologies that are available today and what the homeowner-consumer needs to know and consider before purchasing.

The matrix scoring was developed by a Heating and HVAC specialist who took local factors into consideration in the development. These factors include local climate, geography, and fuel availability.

IMPORTANT TERMS TO KNOW

Annual Fuel Utilization Efficiency (AFUE)

AFUE measures how efficiently a heating appliance converts fuel to heat. In simpler terms, this metric determines how much fuel your furnace is turning into heat for your home. A higher AFUE means higher efficiency.

Coefficient of Performance (COP)

The COP is a ratio between the rate at which a heat pump transfers thermal energy (in kW), and the amount of electrical power required to do the pumping (in kW). For example, if a heat pump used 1kW of electrical energy to transfer 3 kW of heat, the COP would be 3. A higher COP means higher efficiency.

British Thermal Unit (BTU)

A measure of heat. Originally defined as the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit. BTU is a traditional measurement still used in many heating systems in North America despite the fact that the modern International System of Units (SI) metric system uses the Joule (J).

Greenhouse Gas Emissions (GHG)

Gases released in the earth's atmosphere caused by producing and burning fuels. These gases trap heat, raising the temperature of earth and contributing to climate change.

Energy Security

Energy security is the capability to establish an efficient, sustainable, and affordable energy system that meets the demands of people's lives and their daily activities. There is no universally accepted definition of energy security that is bound to surpass the test of time. The energy security meaning will always depend on the subject, threats, and measures of energy security.

CHOOSING A FUEL TYPE

The first step is to select the heating energy source. Your options may include propane, biomass (wood or pellet), fuel oil, and electricity (including geothermal and air-source heat pumps). You may also choose a mix of these conventional energy sources and/or renewable energy sources.

Heating your home affects the environment in several ways. This could look like 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. Selecting the cleanest energy source available and the highest-efficiency equipment are two things you can do to minimize the environmental impact of heating your home.

Burning natural gas, propane, or fuel oil in your heating system releases pollutants into the local environment. Generating electricity impacts the environment as well, even though it is clean at the point of use.

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.

HEATING FUEL:

Liquid Propane

OVERVIEW

Propane, sometimes known as liquefied petroleum gas or LPG, is a gas normally compressed and stored as a liquid. It is nontoxic, colorless, and virtually odorless; an identifying odor is added so it can be detected. 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 propane than in natural gas.

LPG is most often used in areas that do not have direct access to piped natural gas. A home's propane is transported in by truck and stored in large tanks outside. It is then piped directly into appliances and heating equipment in the home. The typical 500 gallon/1514 litres propane tank can manage the energy demands of a larger home for several weeks or months, depending on usage.

Monitoring usage and scheduling timely refills is essential to avoid running out of propane.

LIQUID PROPANE AT A GLANCE

ADVANTAGES	DISADVANTAGES
• Easy and portable storage of fuel • Available in many remote areas • Less emissions than heating oil and biomass	• Expensive delivery costs • Potential to run out of fuel in tank • Not a renewable resource • Potentially dangerous products of combustion, like carbon monoxide • Negative environmental impact from production and use

ENERGY SECURITY

SCORE: 3

Propane is primarily a byproduct of domestic natural gas processing, though some propane is produced from crude oil refinement. Because of the natural gas and the oil-refining industry, located in western Canada, the supply of available liquid propane is fairly safeguarded.

The supply of propane cannot easily be adjusted to meet increased demand, because of the by-product nature of propane production.

ENVIRONMENTAL IMPACT

SCORE: 2

Commercially available LPG is currently derived mainly from fossil fuels. Burning LPG releases carbon dioxide, a greenhouse gas. The reaction also produces some carbon monoxide. LPG does, however, release less CO2 per unit of energy than coal or oil, but more than natural gas.

LPG is much less polluting than most traditional solid-fuel appliances. Replacing cook stoves and fireplaces with propane fueled equivalents can greatly reduce a house's air pollution and your carbon footprint.

FUEL COSTS

SCORE: 1

A rough approximation is that 100 GJs of energy is required to heat a new average-sized single detached home in Canada for one year (Natural Resources Canada).

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.

25.3 MJ/Litre	Potential energy of propane
100GJ/year	Annual average heating energy requirement for a house
.0253 GJ/Litre	Potential energy of propane
100/.0253 = 3,953 litres	Calculated average of required propane per year
$1.09	Cost per litre, April 2024
1.09x3,953=4,308.77	Total annual cost

Total annual fuel cost $4,308.77
Corrected for average equipment efficiency of 92 percent

Total annual fuel cost $4,683.45
This value does not account for delivery costs and potential fees for tank rental.

HEATING FUEL:

Natural Gas

OVERVIEW

Natural gas is often marketed as a conventional energy that is clean-burning, abundant, safe, reliable and efficient; and has become a popular fuel of choice in residential, commercial, and industrial applications, as well as for electric power generation.

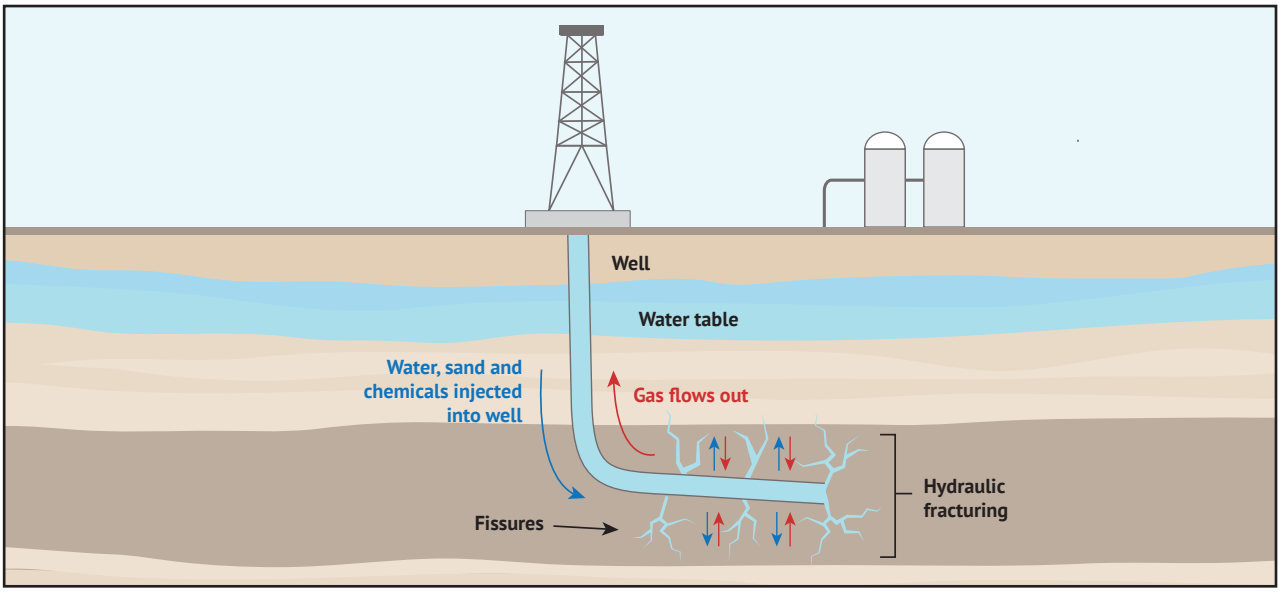
What is not widely known is that approximately 85% to 90% of BC's natural gas production comes from fracked wells, primarily in the northeast region of BC.

Fracked gas also known as hydraulically fractured natural gas is defined as a unconventional natural gas extracted through the process of hydraulic fracturing or ("fracking"). Unlike conventional gas, which flows freely from porous underground reservoirs, fracked gas is trapped in deep shale, tight sandstone, or coal beds. To extract it, industry injects high-pressure mixtures of water, sand, and chemicals into the rock layers to fracture them and release the gas.

Because of these methods used to extract natural gas it is considered an unconventional energy as it requires more intensive industrial processes compared to traditional drilling.

While fracked gas is a significant domestic energy source and is often promoted as a "transition fuel" to help move away from coal and oil, its long-term sustainability is debated. It is non-renewable, and large-scale fracking operations raise concerns about water use, landscape disruption, and greenhouse gas emissions notably methane leaks, a powerful climate-warming gas.

Natural gas has many qualities that make it an efficient, relatively clean burning, and economical energy source. However, natural gas production and use have many environmental and safety considerations.



Shale gas extraction. https://www.consumernotice.org/environmental/fracking/ (modified)

NATURAL GAS AT A GLANCE

ADVANTAGES	DISADVANTAGES
• Lower cost than other fuels • Lower emissions than other fossil fuels • Reliable and simple	• Not a renewable resource • Potentially dangerous products of combustion like carbon monoxide • Negative environmental impact from production, distribution, and use • Not available in remote locations

ENERGY SECURITY

SCORE: 3

Canada has 0.9% of the world's proven natural gas reserves and is the third largest global producer. Conventional gas in western Canada represents nearly a third of the country's remaining available resources, complemented by considerable unconventional reserves, which have recently become financially and technologically viable.

The National Energy Board projects an increase in the growth of drilling activity in Canada in the coming years, as well as price stabilization. Nevertheless, there will be a decrease in conventional gas production because of fewer new discoveries and decreasing production from existing fields. As a non-renewable resource there is a limit to the amount of natural gas available, and with the increase in demand, natural gas reserves will be emptied within the next century. (MET Group article).

ENVIRONMENTAL IMPACT

SCORE: 2

Natural gas is the most environmentally friendly fossil fuel because it burns cleaner. However, the emissions from natural gas-fired boilers and furnaces include nitrogen oxides (NOx), carbon monoxide (CO), and carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), volatile organic compounds (VOCs), trace amounts of sulfur dioxide (SO2), and particulate matter (PM).

The production, transport and processing of oil and gas resulted in 5.1 billion tons (Gt) CO2 equivalent in 2022 – just under 15% of global energy sector GHG emissions.

Hydraulic fracturing, or fracking, is a drilling method used to extract natural gas from deep in the planet. In the fracking process, cracks in and below Earth's surface are opened and widened by injecting water, chemicals, and sand at high pressure. The environmental effects of hydraulic fracturing include air emissions and climate change, high water consumption, groundwater contamination, land use, risk of earthquakes, noise pollution, and various health effects on humans and wildlife.

SPECIFIC ENVIRONMENTAL IMPACTS

- Water Use and Contamination: Fracking uses millions of liters of water per well, drawing from surface and groundwater sources. There is also the risk of groundwater contamination from chemicals used in fracking fluids.
- Methane Emissions: Methane leaks during extraction, processing, and transportation contribute significantly to climate change. Methane is about 80 times more potent than CO_2 over a 20-year period.
- Induced Seismicity (Earthquakes): Injection of wastewater from fracking into deep underground wells has been linked to increased earthquake activity, particularly in northeastern BC.
- Landscape Disruption: Fracking leads to extensive road building, pad construction, and pipeline installation, fragmenting ecosystems and affecting wildlife.
- Community Impacts: Industrial expansion into rural and Indigenous territories can disrupt traditional land use, cultural practices, and create long-term environmental liabilities.

FUEL COSTS

SCORE: 5 *(if there is preexisting Natural Gas infrastructure in the community)*

A rough approximation is that 100 GJs of energy – or 2,700 cubic meters or 94,800 cubic feet of natural gas – is required to heat a new average-sized single detached home in Canada for one year. (Natural Resources Canada)

Natural Gas Billing Rates from FortisBC (Effective July 1, 2024)

Basic Charge per day	$0.4216
Delivery charge per gigajoule (GJ)	$6.527
Storage and transport charge per GJ	$0.420
Cost of gas per GJ	$2.230

Using these numbers, we can calculate the average annual natural gas heating cost in a new house at:

Basic Charge per day	$0.4216 x 365	$153.88
Delivery charge per gigajoule (GJ)	$6.527 x 100	$652.70
Storage and transport charge per GJ	$0.420 x 100	$42.00
Cost of gas per GJ	$2.230 x 100	$223.00

Total annual fuel cost $1,071.58 to create 100GJs of energy
Corrected for average equipment efficiency of 95 percent

Total annual fuel cost $1,127.98

What is important to note is that FortisBC has been given approval by the BC Utilities Commission (BCUC) to jack natural gas prices up 17.5 per cent on January 1, 2025.

This is despite the fact Western Canadian natural gas prices have been at historic lows in 2024. The hike will increase the average residential customer's gas bill by $14.25 per month, based on consumption of 7.5 gigajoules of gas, according to FortisBC. (https://www.biv.com)

NATURAL GAS SUMMARY IN AN ENERGY RETROFIT CONTEXT

When assessing energy strategies for rural and First Nation communities, it's important to recognize that while fracked gas is a major part of BC's current energy supply, it is a high-impact, non-renewable resource. Shifting towards renewable, locally controlled energy solutions like solar, wind, biomass, or micro-hydro can provide stronger long-term energy security, reduce environmental risks, and support community sovereignty and resilience.

HEATING FUEL:

Electricity

OVERVIEW

Electric heating is a process in which electrical energy is converted directly to heat energy.

The heating element inside every electric heater, whether it is a furnace or baseboard radiator, is an electrical resistor. An electric current passing through a resistor will convert that electrical energy into heat energy. Most resistor type heating elements are considered to be 100 percent efficient because all of the electrical energy used is converted into heat and there are no combustion losses through a chimney like fossil fuels.

Alternatively, a heat pump can achieve around 150 percent - 600 percent efficiency for heating, or COP 1.5 - 6.0 Coefficient of Performance, because it uses electric power only for transferring existing thermal energy. The heat pump uses an electric motor to drive a reversed refrigeration cycle, draws heat energy from an external source, such as the ground or outside air, and directs that heat into the space to be warmed. This makes much better use of electric energy than direct electric heating, but requires much more expensive equipment, plus complicated and intricate systems. Some heating systems can be operated in reverse for air conditioning so the interior space is cooled, and even hotter air or water is discharged outside or into the ground.

ELECTRICITY AT A GLANCE

ADVANTAGES	DISADVANTAGES
• 100 percent or higher efficiency • Lower GHG emissions	• Reliant on a dependable electricity supply • Higher costs, and rising, per Joule

ENERGY SECURITY

SCORE: 4

Electric heating systems are heavily reliant on a functioning power grid. A significant concern in areas prone to outages or during severe weather conditions is during power outages these systems cease to provide heat., This vulnerability can lead to discomfort and inconvenience when you need heat the most.

ENVIRONMENTAL IMPACT

SCORE: 4

The majority of BC's electricity demands (91 percent) are met by hydroelectric generation. Hydroelectricity is the cleanest electric generation in Western North America and amongst the lowest GHG emissions of any utility in North America.

The GHG intensity of hydroelectricity typically ranges between 10 and 30 tonnes per GWh. That's in comparison to other jurisdictions that rely on fossil fuels, which often range between 160 to 200 tonnes per GWh. However, there are other environmental concerns with hydroelectricity. Hydropower systems interrupt the natural flow of a river system. This leads to disrupted animal migration paths, issues with water quality, and human or wildlife displacement.

The electrification of space and water heating is increasingly proposed as the way to decarbonize the current energy system, particularly with heat pumps.

FUEL COSTS

SCORE: 1-6

A rough approximation is that 100 GJs of energy is required to heat a new average-sized single detached home in Canada for one year (Natural Resources Canada).

0.0036 GJ / 1 kWh > To convert GJ to kWh, multiply by 277.8 > 277.8x100=27,780 kWh/year required for heating

BC Hydro

Basic charge - 22.53 cents per day
$.1097 cents per kWh Up to 675 kWh / month
$.1408 cents per kWh over the threshold

27780/12=2315
2315-675=1640
675x0.1097=74.0475
1640x.1408=230.912
74.0475+230.912=304.9595 / month
304.9595x12=3,659.514
.2253x365=82.2345 basic
3,659.514+82.2345=3,741.7485

Total annual fuel cost $3,741.75 to create 100GJs of energy
Corrected for average resistor element efficiency of 100 percent
Total annual fuel cost $3,741.75

Total annual fuel cost $3,741.75 to create 100GJs of energy
Corrected for cold climate heat pump efficiciency of 220% percent 2.2 COP
(Ecologix Cold Climate Heat Pump CCHP)
Total annual fuel cost $1,700.80

HEATING FUEL:

Biomass Sold Fuel (Wood/Pellet)

OVERVIEW

Historically, the use of wood has been important in Canada for space and water heating, as well as for cooking. It is still important today, as wood, mainly firewood and wood pellets, is the third largest energy source for residential space heating at 9% in 2020. Every year, over 80 petajoules of energy from wood are consumed in the residential sector.

Heating with wood has been a Canadian tradition for decades. Everyone knows the comfort and ambiance associated with curling up beside the fireplace on a winter's night. But burning wood for residential home heating can also be economical, sustainable, environmentally friendly, and rewarding. By investing in a certified, clean-burning appliance, using the proper techniques for burning your fuel and being diligent about the upkeep of your appliance, wood heat is a great alternative for many Canadians.

BIOMASS SOLID FUEL AT A GLANCE

ADVANTAGES	DISADVANTAGES
• Low cost readily available fuel (wood) • Mechanically simple • Does not require electricity to produce heat (some exceptions) • Traditional, comfy feeling heat	• Fuel storage for cord wood and pellets can take up large spaces • Physically demanding: sourcing, processing, and feeding fuel • Significantly higher emissions and pollutants

ENERGY SECURITY

SCORE: 4

There are 367 million hectares of forest across Canada. Wood is our largest and most important renewable resource. As biomass and pellet technology improves it will contribute in a positive way with both energy security and reducing GHG emissions from other heating sources.

ENVIRONMENTAL IMPACT

SCORE: 2

Using solid fuels for heat is popular in many areas of BC and it offers many environmental benefits, such as contributing to the conservation of the world's non-renewable fossil fuels and lowering dependency on the power grid. However, wood generates more pollution than other heating alternatives, such as electricity or natural gas.

Wood heating emits many pollutants including:

- Fine particulate matter (PM2.5)
- Volatile organic compounds
- Carbon monoxide
- Polycyclic aromatic hydrocarbons (PAH)

Wood smoke from home heating contributes about 27 percent of PM2.5 emissions in BC. Studies have shown that in some remote communities the wood smoke contribution to pollution is much higher.

FUEL COSTS

SCORE: 4

A rough approximation is that 100 GJs of energy is required to heat a new average-sized single detached home in Canada for one year (Natural Resources Canada).

One seasoned cord of softwood contains an average heating value of 22.1 million BTU per cord (23.3 GJ/cord). The average cost of a cord of firewood in BC is $300. Four cords would then make the required 100GJs of heat energy, but due to the lower efficiency of wood burning equipment, the number of required cords to heat a house for a winter is actually closer to double that. This also doesn't account for the space heating nature of most wood burning heating equipment, where auxiliary zone heating would be required.

Total annual fuel cost $1,200 to create 100GJs (cord wood)
Corrected for average equipment efficiency of 70 percent
Total annual fuel cost $1,714

Good-quality wood pellets at 5 to 10 percent moisture content have a heating value of approximately 16,000,000 BTU per ton 16.8GJs per ton (Source). Pellet burning equipment certified by the Environmental Protection Agency (EPA) are in the 70 to 80 percent efficiency range (source). Taking an average of 75 percent efficiency it would require around 8 tonnes of pellets to make the required 100GJs. The trend in costs for heating pellets has been increasing. The cost per bag of heating pellets is an average of $7, roughly $350/tonne. This does not include the costs for delivery.

Total annual fuel cost $2,083 to create 100GJs (wood pellet)
Corrected for average equipment efficiency of 75 percent
Total annual fuel cost $2,777

Supplemental Biomass and Solid Fuel (Wood/Pellet) Information

WOOD HEATING:
Benefits, Challenges, and Modern Best Practices

OVERVIEW

Wood heating has a long-standing role in rural and First Nation communities across northern BC. Wood is often locally available, renewable when sourced sustainably, and culturally significant as a traditional energy source.

When managed properly, wood heating can be an affordable and resilient option, supporting energy independence and local ecosystems through responsible forestry practices.

BENEFITS OF WOOD HEATING

- Energy Resilience: Wood heating provides independence from external fuel supply chains — important during emergencies, power outages, and harsh winters.
- Cost-Effective: For many rural households, sourcing or harvesting wood locally is less expensive than relying on propane, diesel, or electric heating.
- Carbon Neutrality (When Managed Sustainably): When trees are regrown or harvested selectively, the carbon released during burning is balanced by carbon absorbed during regrowth, making wood potentially "carbon neutral" over time.
- Cultural Importance: In many communities, firewood gathering, preparation, and the use of wood heat are tied to traditions, community practices, and knowledge-sharing.
- Challenges and Risks
- Air Quality Impacts: Older or improperly operated wood stoves can release smoke that contains fine particulate matter (PM2.5), carbon monoxide, and volatile organic compounds, contributing to poor indoor and outdoor air quality.
- Health Risks: Exposure to wood smoke, especially in poorly ventilated homes, can cause or worsen respiratory conditions like asthma, bronchitis, and heart disease.
- Climate Concerns: Although burning wood is sometimes considered carbon-neutral, inefficient stoves and incomplete combustion can release methane and black carbon — potent short-term climate pollutants.
- Labour Intensive: Gathering, chopping, stacking, drying, and loading wood requires significant physical labour and time.

MODERN WOOD HEATING SOLUTIONS

Newer, certified wood stoves and high-efficiency units dramatically reduce emissions compared to older models.

KEY FEATURES OF MODERN UNITS INCLUDE:

- Secondary combustion technology burns off gases and particulates that would otherwise become smoke.
- Catalytic converters: further clean the exhaust before it exits the chimney.
- Air-tight designs: provide better control of combustion, resulting in hotter, cleaner burns with less smoke.
- EPA/CSA Certifications: New units certified by the Environmental Protection Agency (EPA) or Canadian Standards Association (CSA) meet strict emissions standards.
- Upgrading to a modern, certified wood stove can reduce emissions by up to 90% compared to older uncertified models.
- Maintaining a Healthy Home While Using Wood Heat
- Use only seasoned (dry) wood: Wood should be dried for at least 6–12 months. Moisture content should be below 20% to reduce smoke and improve combustion.
- Burn hot, not slow: Keeping the fire hot and burning strongly (not smoldering) ensures more complete combustion and fewer emissions.
- Maintain your stove and chimney: Regular cleaning prevents creosote buildup (which is a fire hazard) and ensures the system is operating efficiently.
- Ensure good ventilation: Use kitchen and bathroom exhaust fans and, if needed, a fresh air intake system to balance air pressure and maintain indoor air quality.
- Install carbon monoxide and smoke detectors: These alarms are essential for safety in any home with combustion heating.
- Proper stove sizing: Using a stove that is the right size for the home avoids over-firing or under-firing, both of which can reduce efficiency and increase emissions.

SUMMARY IN AN ENERGY RETROFIT CONTEXT

Wood heating remains a valuable and culturally significant part of community energy strategies in rural and First Nation communities.

Modern wood stoves and good burning practices can maximize the benefits of wood heat while minimizing environmental and health impacts, making wood heating an important piece of a resilient and sustainable energy plan.

HEATING FUEL:

Heating Oil

OVERVIEW

Fuel oil, also known as furnace or heating oil, is Canada's least efficient, most expensive, and most polluting way of heating buildings and water. According to the latest data, more than a million homes in Canada are still being heated with oil. Rapidly increasing fuel costs (prices have doubled since 2020), equipment and technicians becoming rarer, and increased government regulations are leading to heating oil becoming an outdated option.

Heating oil is delivered by tank truck to houses and stored in above-ground storage tanks (ASTs) located in basements, garages, or outside, adjacent to the building. Previously some installations stored fuel in underground storage tanks (USTs), but this is no longer a common practice due to the higher environmental risks associated with leaks from USTs.

Leaks from tanks and piping are an environmental and health concern. Various regulations are in place regarding the proper transportation, storage, and burning of heating oil.

HEATING OIL AT A GLANCE

ADVANTAGES	DISADVANTAGES
• Often able to partially function without electricity • Available in many remote areas	• High output of pollutants • Expensive and • Government regulation may lead to outright bans and additional taxes

ENERGY SECURITY

SCORE: 2

The Government of Canada has committed to introducing a regulatory framework that will allow for the phase-out of the installation of expensive and polluting oil heating systems in new construction as early as 2028. Heating oil is a distillate of crude oil and as a fossil fuel is not a renewable resource.

ENVIRONMENTAL IMPACT

SCORE: 1

A drop of oil can contaminate up to 25 litres of water, rendering it undrinkable. An oil tank leak poses extensive environmental risks that if undetected, can infiltrate surrounding properties and require extensive soil remediation, potentially creating the need to remove affected trees and plants. Inside the home, a furnace oil leak can affect indoor air quality, potentially causing health effects for residents.

Fuel oil furnaces produce more greenhouse gas emissions (GHG) when compared to its closest comparable fuel type, propane. Homeowners can reduce their environmental footprint by heating with propane, which can emit up to 38 percent fewer GHGs than fuel oil in furnaces.

FUEL COSTS

SCORE: 1

A rough approximation is that 100 GJs of energy is required to heat a new average-sized single detached home in Canada for one year (Natural Resources Canada).

Consumption of heating oil is usually measured in litres (L). One litre of heating oil contains approximately 38.3 MJ (137, 500 Btu/US gallon) of energy.

38.3 MJ/Litre	Potential energy of heating oil
100GJ/year	Annual average heating energy requirement for a house
.0383 GJ/Litre	Potential energy of heating oil
100/.0383 = 2,611 litres	Calculated average of required heating oil per year
$1.85 / Litre	Heating oil cost 24-10-22

Total annual fuel cost $4,830.35
Corrected for average equipment efficiency of 83 percent

Total annual fuel cost $5,819.70
This value does not account for delivery costs and potential fees for tank rental

HEATING SYSTEMS

The next step after deciding on a heating fuel type is to decide on your heat delivery system and equipment. 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.

When choosing a heating system, there are a few questions to consider:

- 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?
- Is this an upgrade to my existing heating equipment or will it replace it entirely?

In many situations it can be beneficial to add redundancy to a heating system. This can be accomplished by using more than one fuel type or by having auxiliary space heating systems designed to heat a specific zone of your home.

HYDRONIC HEATING SYSTEMS

WHAT IS A HYDRONIC HEATING SYSTEM?

Hydronic systems use a heated liquid to distribute heat throughout a home or building. This heated fluid, normally a mixture of water and glycol, from a central boiler is circulated to radiators, or radiant floor coils, in each room through a piping system.

Radiant heat warms your body and objects in the room rather than just the air in the room. This provides a cozy and comfortable warmth, even with the thermostat turned two to three degrees lower than normal.

Hydronic heating systems can also be combined with a forced air system by placing a heating coil into the air stream. This allows a boiler/hydronic system to work with a duct system to communicate heat to multiple heating zones and work with a secondary forced air heating source.

BENEFITS

Comfortable

Hydronic systems and radiant heat excel at maintaining a specific heating comfort level. There is less variance than forced air systems that have peaks and drops in temperature as the heating system runs then shuts off.

Flexible and adaptable

A hydronic system can provide both space and zone heating. It can handle your domestic water heating needs (supported with a separate water storage tank). This system is the most versatile form of heating, as it can provide heat using a variety of different methods including: under-floor radiant; freestanding radiators; radiant panel baseboards; heated towel racks in a bathroom; and/or combining with a forced air system. It can also be used to heat other things around the home such as greenhouses, garages, swimming pools, hot tubs, and spas.

Extendable

When installing a hydronic system for your home, it's relatively easy and cost effective to add extra piping for additional heating zones or accessories that require heat–like a swimming pool or spa you might be planning to add later.

Space Saving

A small volume of hot water will deliver the same amount of heat as a large volume of warm air. Hot water piping also uses significantly less space than ductwork.

Sustainable

Alternative energy sources, such as ground-source heat pumps or solar panels, can be combined with a hydronic system.

Zone heating

Unlike a forced air system which shares the heat all over the house, a hydronic system employs individual zone valves, so you can select the area you wish to heat.

DISADVANTAGES

Heat delivery time

Hydronic systems can take longer to deliver heat to a space than a forced air system and tend to have a ramp-up time to a comfortable heat. The recovery time in a situation where heat has been lost by leaving a door open or an extreme temperature drop outside can be longer than that of a forced air system.

Cooling

Radiant hydronic heating systems will not cool your home. If you live in a climate where cooling is necessary, you'll need additional equipment for the job. This could look like zone air conditioners or heat pumps.

Fresh air

Radiant hydronic heating systems will not provide fresh air or an exchange of air. Additional equipment is required by most building codes, such as an HRV (Heat Recovery Ventilator). This is a ventilation device that helps make your home healthier, cleaner, and more comfortable by continuously replacing stale indoor air with fresh outdoor air.

Maintenance is important

Ask a hydronic certified installer/plumber to maintain your system. Not all plumbing or heating companies have the knowledge or training to perform the work. Routine maintenance will keep your system at peak efficiency, save on fuel, and keep repairs to a minimum.

Liquid risks

As the hydronic system is filled with a liquid there is a chance that in extreme cold temperatures if the power goes out or fuel runs out the piping system could freeze. A frozen piping system can cause costly leaks. Leaks, whether caused by freezing, damage, or poor maintenance, can result in major property damage.

CONSTRUCTION CONSIDERATIONS

NEW CONSTRUCTION OR RETROFITTING AND RENOVATING

If you're considering a radiant floor heating system, consider whether the installation will be "wet" (embedded in a concrete slab or lightweight concrete) or "dry" (attached on top or beneath the sub-floor or sandwiched between two layers of sub-flooring). Your choice will depend on whether you're retrofitting or building new, the type of floor finish, and your overall budget.

Factors that can affect the installation costs:

- Boiler type
- Boiler size
- How many zones must be connectedInstallation locationIf additional lines or pipes are required

NEW CONSTRUCTION

When building a new house, in-slab radiant piping systems are easier to accommodate, particularly if a concrete floor is being used.

RETROFITTING AND RENOVATING

If you plan on adding a boiler to an existing house that doesn't have an existing hydronic system, especially when you have an existing forced air system, consider a hybrid system that utilizes existing duct systems to transmit heat.

COMFORT

Hydronic systems and radiant heat provide a higher level of felt comfort than convection and forced air heaters. There is less variability in air temperatures. With a modern system, built-in controls constantly monitor and dynamically adjust water temperature, water flow, and air temperature as necessary to optimize comfort and efficiency. Having warm floors and surfaces makes for a warmer feeling.

HYDRONIC HEATING SYSTEM:

Natural Gas or Propane Boilers

OVERVIEW

Gas-fired boilers are highly efficient heating systems, typically achieving more than 90 percent Annual Fuel Utilization Efficiency (AFUE). These condensing boilers use the heat generated from the initial gas combustion and capture residual heat energy that would otherwise be lost in the exhaust. This cuts down on fuel costs as well as CO_2 emissions compared with older gas-fired boilers. Additionally, modern boiler systems such as these are easier to control and maintain over the long term.

ENERGY EFFICIENCY

SCORE: 3-4

Older boilers can have AFUE ratings as low as 50 percent, which means 50 percent of the energy is being wasted. By comparison, modern high-efficiency boilers have AFUE ratings between 90 and 98 percent, meaning as little as 2 percent of the energy is wasted.

Condensing boilers are among the most efficient because they recycle the heat from water vapor in the system, so they require less energy to preheat cold water coming into the boiler. Because of this design, condensing boilers use more of the energy they draw and have lower operating temperatures, making them more efficient overall.

Modern high efficiency systems

90 percent to 98.5 percent AFUE

- Condensing flue gases in a second heat exchanger for extra efficiency
- Sealed combustion

Mid efficiency systems (does not meet code requirements for new installations)

80 percent to 83 percent AFUE

- Exhaust fan controls the flow of combustion air and combustion gases more precisely
- Electronic ignition (no pilot light)
- Compact size and lighter weight to reduce cycling losses
- Small-diameter flue pipe

Old low efficiency systems (does not meet code requirements for new installations)

56 percent to 70 percent AFUE

- Natural draft that creates a flow of combustion gases
- Continuous pilot light

COST REQUIREMENTS

SCORE: 2-3

A new gas fired boiler unit could run anywhere from $1,200 to $5,000+, and that doesn't include installation. With installation, a combi boiler will cost an average of $3,500 to $10,000+, and a conventional boiler could cost $5,000 – $10,000+ or more.

This does not include costs for the heat distribution system. Be it in floor heating, radiators, heating coils in an air handler, or a combination of multiple heat delivery options, hydronic heating is one of the more expensive heating systems to install.

RELIABILITY AND MAINTENANCE

SCORE: 4

In general, most boilers last for 10-15 years, with some modern equipment manufacturers going as far as to offer 10 or more years of warranty coverage. However, regular services will boost life expectancy up to 15-30 years or longer for some equipment.

Like all heating equipment, routine maintenance will keep your system at peak efficiency, save on fuel, and keep repairs to a minimum. The BC Safety Authority advises homeowners to maintain all gas fired appliances regularly for efficient and safe operation. Annual (yearly) servicing is recommended. You should have all home heating devices, regardless of fuel type, serviced annually by a certified professional.

COMFORT

SCORE: 4-5

With gas fired equipment there is basically zero requirement for the homeowner, other than costs. With a constant fuel source there is no harvesting fuel and feeding a fire, just sit back and enjoy the warmth.

HYDRONIC HEATING SYSTEM:

Electric Boilers

OVERVIEW

Electric boilers are considered a more environmentally friendly alternative to fossil fuel boilers like gas and oil-fired boilers. This is mainly due to their higher efficiency and because they don't release GHGs into the atmosphere, thus reducing your house's carbon emissions. They can also operate on alternative energy sources such as solar.

Electric boilers are compact devices that operate by running an electrical current through a resistive conductor, which heats the water held within the internal heating element. A circulating pump then sends this hot water out into the delivery system to heat your home.

Typically, gas boilers are a more cost-effective hydronic heating solution as the cost of fuel is significantly lower than electricity in most parts of Canada. However, there may be situations where electrical heating is actually more cost effective, or where gas fuel is not an option.

Unless you have a well-insulated or smaller space with a low heating requirement, electric boilers are best suited as an auxiliary or back up system.

ENERGY EFFICIENCY

SCORE: 5

Electric boilers are, by the nature of their design, more efficient. With most electric boilers achieving a thermal efficiency greater than 99 percent.

Most electric boilers deliver a lower temperature (water temperature in the heating zone is typically between 29° and 60°C) and if you have an old, poorly insulated house requiring high-temperature heating, then an electric boiler would need to work harder to maintain heat, leading to more energy consumption.

COST REQUIREMENTS

SCORE: 3

Without venting and gas connections, electric boilers are quick and easy to install. The average costs of equipment for an electric boiler range from $1500 - $4000. With heating capacity being the primary variable, the larger the heat load the higher the cost of equipment.

This equipment cost does not include the traditionally expensive installation of heat distribution systems.

RELIABILITY AND MAINTENANCE

SCORE: 4

With fewer moving parts than gas/oil boilers, electric boilers require less maintenance.

In general, most boilers last for 10 to 15 years, with some modern equipment manufacturers going as far as to offer 10 years+ warranties. However, regular services will boost life expectancy to 15 to 30 years, or longer.

Like with all heating equipment, routine maintenance will keep your system at peak efficiency, save energy, and keep repairs to a minimum. Annual (yearly) servicing is recommended. You should have all home heating equipment, regardless of fuel type, serviced annually by a certified professional (source).

Electric heating equipment relies on having a dependable power supply. If your electrical supply is prone to outages, the efficiency of electric heating equipment might be greatly lowered. Even with short outages, the system has to work harder to recover building heat. This is most apparent in hydronic systems with their longer recovery times.

COMFORT

SCORE: 5

With electric powered equipment there is basically zero requirement for the homeowner–other than costs. No harvesting fuel and feeding a fire, just sit back and enjoy the warmth.

HYDRONIC HEATING SYSTEM:

Biomass Boilers (Wood/Pellet)

OVERVIEW

Biomass or bioenergy includes multiple fuel sources such as: cord wood, pellets, wood chip, and coal. Often a biomass boiler is designed to burn more than one type of fuel. There is also a wide variety of installation designs for biomass hydronic systems. Some are very similar to modern electric, or gas fueled boilers, and are located inside the home in a mechanical room. More frequently you will find a biomass boiler outside the home.

Outdoor wood boilers, also sometimes known as outdoor wood-fired hydronic heaters, are appliances installed in sheds outside the home. They operate by heating water that runs through pipes to heat the home or building. They can be used to heat multiple buildings simultaneously, including homes, garages, outbuildings, greenhouses, and farm buildings. Another advantage of being outside is the elimination of potential fire hazards and "wood messes" in the home.

Until recently these appliances didn't have to meet any emission standards and often caused significant smoke impacts in populated areas.

Many biomass boilers operate without the need for electricity and can effectively heat during power outages or inconsistencies. Hydronic heat delivery systems usually involve an electric pump to circulate the heated water, so in order to operate as designed there is a power requirement.

The efficiency of wood fired boilers has increased to the point where some are approved by the Canadian Standards Association (CSA) for installation indoors. This allows you to stay out of the weather while loading fuel.

Highly efficient and fully automated, stand-alone wood pellet boiler systems are sustainable and environmentally friendly solutions for home heating. These systems can have either a hopper located with the boiler that requires frequent loading by a homeowner or have a large remote storage container that feeds bulk amounts of pellet fuel through an automated system. Depending on the technology, you could see increased costs, higher maintenance requirements, and a more complicated operation.

Large biomass boilers are often used in district heating systems. A district heating system is a large-scale biomass heating system. This system can generate heat for multiple buildings in a community from a separate location. Large biomass boilers are large capital projects, with their own unique advantages and disadvantages depending on the engineered design. They are more commonly used for commercial projects.

ENERGY EFFICIENCY

SCORE: 2

As of 2017, only boilers that are certified to meet emissions standards set by the US EPA or the CSA are legal to sell in BC (Source).

Generally, outdoor wood boilers range between 90 percent efficient, at best, to around 40 percent efficient. This means that of the energy available in the wood placed in the furnace, between 40 and 90 percent will be transferred into the water jacket to be circulated to your heating system. This is a large variance in efficiency.

One of the reasons for the large variance in equipment efficiency numbers for biomass boilers is the inconsistency of its fuel.

Most modern equipment, and any that include CSA approval, must be able to meet the strict EPA/CSA emissions standards. The standards don't govern a specific efficiency percentage but rather controls equipment emissions.

COST REQUIREMENTS

SCORE: 3

Outdoor biomass boilers have a very high equipment cost and can cost around $8,000 - $22,000+, depending on the make and model.

Modern high efficient pellet boilers involve a lot more complicated and automated systems. These come with an increased cost. Pellet boilers have an equipment cost ranging from $6,000 - $14,000+.

These equipment costs do not include the costly installation of heat distribution systems, including the additional requirement of underground piping systems to communicate the generated heat into a home. District heating systems have project costs higher than that of building a new home, and are usually built by a community rather than by a single homeowner.

RELIABILITY AND MAINTENANCE

SCORE: 3

An outdoor boiler means a morning and evening trip to the woodshed to reload the firebox. Cutting and seasoning your wood is also highly recommended, which means some extra Saturdays spent working and extra tools purchased, like a wood splitter. Outdoor furnaces also require regular maintenance including cleaning out the ash and end-of-season care if you turn off the furnace in the summer.

In general, most boilers last for 10 to 15 years, with some modern equipment manufacturers going as far as to offer 10 years+ warranties. However, regular services will boost life expectancy to 15 to 30 years or longer.

COMFORT

SCORE: 3

As mentioned, biomass boilers, especially those located outdoors and fueled by cord wood, require additional efforts taking you out of the comfort of your home and involving heavy labor. Many would agree trudging through snow in freezing temperatures to load a firebox with heavy logs is not comfortable.

HYDRONIC HEATING SYSTEM:

Hybrid or Comination Duel Fuel Boilers

OVERVIEW

Having more than one source of heat is a good idea for anyone that wants to be better prepared. A loss of electricity or running out of fuel can leave you in the cold. The installation of a system that is capable of burning more than one fuel type for heating is generally more expensive, due to the added equipment and systems. Choosing the right combination can be difficult and is heavily based on the fuel types you have available to you.

Electricity is the most common back up system for hydronic heating. With a primary fuel like LPG or biomass there is the potential to run out of fuel. A smaller electric system is often installed as a failsafe. Electric boilers, despite being very efficient, are expensive to operate and depend on a reliable power grid.

An outdoor biomass boiler has a higher equipment cost, but firewood is plentiful in remote areas. So, if you are willing to put in the work required to gather and stockpile fuel, wood boilers are a great auxiliary system.

A hydronic system can be added to an existing forced air system too. This allows for use of a secondary, or even tertiary, fuel to be combined with an existing ducted system. Think of an efficient heat pump, with a gas or electric forced air furnace, attached to a wood fired outdoor boiler, tied together into a single modern thermostat control. There are many possibilities.

WHAT IS A FORCED AIR HEATING SYSTEM?

A forced air heating system has a heat source, often called a furnace, fueled by electricity, gas, or other fuel, to increase the temperature of a volume of air. The air is then pushed by a powerful fan through a central duct system that carries the heated air to various parts of the house, while returning air back to the furnace to be heated.

Compared to water, air masses have a lower heat capacity. This means the temperature of the volume of air in a room can change faster. An exchange of air can increase the comfort level of a room and the temperature quickly, but the same air volume also cools down faster. This can result in a noticeable swing in temperature, especially with lower efficiency systems.

Hydronic heating systems can also be combined with a forced air system by placing a heating coil into the air stream. This allows for a secondary heating source that can utilize the same central duct.

The most common type of heat pump installation requires a ducting system and secondary equipment to move air, such as an air handler or furnace.

BENEFITS

Improved indoor air quality

Forced air systems result in higher indoor air quality. Dust, allergens, mold, and other particles are constantly captured out of the air by an instream air filter.

Fast comfort

Heat distribution is almost instantaneous with a forced air system. The heated air is circulated through entire rooms rather than gradually radiated from distribution sources.

Simple and reliable

Forced air systems are reliable. Ductwork is a simple and dependable heat distribution system. There are fewer moving parts in the system meaning less damage and failures over time. The moving parts (fans, belts, and motors), can easily be replaced if they wear out. A furnace can last up to 30 years if maintained. If equipment fails, the ducting system can be reused with another furnace.

Multipurpose and compatible

A single central forced air system can be used to deliver heated air from a furnace, cooled air from an air conditioner or heat pump, fresh outside air on its own or with an HRV, and can control humidity with an auxiliary humidifier. Multiple heat sources can be tied into a single duct system.

Affordability

Forced air furnaces can have a high initial cost due to the installation of central ducting systems, but repair, maintenance, and replacement costs are, on average, lower than other heating methods.

Cleaner aesthetics

While ducting systems can take up more space in walls and ceilings, the heat is delivered to occupied spaces through low profile grilles and louvers. This results in a "cleaner," less apparent look in the home. Radiant/hydronic systems can require radiators or individual equipment in each room in highly visible locations.

DISADVANTAGES

Noise

Most forced air systems are not considered loud, but the sound of a fan and moving air are noisier than radiant systems. Air pushing through the ducts and vents is audible, and the sounds of a gas furnace firing up might also be transferred through the duct.

Ducting systems

There are some disadvantages to a central ducting system. The duct work takes up significantly more space in floors and walls than a hydronic system's piping. If not cleaned regularly, ducts can accumulate dust and sometimes mold. These contaminants spread throughout the house when air blows past them. Some heat is lost while the air travels through the vents.

Uneven heat distribution

Heat distribution throughout homes with forced air systems is often uneven. The single thermostat only measures the temperature of the room in which it's located. A room's size and location, and the location or length of the ductwork, may cause some areas of the home to be warmer than others.

Maintenance

Routine maintenance is required. Changing the air filter every two to three months, cleaning the ducts every three to five years, and scheduling yearly furnace maintenance inspections are recommended.

CONSTRUCTION CONSIDERATIONS

New construction

When building a new home, designers often overlook the large amount of space a central ducting system occupies. For proper air circulation and adequate air flow, involving your heating contractor in the design process is important.

Retrofitting and renovating

If you have a central duct system and are looking to upgrade or update your furnace to a different more efficient fuel type or a modern higher efficiency version of your existing fuel, there are important factors to consider.

A contractor should perform a heat loss calculation to confirm what size furnace your home needs. An oversized system providing more heat than your home needs can lead to a major loss in operational efficiency.

The existing ductwork needs to be sized properly for adequate airflow and air return with the new higher-efficiency equipment.

If there are areas of your house that are colder than others, changes or additions might need to be made to the existing duct. This can be costly and invasive, often requiring additional demolition and construction to access the ducting system.

Installing new ductwork in a home is a complicated and expensive job, usually costing many thousands of dollars and requiring extensive work. Walls and ceilings may need to be opened up to install the ductwork.

COMFORT

Forced air systems are quick to deliver a comfortable level of heat. If you are cold, the rapid heating of air will make you feel warm quicker than waiting on a radiant heat source like hydronic heated floors. There is more variability in air temperatures with forced air, but modern equipment with multiple stages of input rates and fan speeds significantly lowers the drastic spikes and dips in air temperature.

Forced air systems are slightly louder than radiant systems.

FORCED AIR HEATING SYSTEM:

Natural Gas or Propane Furnaces

OVERVIEW

This is the most prevalent form of residential heating in North America. The gas furnace is a type of heating system utilizing natural gas or propane to generate warm air. This air is then pushed through ductwork and distributed throughout the entire home, ensuring even temperatures in each room. Gas furnaces are energy efficient, cost-effective and easy to operate.

Gas furnaces are commonly used in northern climates in combination with heat pumps or air conditioners to deliver tempered air in all seasons. They can also be used in combination with a hydronic system coil in the airstream as a heat delivery system.

ENERGY EFFICIENCY

SCORE: 3

High efficiency furnaces (95 - 99 percent AFUE) are now required by the building code for new construction and for the replacement of an existing furnace. Mid efficient models, installed after 1990, can achieve an annual efficiency of 82 percent. Standard efficiency furnaces, 20 years old or more, may be as little as 60 percent efficient.

There has been such a large improvement to the efficiency of gas burning furnaces that the most cost-effective way to reduce your environmental impact and lower heating costs could be as simple as upgrading your furnace.

COST REQUIREMENTS

SCORE: 3-4

The average cost of a new gas furnace in Canada is between $2,000 and $4,500 for the equipment alone. Every home and installation is different. Like any home improvement project, various factors can impact the final price of installation. The labor and materials cost of replacing an existing furnace is roughly $1,500 to $3,500. The complete cost to upgrade an existing furnace is on average between $3,500 and $8,000. In more remote areas this cost could drastically increase.

Factors affecting costs can include:

- The size of your home and its heating requirements. Larger equipment comes with a slightly higher price.
- Natural gas and propane furnace prices are generally similar, but propane forced air furnaces might be pricier.
- Installation costs will be higher if you have to upgrade your existing ductwork or if you have a floor plan that makes installing the duct work difficult.
- Higher efficiency furnaces with variable-speed fan motors and modulating input burners are more expensive.

Costs of installing a new forced air system are lower than a hydronic system of a similar heating capacity. To ensure safe installation and optimal performance from your new equipment, you will need to get your gas furnace professionally installed. Gas furnace installation is a complex job that includes work with electricity and gas lines. It requires the skill and expertise of a licensed Heating Ventilation and Air Conditioning (HVAC) technician.

RELIABILITY AND MAINTENANCE

SCORE: 4

Burning gas for heat comes with the added concern of combustion byproducts entering the air stream and finding their way into the home. Modern furnaces have multiple safety devices and controls designed to ensure their safe operation and will shut off in the event of a failure. Annual maintenance should include checking these safeties and will lower the chances of equipment failure when the furnace is needed in colder temperatures.

Like all heating equipment, routine maintenance will keep your system at peak efficiency, save on energy, and keep repairs to a minimum. Annual (yearly) servicing is recommended. You should have all home heating equipment, regardless of fuel type, serviced annually by a certified professional (source).

In general, most furnaces last 10 to 15 years. With some modern equipment, manufacturers are going as far as offering 10+ year warranties. However, regular services will boost life expectancy to 15 to 30 years or longer.

COMFORT

SCORE: 4-5

With gas fired equipment there is basically zero requirement for the homeowner, other than costs. With a constant fuel source there is no harvesting fuel and feeding a fire, just sit back and enjoy the warmth.

FORCED AIR HEATING SYSTEM:

Electric Furnaces

OVERVIEW

An electric furnace is a forced air heating system that heats air by passing cooler air over an electric resistance element that converts electrical energy into thermal energy. The heated element (much like the one in a toaster) warms the air as it is passing over, and this heated air is then distributed by the blower fan throughout your home duct system.

Blowers (large fans) in electric furnaces move air over a stack of two to seven electric resistance coils, called elements, each of which are typically rated at five kilowatts. The furnace's heating elements activate in stages to avoid overloading the home's electrical system. A built-in thermostat, called a limit, prevents overheating. This limit may shut the furnace off if the blower fails or if a dirty filter is blocking the airflow.

Electric furnaces can serve multiple functions, which is why they are often referred to as Electric Air Handlers or Air Handling Units (AHU). Electric forced air furnaces, as with most other types of forced air furnaces, can be used as an AHU paired with a central heat pump system to provide a hybrid heating solution.

ENERGY EFFICIENCY

SCORE: 4

Converting electricity into heat energy is a very efficient process, most times reaching close to 100 percent conversion efficiency and 95 to 99 percent overall unit efficiency (how much of the heat is transferred to the passing air).

If the thermal conversion rate of energy on a resistance element is 100 percent, why is the actual efficiency of an electric furnace a few percent lower?

Electric furnaces require additional energy to distribute the heated air throughout your home (which is common for any heating system that uses ducts for distribution). Heated air is delivered throughout the home through supply ducts and returned to the furnace through return ducts. If these ducts run through unheated areas, they lose some of their heat through air leakage,radiation, and convection from the duct's surface.

COST REQUIREMENTS

SCORE: 4

The average cost of a new electric furnace in Canada is between $1,500 and $6,000+ for the equipment alone. Every home and installation is different. Like any home improvement project, various factors can impact the final price of installation. The labor and materials costs of replacing an existing furnace are roughly $1,500 to $2,000. The complete cost to upgrade an existing furnace is on average between $3,000 and $8,000. In more remote areas this cost could drastically increase.

The upfront purchase costs for an electric furnace are very similar to the costs of upgrading to a modern high efficiency condensing gas furnace. However, if you are planning to replace an existing gas furnace with an electric furnace, you will also need to consider that your home's electrical system may require upgrades to cope with the increased electrical power draw required for an electric furnace.

If your home already has an electrical system that can handle the increased capacity needed for heat pumps or electric heating, an electric furnace would be a cost effective and environmentally friendly option.

RELIABILITY AND MAINTENANCE

SCORE: 5

The single most important thing you can do to ensure the longevity of your furnace is to have it serviced when needed and change air filters on a regular schedule.

Like all heating equipment, routine maintenance will keep your system at peak efficiency, save on energy and keep repairs to a minimum. Annual (yearly) servicing is recommended. You should have all home heating equipment, regardless of fuel type, serviced annually by a certified professional (source).

In general, most electric furnaces last longer as they have fewer components. An electric furnace has a life expectancy of 15 to 30 years, but as they age the heating elements lose efficiency and can fail, requiring a replacement element.

COMFORT

SCORE: 5

With electric powered equipment there is basically zero requirement for the homeowner, other than costs. No harvesting fuel and feeding a fire, just sit back and enjoy the warmth.

FORCED AIR HEATING SYSTEM:

Biomass Furnaces (Wood/Pellet)

OVERVIEW

Biomass or bioenergy includes multiple fuel sources such as: cord wood, pellet, wood chip, and coal. When dealing with biomass furnaces you will regularly be talking about a cord wood furnace or a wood pellet furnace. These furnaces, unlike a biomass boiler system, are usually located inside a house. They operate very similarly to a gas or electric furnace, by burning a fuel to create heat that is introduced into an air stream and communicated to the house via ductwork by a large fan. Like gas furnaces, biomass furnaces use a heat exchanger system. This ensures that the combustion process is isolated, and any harmful byproducts are safely vented outside through a chimney.

Both pellet and cord wood burning furnaces come with the requirement of some physical labor on the hands of the homeowner. Wood must be harvested and processed then brought into the house and fed into the furnace manually. Pellets must also be packed into the house and loaded into a large storage device called a hopper, that then automatically feeds the burner. Both fuels also leave the homeowner with a fair amount of clean up with extra wood dust from the fuels, ash that must be cleaned out from the furnace regularly, and in most cases, a chimney that must be swept.

Cord wood burning furnaces offer a readily available fuel source in remote areas and can be gathered with little to no cost (other than a large amount of work). Most wood burning furnaces can operate in a limited capacity without electricity. They are great in a power outage or when electricity isn't reliable.

Pellet furnaces take some of the work out of the homeowners' hands by automatically feeding fuel from a hopper into the fire and in most cases automating the ignition process. This allows for longer periods of time between adding fuel and less work. This unfortunately comes with the side effect of a greater reliance on electricity in comparison to cord wood.

With most biomass furnaces acting as a dual fuel or hybrid system you will never again be dependent on a single source of energy to guarantee the comfort and safety of your family. Depending on the furnace, you can add an electric element, an oil unit, or use it as a wood add-on to an existing furnace.

Most biomass furnaces are controlled by a wall thermostat that gives you the exact comfort level you want for your home. This is usually done by modulating air intake to throttle the burner and cycling the fan blower to deliver the required heat. Some systems even incorporate automatic ignition systems, so whether or not you are present, your home will be comfortable without interruption.

ENERGY EFFICIENCY

SCORE: 2

As of 2017 only boilers that are certified to meet emissions standards set by the US EPA or the CSA are legal to sell in BC (Source).

Most modern equipment, and any that include CSA approval, must be able to meet the strict EPA/CSA emissions standards. This doesn't govern a specific efficiency percentage but rather controls equipment emissions.

Wood and pellet furnaces now commonly feature a secondary combustion system, like a catalytic converter, to increase their efficiency by taking heat from the smoke made by the initial burning of fuel. These furnaces easily reach up to a 30 percent reduction in fuel wood used. EPA certified or CSA B415.1-10 tested wood furnaces are 80 to 90 percent efficient, compared with 40 to 60 percent for conventional units.

COST REQUIREMENTS

SCORE: 2

Biomass furnaces have a high initial equipment cost. Wood furnaces range from $5,000 to $10,000+ and require an expensive chimney system that often costs upwards of $2,000. Pellet furnaces with the added complicated mechanical systems range from $6,000 to $12,000+.

Biomass furnaces are larger and heavier than furnaces of other fuel types and often require more space. Clearances to combustible surfaces and framing are important to note as some equipment requires a specific distance from it to anything combustible for safety.

Fuel storage for biomass fuels often requires a large amount of area in a dry space separate from the area in the house where the equipment is located. This often means that the fuel needs to be stored in an outbuilding designed or built for this purpose.

RELIABILITY AND MAINTENANCE

SCORE: 3

The longevity and efficiency of a biomass furnace is heavily dependent on the quality of the fuel used. Poor-quality fuel can cause incomplete combustion, producing excess ash and smoke. This can increase maintenance needs, reduce efficiency, and lead to catastrophic failures due to ash buildup in components, combustion failures, smoke or ash pollution in the home, and even chimney blockages or fires. Using good fuel and proper maintenance is essential.

In addition to regularly changing air filters, many manufacturers require homeowners to perform maintenance tasks such as cleaning ash pans and combustion chambers. While these tasks can be done by homeowners, annual servicing, including cleaning vents/chimneys and heat exchangers, should be completed by a certified professional.

Biomass furnaces are made from durable heavy metals to endure the combustion process, making them more resilient than some other furnace types. With proper care and fuel quality, they typically last 15 to 30 years. However, neglecting maintenance or using poor fuel can significantly reduce their reliability/lifespan.

COMFORT

SCORE: 3

As mentioned, biomass furnaces require additional efforts that take you out of the comfort of your home and involve heavy labor. Delivering fuel from its outdoor storage to the equipment indoors can be required in poor weather conditions and at inopportune times. Failure to add fuel can result in outages and cold or freezing indoor temperatures.

Biomass heat is considered a dryer heat, and the burning of wood or pellets can lead to lower home humidity.

Traditionally, wood burning fireplaces offer a higher comfort and ambiance. Many biomass furnaces can offer the same feeling..

Hybrid or Combination Duel Fuel Furnaces

OVERVIEW

Having more than one source of heat is a good idea for anyone wanting to be better prepared. A loss of electricity or running out of fuel can leave you in the cold. The installation of a system that is capable of burning more than one fuel type for heating is generally more expensive, due to the added equipment and systems. Choosing the right combination can be difficult and is heavily based on the fuel types you have available to you.

COMBINATION/DUAL FUEL FORCED AIR

Wood furnaces can be installed to work in conjunction with systems using other fuels such as oil, natural gas, and electricity. Combination wood-oil furnaces can use both energy sources in a single packaged unit. Add-on furnaces can be installed beside existing furnaces using other fuels. All such units must be safety tested and certified for this purpose.

HYBRID HEAT

A hybrid system, also called a dual fuel heat pump, is made up of both an electric heat pump and a furnace. The system alternates between using each of the two units, depending on the season, temperature, and function needed, to maximize efficiency and effectively heat and cool your home all year long.

The heat pump in the system works like a central air conditioner in the summer months by transferring hot air out of your home until your thermostat reads your desired temperature. The heat pump also does the majority of the work in the fall and spring months by providing cost-efficient heat during milder temperatures.

The furnace takes over and works to heat your entire home when the temperature takes a dip during the cold, winter months. The main function of a furnace is converting fuel into heat quickly and efficiently. When it's cold outside, the furnace in your hybrid heat system will do just that.

HYDRONIC COILS

Hot water coils are a type of heat exchanger, often called hydronic coils, using hot water from a boiler to heat air. The air moves through the fins of the coil, which is hot from water flowing through the tubes. This allows for use of a secondary or even tertiary fuel to be combined with an existing ducted system.

WHAT IS A HEAT PUMP SYSTEM?

Heat pumps have gained significant popularity due to their environmental and economic advantages. As the world addresses climate change, these systems offer a crucial tool for reducing carbon emissions by generating heat using electricity instead of burning fossil fuels. This makes them an enviromentally friendly alternative to traditional heating systems.

Their improved energy efficiency means lower operating costs, with heat pumps typically generating about four times the energy they consume. Government incentives have made the initial investment more attractive and technological advancements in cold climate performance have also helped broaden their appeal. The benefits, cost savings, improved performance and their alignment with global decarbonization efforts have helped drive the widespread adoption of heat pumps across homes and businesses globally.

OVERVIEW

A heat pump is an electric heating and cooling system. The pump is an electrically driven device that extracts heat from a low temperature place (a source) and delivers it to a higher temperature place (a sink). In summer, the heat pump moves heat out of the house, and in the winter, it moves heat into the house–even if it's cold outside. Heat pumps use less energy to heat and cool the space in your home than traditional equipment does and are an excellent choice for both new homes and retrofits of existing heating and cooling systems.

WHY THE HYPE?

Furnaces and boilers provide space heating by adding heat to the air through the combustion of a fuel such as fossil fuels (gas/wood) or directly through an electric resistance coil. While efficiencies have continually improved, they remain below 100 percent, meaning not all the available energy is used to heat the air. Heat pumps operate on a different principle. The electricity input into the heat pump is used to transfer thermal energy between two locations. This allows the heat pump to operate more efficiently, with typical efficiencies well over 100 percent. Heat pumps today can reach 300 to 400 percent efficiency or even higher, meaning they're putting out three to four times as much energy in the form of heat as they're using in electricity.

SPECIALTY HEATING SYSTEM:

Air Sourced Heat Pumps

HOW DO HEAT PUMPS WORK

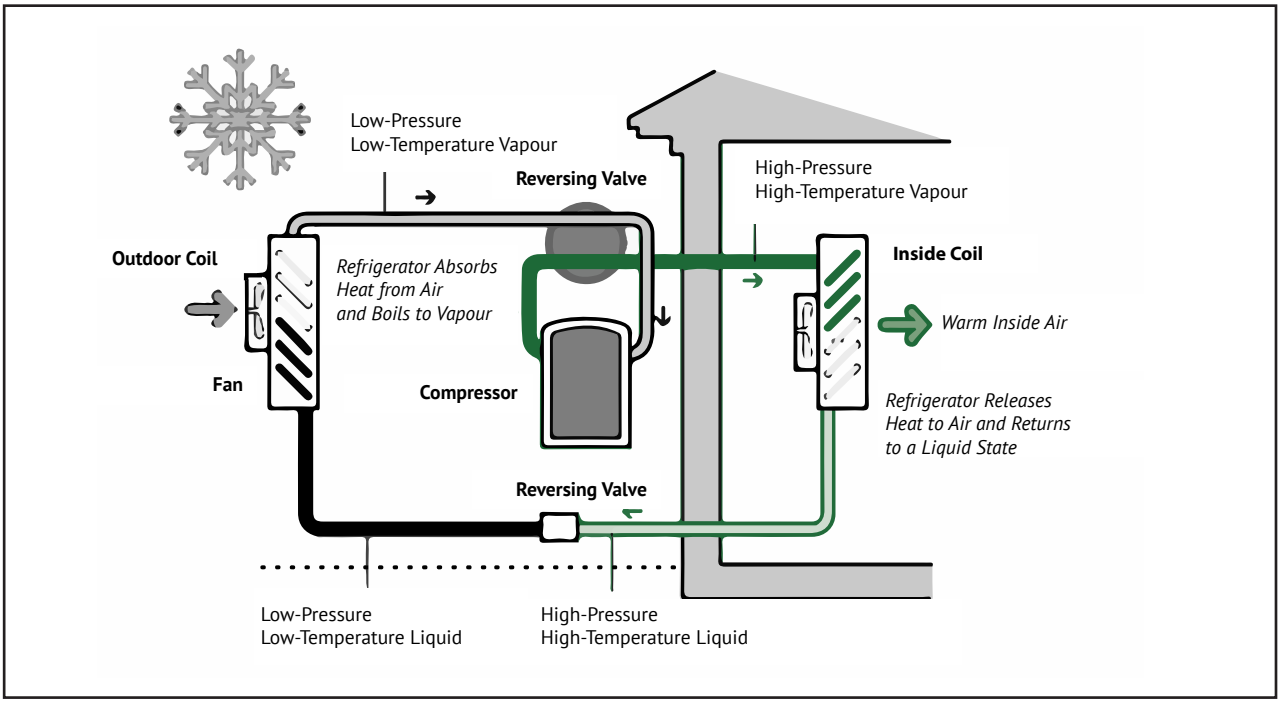
Heat pumps transfer heat rather than generate heat, making them energy-efficient while they provide comfortable temperatures for your home year-round. Heat pumps are able to transfer heat using a process of evaporation and condensation of a substance called refrigerant.This substance cycles between the indoor and outdoor units.

A heat pump's refrigeration system consists of a compressor and two coils (one indoors and one outside).

In heating mode, heat energy is extracted from the outdoor air and brought into the house via a compressor circulating refrigerant. A reversing valve changes the direction of refrigerant flow for cooling and for the winter defrost cycle. In warmer months, heat is extracted from the home and transferred outdoors.

If the outdoor temperature falls to near or below freezing when the heat pump is operating in the heating mode, moisture in the air passing over the outside coil will condense and freeze on it. The amount of frost buildup depends on the outdoor temperature and the amount of moisture in the air.

This frost buildup decreases the efficiency of the coil by reducing its ability to transfer heat to the refrigerant. At some point, the frost must be removed. To do this, the heat pump automatically switches into defrost mode.



https://natural-resourcescanada.ca

DO HEAT PUMPS WORK IN THE COLD?

The claim that heat pumps don't work well in really cold weather is often repeated by fossil-fuel companies, which have a competing product to sell. There's a kernel of truth here: heat pumps are less efficient in extreme cold. As the temperature difference between inside and outside increases, a heat pump will have to work harder to gather heat from that outside air and disperse it into the room, causing efficiency to drop.

Natural Resources Canada has developed guidelines to help with the sizing and selection of heat pumps based on climate, heating or cooling load, and intended use. While the report is intended for mechanical designers and contractors, it is a good source of information.

Interestingly, the highest penetration of heat pumps can be found in the coldest climates–despite frequent claims in parts of the media that heat pumps do not work in cold climates. In Europe, the four countries with the largest share of heat pumps are Norway (60 percent of households), Sweden (43 percent of households), Finland (41 percent of households) and Estonia (34 percent of households). These four nations also face the coldest winters in Europe. This heat pump leadership has been, in part, attributed to the high historical prevalence of fossil fuel-based heating in these countries.

SUPPLEMENTARY HEAT SOURCES

Since air source heat pumps have a minimum outdoor operating temperature (between -15°C to -25°C) and reduced heating capacity at very cold temperatures, considering a supplemental heating source for air source heat pump operations is important. Supplementary heating may also be required when the heat pump is defrosting. Different options are available:

All Electric

In this configuration, heat pump operations are supplemented with electric resistance elements located in the ductwork or with electric baseboards. These resistance elements are less efficient than the heat pump, but their ability to provide heating is independent of outdoor temperature.

Hybrid System

In a hybrid system, the air source heat pump uses a supplemental system such as a furnace or boiler. This option can be used in new installations and is also a good option where a heat pump is added to an existing system, for example, when a heat pump is installed as a replacement for a central air conditioner.

COMMON TYPES OF HEAT PUMPS

When choosing a heat pump, understanding the different configurations available is essential. These systems can be tailored to suit various home layouts, preferences, and heating and cooling needs. Here's an overview to help you make an informed decision:

Split vs packaged:

Split systems

Have components both inside and outside the building, with the air handler and evaporator indoors and the condenser and compressor outdoors. This system is ideal for homes where space is available for both indoor and outdoor units.

Packaged systems

Contain all components in one unit. Similar to traditional window mounted air conditioners. These systems are often located outside and heated or cooled air is delivered via ductwork passing through a wall or roof. They take up less space inside and can be easier to install.

Ductless vs ducted:

Ductless systems

Often called a mini-split system. In a ductless system, refrigerant lines run from one or more indoor ductless units to one or more outdoor units. Each indoor ductless unit controls the temperature of a zone, so a larger property may require more than one indoor unit. Since each indoor unit is responsible for a specific zone, heating and cooling can be adjusted based on occupant comfort to save on energy consumption. The modern design of the indoor ductless unit can be installed on a wall, ceiling, or floor of an existing space, requires minimal construction, and is ideal for additions, studio apartments, or smaller homes. They avoid ductwork efficiency losses but lack air filtration or the ability to add ventilation.

Ducted systems

In a ducted heat pump system with standard technology, there is one outdoor compressor/coil unit, and one centrally located air handler. The heat pump and air handler work together to heat or cool the air, which is then pushed throughout the home's ductwork. The entire system is typically controlled by a thermostat in one location. These systems are ideal for homes with an existing forced air system as the traditional furnace can be used as an air handler and provide a backup or auxiliary heat source.

WHAT'S NEW WITH HEAT PUMP TECHNOLOGY?

Cold Climate Air Source Heat Pump (Cc-Ashp) Technology

At lower outdoor air temperatures, the efficiency and capacity of heat pumps decrease because the colder air has less heat energy available to extract. Historically, this meant heat pump installers needed to provide supplemental heating or leave existing heating systems in place to serve as backups during extremely cold weather. However, recent advances in technology have led to the development of units that, when properly sized and commissioned, can continue efficient operation at low temperatures such that the supplemental or backup heating systems are rarely needed to efficiently meet the heating load of the building.

Since the air outside will always contain some heat, a heat pump can supply heat to a house even on cold winter days. In fact, air at –18°C contains about 85 percent of the heat it contained at 21°C.

CC-ASHP are designed to maintain a higher COP efficiency under the increased demand of colder climates. Cold climate heat pumps are built to work efficiently in conditions down to -25°C, with some systems maintaining an efficiency of over 200 percent at -18°C. Cold climate heat pumps have been in development and testing in Canadian winters since the early 2010s. Many leading brands have a cold climate option, and it is one of the most discussed subjects regarding heat pump technology research.

Improvements in several of their main components have helped boost the efficiency and performance of heat pumps, especially in the cold. New compressors used in heat pumps today can get refrigerants to higher pressures using less power. There are also variable-speed compressors that allow heat pumps to ramp their power up and down. The heat exchangers that transfer heat between the air and the refrigerant are getting bigger and better, so they can move heat around more effectively. Finally, the one major improvement is in the refrigerants. Freon, also called R-22, used to dominate the market, but has been phased out due to its ozone depleting effects.

Finding The Right Refrigerant

Today, a mixture of chemicals referred to as R-410A is one of the most widely used refrigerants in heat pumps. In addition to being slightly less harmful for the ozone layer, R-410A has a lower boiling point than R-22. This means it can absorb more heat at lower temperatures, boosting efficiency in the cold.

Because R-410A operates at such high pressures, there is an increased risk of an environmentally harmful refrigerant leak during maintenance and repair work. R-410A is currently being phased out. New systems will use more sustainable A2L refrigerants, which are a class of refrigerants that have higher efficiency and lower Global Warming Potential (GWP). The two foremost R410a replacements are R-32 and R-454B.

Existing air conditioners cannot simply switch from R410-A to the new refrigerants. A2L refrigerants may only be used for new AC and heat pump units specifically built for them. This means that consumers can continue to use their existing HVAC units and not have to replace them, or replace the R410-A refrigerant that they use with A2L. However, the EPA has proposed banning the use of R410-A in new air conditioners and heat pumps by January 1, 2025.

SPECIALTY HEAT PUMP HEATING SYSTEM:

Ducted Air Sourced Heat Pump

OVERVIEW

An air sourced heat pump (ASHP) connects to a central duct system. The ASHP sits outside your home like a central AC unit would, utilizing a coil in the air stream and an air handler to communicate heat in or out of the home through ductwork connected to every room.

ENERGY EFFICIENCY

SCORE: 5

Heat pumps are a low-carbon heating technology with the potential to deliver large-scale reductions in carbon emissions from building heat. They use electricity to move heat from ambient outside air to a building's interior. This process is highly efficient, with heat pumps delivering three to five units of heat for each unit of electricity needed to run them. When the electricity used to drive the electric compressor is produced from low-carbon sources such as hydroelectric, nearly all the useful heat provided becomes low or even zero carbon.

INSTALLATION COSTS & REQUIREMENTS

SCORE: 4

Our modelling finds that heat pumps are the lowest-cost heating and cooling option for most households, lower than gas-fired heating with air conditioning. Despite heat pumps having higher upfront costs, their efficiency and the fact that they double as a cooling and heating technology supports their cost competitiveness.

Heat pumps have been repeatedly identified as a key, cost-effective solution for tackling the carbon emissions associated with keeping buildings warm at international, regional, and national level. The costs of low carbon electricity have also declined significantly over the last decade, bolstering the case for electric heat pumps.

Depending on the size of your new heat pump, some modifications may be needed to your ductwork to avoid added noise and fan energy use. The cost of installing an air-source heat pump depends on the type of system, your design objectives, and any existing heating equipment and ductwork in your home. In some cases, additional modifications to the ductwork or electrical services may be required to support your new heat pump installation.

EQUIPMENT RELIABILITY AND MAINTENANCE

SCORE: 4

Heat pumps are considered a safer HVAC system because they don't rely on combustion. Oil and gas furnaces pose a greater risk due to lack of maintenance, and heat pumps reduce your overall carbon emissions compared to other heating options. Additionally, they require less maintenance than combustion heating systems, meaning there's less room for error when working on them and fewer ongoing air conditioner repair costs.

The single most important thing you can do to ensure the longevity of your furnace is to have it serviced when needed and change air filters on a regular schedule.

Like all heating equipment, routine maintenance will keep your system at peak efficiency, save on energy, and keep repairs to a minimum. Annual (yearly) servicing is recommended. You should have all home heating equipment regardless of fuel type, serviced annually, by a certified professional (source).

COMFORT

SCORE: 5

With electric powered equipment there is basically zero requirement for the homeowner, other than costs. No harvesting fuel and feeding a fire, just sit back and enjoy the warmth.

SPECIALTY HEAT PUMP HEATING SYSTEM:

Geothermal Heat Pumps

OVERVIEW

Ground-source heat pumps use the earth or ground water as a source of thermal energy in heating mode, and as a sink to expel heat energy when in cooling mode.

These types of systems contain two key components:

- **Ground heat exchanger:** This is the heat exchanger used to add or remove thermal energy from the earth or ground. Various heat exchanger configurations are possible, and are explained later in this section.
- **Heat pump:** Instead of air, ground-source heat pumps use a fluid flowing through the ground heat exchanger as their source (in heating) or sink (in cooling).

On the building side, both air and hydronic (water) systems are possible. Operating temperatures on the building side are very important in hydronic applications. Heat pumps operate more efficiently when heating at lower temperatures of below 45 to 50°C, making them a better match for radiant floors or fan coil systems. Care should be taken if you are considering their use with high temperature radiators that require water temperatures above 60°C, as these temperatures generally exceed the limits of most residential heat pumps.

Depending on how the heat pump and ground heat exchanger interact, two different system classifications are possible:

- **Secondary loop:** A liquid (ground water or anti-freeze) is used in the ground heat exchanger. The thermal energy transferred from the ground to the liquid is delivered to the heat pump via a heat exchanger.
- **Direct expansion (DX):** A refrigerant is used as the fluid in the ground heat exchanger. The thermal energy extracted by the refrigerant from the ground is used directly by the heat pump–no additional heat exchanger is needed.

In these systems, the ground heat exchanger is a part of the heat pump itself, acting as the evaporator in heating mode and condenser in cooling mode.

Ground source heat pumps can serve a suite of comfort needs in your home, including:

- **Heating only:** The heat pump is used only in heating. This can include both space heating and hot water production.
- **Heating with "active cooling":** The heat pump is used in both heating and cooling.
- **Heating with "passive cooling":** The heat pump is used in heating and bypassed in cooling. In cooling, fluid from the building is cooled directly in the ground heat exchanger.

ENERGY EFFICIENCY

SCORE: 5

In Canada, where air temperatures can go below –30°C, ground source systems are able to operate more efficiently because they take advantage of warmer and more stable ground temperatures. Typical water temperatures entering the ground-source heat pump are generally above 0°C, yielding a COP of around 3 for most systems during the coldest winter months.

INSTALLATION COSTS & REQUIREMENTS

SCORE: 2

The installation price of a geothermal system can be several times that of an air source system of the same heating and cooling capacity. The wells or ground loops come at a very high expense but can last for a long time.

EQUIPMENT RELIABILITY AND MAINTENANCE

SCORE: 4

System life is estimated at up to 24 years for the inside components and 50+ years for the ground loop.

Like all heating equipment, routine maintenance will keep your system at peak efficiency, save on energy and keep repairs to a minimum. Annual (yearly) servicing is recommended. You should have all home heating equipment regardless of fuel type, serviced annually, by a certified professional (source).

COMFORT

SCORE: 4

Geothermal heat pumps (GHPs), take advantage of the constant temperature of the shallow earth (40°-70°F/4.5°-21°C) to efficiently exchange temperatures, heating homes in the winter and cooling homes in the summer.

SUPPLEMENTARY HEATING SYSTEMS

WHAT IS A SUPPLEMENTARY HEATING SYSTEM?

Supplementary heating refers to supplemental heating devices used to provide extra warmth in specific areas or rooms beyond the home's primary heating system.

Heating systems, like hydronic and forced air systems, are the traditional way we think about heating. There are also other potentially more efficient, targeted, or inexpensive options.

If you're like most homeowners, you spend most of your time in just a few rooms of your house. Of course, you need to keep the temperature at a certain level to avoid frozen pipes, but it certainly doesn't need to be a comfortable 20 degrees in the empty guest room or a basement storage room.

Enter the concept of secondary heating: These are *more targeted heat sources* that boost the temperature in the zones where you spend the most time. Fireplaces, space heaters, and baseboard heaters all deliver heat at the right place and time allowing you to keep the thermostats turned down lower without sacrificing comfort.

Supplemenatry heat sources are not just for when the power goes out or there's a serious cold snap. Many folks these days are thinking about a supplementary heat source as a way to save energy and money.

Supplementary heat sources include:

- Gas space heating
- Biomass space heating
- Electric baseboards

SECONDARY HEATING SYSTEM:

Gas Space Heating

OVERVIEW

Gas fireplaces have increased in popularity over the past few years. For many homeowners, the attraction of owning a gas fireplace lies in the following:

- the convenience of an on/off switch and an ever-present fuel supply;
- the cleanliness factor (gas fireplaces generate no mess in terms of ashes, wood chips, bark, etc.);
- the elimination of chimney cleaning;
- the safety of sealed combustion units, which offer little chance for toxic combustion gases to spill into the room; and
- the environmental benefits as compared with those of a conventional wood fireplace.

Although gas fireplaces have been around for a few years, many homeowners disliked their "fake-looking," uninteresting flames. To counteract this negative perception, manufacturers have devoted much effort to producing a yellow flame that more closely resembles the flame of a wood-burning fireplace, yet is still clean-burning. Other aesthetic improvements have made gas fireplaces much more appealing as well.

However, quality varies widely among models. Some are highly efficient, safe, and provide ample heat, while others may be inefficient or cause air quality issues, especially vent-free types.

Gas fireplaces and the environment

Gas fireplaces are noted for their clean-burning characteristics. Compared with wood fireplaces, natural gas and propane fireplaces produce much less carbon monoxide and particulate emissions.

However, no energy source is completely environmentally friendly. Natural gas and propane do release some pollutants when burned, primarily nitrogen oxides (which contribute to ground-level ozone or smog) and carbon dioxide (a greenhouse gas). They also release significant amounts of moisture into the air. A poorly adjusted gas fireplace can generate incomplete combustion products, including carbon monoxide.

As with other energy-using appliances, keep in mind that buying an energy-efficient gas fireplace and using it wisely will use less energy and reduce greenhouse gas emissions that contribute to climate change.

Efficiency ratings

Until recently, most efficiency ratings were steady-state measurements–the maximum efficiency the fireplace could achieve operating under controlled laboratory conditions and after running at equilibrium for a long period of time. This measurement does not take into account many of the ways in which heat loss occurs in a fireplace. A steady-state rating is comparable to the good gas mileage a car achieves when cruising on the highway, as opposed to the much lower mileage you get in start-and-stop city driving. With a gas fireplace, the actual operating efficiency of the unit once it is installed in your home will be lower than the steady-state efficiency–in some cases, much lower.

SECONDARY HEATING SYSTEM:

Biomass Space Heating

OVERVIEW

Wood stoves

Wood stoves are the most common space-heating appliances and can be installed almost anywhere in the house, provided there is enough clearance and proper routing of the chimney.

Seeking expert advice when purchasing a new stove is important to ensure you have the right stove size and output. Wood stoves vary in their use of emission-reduction technology (catalytic or non-catalytic) and heat transfer (direct radiation, convection, or a combination).

Fireplace inserts

These are like wood stoves but designed to be installed within the firebox of an existing masonry fireplace. A chimney liner is installed within the chimney to vent the insert's emissions outdoors and improve performance and safety.

Using an insert reduces the emissions produced compared to conventional fireplaces and, unlike conventional fireplaces, can effectively transfer heat to the house.

Pellet burning stoves and inserts

Pellet burning stoves and inserts burn pellets made from compressed wood wastes that are fed automatically from a storage hopper into the combustion chamber. Pellet stoves need less maintenance than wood burning appliances, as one load of fuel can last 24 hours. They have some of the lowest emission ratings and are highly efficient heating appliances. Pellet stoves do require the use of electricity to operate, though some will run on batteries and not be affected by power outages.

Other space-heating wood-fuel appliances include high efficiency fireplaces, masonry heaters, and cook stoves.

As with other energy-using appliances, keep in mind that buying an energy-efficient gas fireplace and using it wisely will use less energy and reduce greenhouse gas emissions that contribute to climate change.

SECONDARY HEATING SYSTEM:

Electric Baseboards

OVERVIEW

Electric baseboard heaters are based on one of the first whole house heating systems: hydronic heat or radiators. Electric models are a more modern, more reliable source of secondary heat.

Think of electric baseboard heat like a toaster. They work by sending an electric current through the unit heating the metal fins which then radiate that heat into the air. Currents in the room circulate the heat keeping the room toasty—pun intended.

Electric baseboard heat is the most sought after form of secondary heat in the Northeast, where it can be bitterly cold. Electricity performs better in extreme temperatures where other sources might struggle.

One downside to electric baseboards is that they aren't very subtle in the space, nor are they attractive to look at.These concerns were eliminated by launching nice looking covers (very similar to the hydronic baseboard heater covers). These are available in kits for full update to your baseboard heat that are easy and quick to install.

OTHER HEATING-RELATED FACTORS TO CONSIDER

No matter what kind of heating system you have in your house, you can save money and increase your comfort by properly maintaining and upgrading your home. By taking some simple steps you can maximize your retrofit gains and can improve your home's heating, cooling and ventilation performance, and overall durability. Even more important, you will create a healthier, more comfortable living environment.

DO IT YOURSELF / SIMPLE FIXES

Hiring a professional to perform major home improvements and renovations is recommended, but if you're skilled enough or willing to learn, some tasks can be managed without help. Some simple lifestyle changes can also have a major impact on the energy costs of home heating. As the temperature starts to take a dip, there are some simple things you can do to cut back on heating bills.

Make your curtains work for you

Windows are one of the biggest sources of heat loss in a house. Window coverings can reduce energy loss through your windows, lower heating and cooling bills, and improve your home's comfort. Remember to open your curtains or blinds in the morning to let in natural heat and sunlight. Be sure to close them in the evening to keep heat from escaping back out through the windows.

Heat is expensive, but you already own a sweater & socks

You don't need to buy, build, or install anything to lower your heating bills. Simple changes in your daily habits can have a significant impact without requiring any financial investment. Adjusting your indoor attire can allow you to keep your thermostat at a lower setting while staying comfortable. A cozy sweater and wool socks can make you feel warmer.

Use your ceiling fan more effectively

Change the rotational direction of your ceiling fan so it spins clockwise. This will pull up more cold air, forcing it to mix with hot air near the ceiling. The resulting warm air will get pushed down and make the room feel warmer.

Refrain from heating unused spaces to conserve heat

If you have unused rooms in your home, don't waste heating energy and money by heating them. Consider reducing heat sent to guest rooms, laundry rooms, or storage areas. Partially close vents in those rooms, close doors, and conduct the flow of warm air to rooms that you use more regularly.

Keep cold air outside and warm air inside

Check for areas in your home where drafts are allowing cold air in and warm air to escape. Check windows and doorways for drafts. You may be able to stop leaking heat with weather stripping, door sweeps, or clear plastic window films to reduce the loss of warm air and better insulate your home.

BE SMART ABOUT SETTING YOUR THERMOSTAT

Cranking the thermostat doesn't warm up the room any faster. If you've ever returned home to a room that feels like the Arctic, it's pretty tempting to crank the thermostat up four or five degrees past where you normally set it. But the space will still take the same length of time to warm up and you'll just use more energy because your heating system continues heating the room after you've passed your regular comfortable temperature. This often results in opening a window to lower the room temperature letting all that expensive heat go to waste and a massive loss of efficiency.

Lowering the temperature of your home two to three degrees Celsius is optimal for saving energy and keeping your home comfortable. A good guide is to program 17°C when you are sleeping or not at home, and 20°C when you are awake and at home. Keep it simple and install a smart thermostat so you can set it and forget it.

Did you know that heating costs can increase by about 5 percent for every degree above 20°C (68°F)? Most people often set their thermostat higher than it needs to be.

Installing a smart or programmable thermostat is one of the most effective ways to reduce heating costs. These devices offer precise temperature control and can learn your habits to optimize heating schedules automatically. However, even standard programmable thermostats can make a big difference when used correctly. Remember, the best programmable thermostat is the one you'll use and use properly, not the one with the most features.

The following temperature guidelines are recommended, but every house has different requirements.

Sleep

16 - 18°C (61 - 64°F)
During sleep or rest set the temperature lower

Active

18°C (64°F)
Doing housework or cooking

Inactive

21°C (70°F)

Watching TV or reading

A higher minimum indoor temperature than 18°C may be necessary for vulnerable groups including older people, children, and those with chronic illnesses, particularly cardiorespiratory disease.

PROFESSIONAL RENOVATIONS AND RETROFITS

In some cases, Do It Yourself (DIY) projects may not be enough. While professional options require a larger upfront investment, they can lead to significant long-term savings on your heating and cooling bills.

Renovating a house so it will keep the heat in during the heating season and keep the temperature cooler during the summer often involves hiring a professional. This means adding insulation, caulking and weatherstripping, improving or replacing windows and doors, and improving the mechanical systems including adequate ventilation. Talk to a professional contractor about the best options for your home. They may do a heat loss calculation and point out the most efficient project to start with.

Natural Resources Canada goes into great detail regarding building science principles and how they can help you control the flow of heat, air and moisture / humidity, and why you must consider these factors together in this document.

Add more insulation

Your house may lose heat quickly if it is not well insulated. This is often the case with older properties that were built before modern-day insulation techniques and do not have the space to add cavity wall insulation.

Too little insulation, especially in your attic or basement, can really affect the warmth of your home, letting hot air escape outside or making it feel colder near the walls. Adding insulation to key places, or even upgrading the insulation in your whole home, can make a big difference.

Eliminate drafts and plug holes

Check for extra space around your windows and doors that could be letting in cold air. If you're not sure, try placing your hand a few centimeters away from the edges and see if you can feel a draft. If so, apply weather-stripping or sealant to fill any cracks. 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. Take a close look at where you can reduce the heating losses by draft proofing and insulating before you change the heating system.

Replace your windows

Does it feel like your windows are wide open, even when they're closed? Is there any mold on your window frame? This problem probably needs more than just sealant; it's likely time to replace your windows. Replacing all of your windows with new certified models could save you up to 45 percent on your energy bill.

By implementing quick fixes like sealing drafts and optimizing your existing system, along with long-term strategies such as improving insulation and considering renewable energy sources, you can significantly lower your heating bills while maintaining a comfortable home environment. We recommend starting with the most accessible and affordable options and gradually working towards more comprehensive solutions as your budget allows.

APPENDIX

Availability Scoring

- Based on remote areas.
- Natural gas is scored 01 because it can't be 0. There are portable Natural Gas options but not feasible.
- Propane is scored at 3 could be 4 based on local delivery service. Usually associated with a higher cost.
- Electricity is scored higher but isn't 5 because of inconsistencies in grid.
- Wood is scored at 5 but pellet needs to be a lower score based on recent supply chain issues.
- Systems on this grid with multiple sources like wood pellet and "gas" propane/natural are scored an average of both.
- Hard to score oil. It has a low score as its availability is lowered by other factors including lack of equipment and technicians.

Health Impacts Scoring

- A summary of household emissions could also account for the small physical activity that comes from processing and loading fuel.
- Properly maintained gas burning equipment is the safest equipment for household emissions. But if a problem occurs CO is a major risk.
- Solid fuels Wood/Pellet bring ash, smoke. and dust into the home when used properly and maintained.
- If solid fuel appliances aren't maintained or operated correctly, they pose a major risk with smoke, fire, and CO
- Solid fuel also offers the positive health benefit of cutting firewood and loading fuel.
- Electric heat from baseboards have a fire risk but also do not allow for air circulation leading to mold and stale air.
- Oil heating appliances have health concerns from both fuel storage and the combustion process.

Self Sufficient "Vacay-able" Scoring

- How often does the end user need to interact, intervene or operate the heating system.
- Natural gas, where available, is usually uninterrupted and can be relied on. Just pay bills. Most equipment requires electricity
- Propane is similar to gas but locally stored. If the user doesn't schedule a delivery fuel can run out.
- Solid fuels at their best require multiple fuel feedings per day.
- Residential solid fuel boilers and furnaces (pellet specifically) have the ability to heat over 24-48 hours depending on hopper size.
- Electric is in most areas the most "fail safe" "set and forget" fuel.
- Oil, like propane, requires a reliable delivery service, but also has a higher failure rate.

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