NET ZERO ENERGY HOMES

The Basics of Residential Energy Efficiency

2021

Table of Contents

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Introduction

In October 2018, the Intergovernmental Panel on Climate Change published a report expressing the need to act to limit global warming to 1.5 degree Celsius in order to prevent the environmental catastrophes that are at risk of occurring with greater warming. On a global scale, the urgent need to respond to climate change becomes more obvious each year. In New Brunswick for example, coastal communities that depend on marine resources are already feeling the effects of climate change such as rising sea levels, coastline erosion and more frequent storms.

The City of Dieppe decided to act to respond to climate change and reduce greenhouse gas (GHG) emissions from buildings. In partnership with the Université de Moncton, the municipality began a research project to identify obstacles to the adoption of building net zero energy (NZE) buildings in New Brunswick. NZE homes are believed to be an effective solution to respond to climate change being that they are built to be very energy-efficient and they generate their own electricity from renewable sources. The results of this study will suggest possible actions to increase the energy efficiency of homes in the municipality, and eventually in the province.

This research was based on a diversified methodology that provided insight on the design of NZE homes and the barriers faced by the owners of energy-efficient homes and construction industry experts. A literature review was first undertaken to define the extent of current knowledge in the field. Then, NZE homes were visited to compare what happens in practice in the region with what is presented in literature. Finally, experts on energy-efficient construction were interviewed to obtain their perspectives on the most efficient construction methods, the advantages of NZE homes and the barriers to energy-efficient construction.

Finally, an important aspect of the research project was the development of a guide on net zero construction. This guide presents the basic concepts of energy-efficient construction and informs readers on residential energy efficiency.

We wish to sincerely thank all the participants who shared their time, experience and expertise so that we could carry out this project.

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Homes in NB waste energy!

In New Brunswick, the residential sector **consumes 15% of all energy** and generates important quantities of **greenhouse gas** (GHG) emissions. Also, many homes around the province do not meet the requirements for attic, wall and basement insulation laid down in the National Building Code (NBC). Indeed, only 6% of homes in New Brunswick have attics that are insulated to the standards in the NBC.

This **lack of insulation** translates to an **enormous waste of energy and money** for most residents in the province.

We have to act now

To limit the frequency of **environmental catastrophes** caused by climate change, we need to **reduce our GHG emissions**. To this end, the City of Dieppe has established an action plan to reduce emissions by 6% for the community by 2025. To reach this goal requires **concrete actions**, especially with regarding our modes of **energy production** and **consumption**.

The process of **energy transition**, that is the transition towards clean energy generation and more responsible consumption, requires advances in both the reliability of renewable energy sources and **building** energy efficiency.

What are they exactly?

NZE homes have **many advantages**, including **lower operating costs, increased comfort** and better indoor **air quality**. They include a number of elements that increase their energy efficiency.

An NZE home usually starts with a **high quality building envelope**. The walls, attic and foundation all have to be **well-insulated** and **draft proof**.

Certain factors must be taken into consideration to reduce energy demand, such as the building's orientation to the sun in order to use **passive solar energy**, for example.

Net zero energy homes as a solution

Net zero energy (NZE) homes are considered to be an effective solution to reduce residential sector GHG emissions because they are built to be very **energy efficient** and they generate their own electricity from **renewable sources**.

NZE homes are connected to the grid, so they have a constant supply of power when the renewable energy systems are unable to meet the demand.

Please note!

Before you consider adding a renewable energy system to your home, you have to make sure that all the other measures to reduce energy demand have been taken. Otherwise, the renewable energy system will never be able to produce enough electricity to meet the demand of the building.

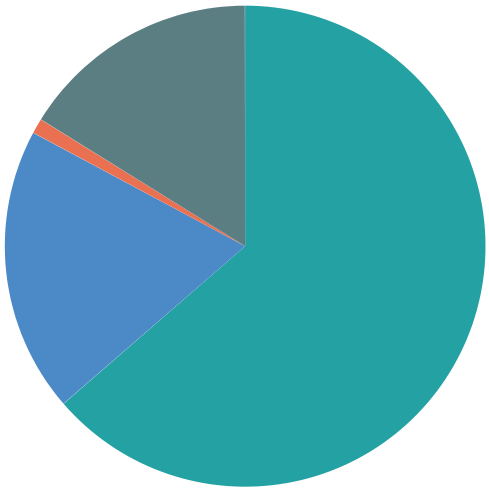
Then **energy-efficient mechanical systems** can be made part of the building. Today's ventilation, heating and household hot water systems are more efficient than ever and help to considerably reduce a building's energy demand.

Finally, a **renewable energy system** can be installed so that the home can generate its own electricity. Net zero annual energy consumption is reached when **the home generates as much energy as it consumes** each year. NZE homes in Canada usually use **solar energy systems**.

Energy consumption of a typical home

As explained, most homes in New Brunswick are inefficient, mainly due to a lack of insulation in the walls, basement and attic. Air leaks into the building envelope and high energy-consuming mechanical systems also contribute to energy inefficiency in homes. Indeed, in typical homes in Canada, over **80%** of electricity is used for **heating** and **hot water**.

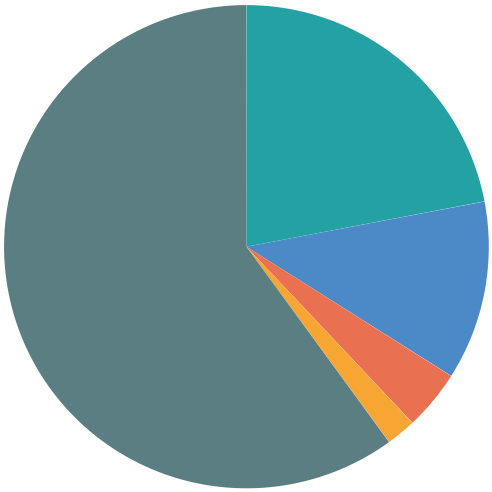
Typical home



- Heating (63.64%)
- Hot water (19.19%)
- Air conditioning (1.01%)
- Occupant load (16.16%)

Natural Resources Canada, Energy Efficiency Trends in Canada 1990 to 2013.

NZ home



- Heating (22%)
- Hot water (12%)
- Air conditioning (4%)
- Ventilation (2%)
- Occupant load (60%)

Natural Resources Canada. (2019). R-2000 Net Zero Energy Pilot. *Average results

Energy consumption of an NZE home

Due to its super-insulated, airtight building envelope and energy-efficient mechanical systems, an NZE home consumes only **34% of its energy for heating and hot water.**

Being that NZE homes are so efficient, the **occupant load**, or load for lighting, appliances and numerous plug-in devices, represents **60%** of the building's energy consumption. If a home is to attain annual net zero energy consumption, its occupants have to **participate actively** in **managing their** energy **consumption.**

THE HOME AS A SYSTEM

In the past, the various components of a home, such as the foundation, lighting, and mechanical systems, were designed and built as separate parts. Today, NZE homes put this notion into question.

Since NZE homes have to reach optimal energy efficiency, **each component** of the home and its **influence** on **the other components** has to be taken into account. For example, if the building envelope, that is, the walls, roof and foundation, is airtight, you have to install an efficient ventilation system to maintain excellent interior air quality.

Thus the home needs to be designed as a **system** with various elements that **interact** with each other. In this way you can **optimize** the **energy performance** of each component and so of the entire home.

What the owners of green homes are saying...

"[It's important for] it to be balanced. I realized that you can't install energy-efficient everything, then install one inefficient door because then you've just lost 80% of the effort you put in."

Passive strategies

You can build an energy-efficient home that uses passive or active strategies. The passive components do not include any mechanical or electrical element, and include **insulation**, **draft proofing** and the **orientation** of the buildings towards the sun, among other factors.

Passive methods to increase home energy efficiency are **reliable** and often **more affordable** than active methods.

Active strategies

In contrast, active strategies include a mechanical element, such as heating, ventilation and hot water **systems.** These components provide active energy savings because they are **highly energy efficient**.

Active components are usually **more expensive** than passive ones, but with them a home can reach **net zero energy efficiency**. To optimize home energy performance and construction costs, it is important to establish a **good balance** between passive and active components.

BUILDING DESIGN

A few principles to follow

As we have explained, you must **reduce** the building's **energy load** so that the renewable energy system can meet the demand of the home. Different building design factors can have major effects on energy consumption.

1. The shape of the building can have an impact on energy demand for heating. A **compact-stacked shape** is the most efficient in northern climates because it reduces the surface area exposed to the cold.
2. A **simple, open plan** is easier to ventilate and heat, especially using passive solar energy. However, measures to mitigate sound and provide a certain level of privacy have to be considered.

Passive solar design

By taking advantage of passive solar energy you can significantly reduce the amount of energy required to heat a building. A well-designed passive solar home can meet up to **40% of heating needs** with radiant energy from the sun.

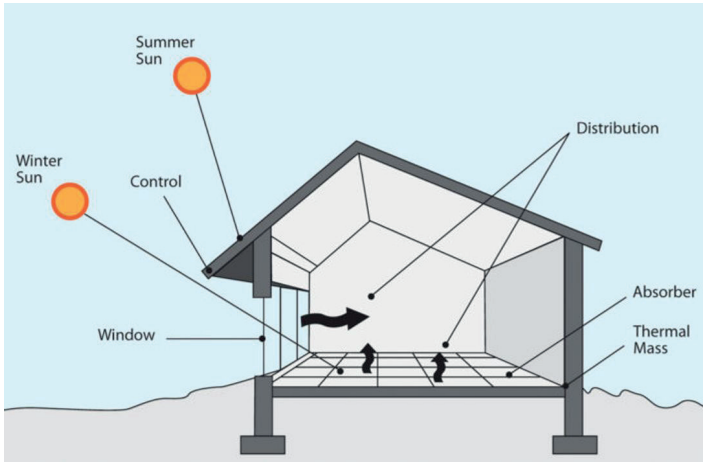


IMAGE: Green Energy Times, (s.d.)

Please note!

In some cases a passive solar design may overheat the home, so it's important to have your plans assessed by an energy efficiency advisor or a passive solar design consultant to ensure that adequate steps have been taken to minimize this risk.

To take advantage of passive solar energy you need to:

1. **Orient** the long side of the home toward the south to maximize exposure to the sun;
2. Install **many windows** on the **south** side and few on the north;
3. Provide a **thermal mass** to absorb heat and release it throughout the day;
4. A **control method** to limit the amount of sunlight entering the home in the summer, such as eaves for example.

FOUNDATION

An energy-efficient foundation

The foundation may account for about **20% of a home's heat losses**, mainly due to its large **under-insulated** surface and the **drafts** which may occur at its various seams.

Since they are in **direct contact with the ground**, foundations are susceptible to water leaks, accumulated dampness and heat losses. These obstacles require additional measures to **control the level of dampness and temperature fluctuations** in basements.

1. You have to **properly insulate the concrete slab and the foundation walls** to minimize heat losses. Even below the frost line, the ground is colder than the inside temperature, so major heat losses can occur if this part isn't insulated.
2. **Water and dampness** leaks through foundation walls must be **limited** by installing a waterproofing membrane and vapour barrier, and by ensuring proper ventilation.
3. **Drafts must be minimized** by taking adequate steps to draft proof seams between the wood and concrete elements.

Example A
Foundation components

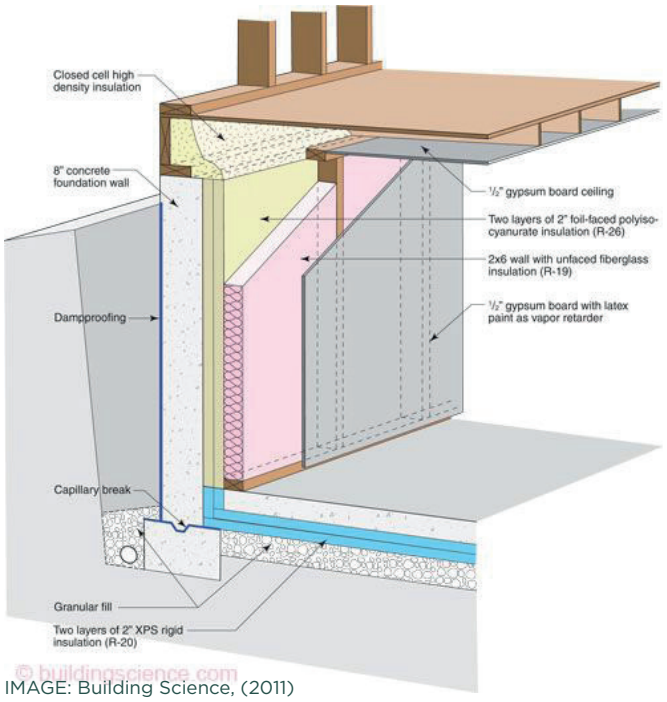


IMAGE: Building Science, (2011)

How do you insulate the foundation?

1. Insulation can be installed on the **outside** of walls. This way, the foundation walls are never exposed to the cold and they remain at a more constant temperature. However, the insulation is exposed to the ground, insects, dampness and frost.
2. Installing insulation on the **inside** of walls is a standard practice suitable for different types of insulation. However, there is a risk of condensation caused by warm basement air coming into contact with concrete that is exposed to the cold.
3. Insulating **both sides** of the foundation can minimize the risks associated with only insulating one of them, but it can be more costly.

There is no perfect way to insulate your foundation because conditions are different on each site. The insulation method is usually determined by the **climate**, the **characteristics of the ground**, your **objectives** and your **budget**.

WALLS

How do I choose the ideal assembly?

There are a **multitude of different** wall **assemblies** that attain a high level of energy efficiency. The choice may be determined by various factors such as the **availability of materials** and your **budget**. However, there are a few rules that have to be followed when building a wall:

1. Walls have to be **draft proof**. A significant portion of the heat in a building is lost through drafts.
2. The movement of **water vapour** through the envelope has to be **controlled** to reduce the risk of dampness and mould building up in wall cavities.
3. Walls need to be **well insulated** to reduce heat transfer between the interior and exterior. Combine different types of insulation to create **several insulating barriers** and minimize heat losses.

Example B

R value: 29.00
RSI value: 5.11

1. Exterior air film
2. Wood siding
3. 3/4" airspace
4. 3" mineral wool insulation
5. Air barrier
6. 1/2" plywood siding
7. 16" c.c. 2x6 studs / R24 semi-rigid insulation
8. Smart vapour retarder
9. 1/2" gypsum board
10. Latex paint finish
11. Interior air film

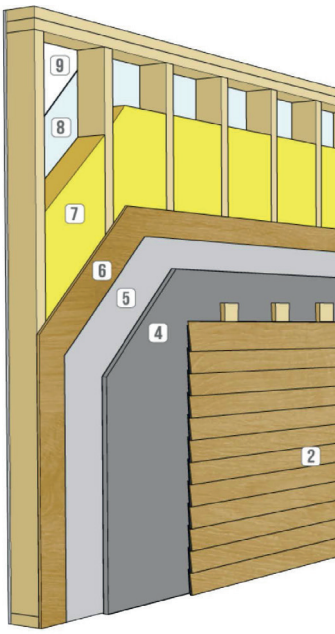


IMAGE: CWC, Effective R Calculator, wall I.D.: 4642

Do I really have to install different layers of insulation?

Wood, an excellent conductor of heat, representing about 20% of the composition of the walls in a typical home. This means that even with high-grade insulation between the studs, **20% of walls are still uninsulated**.

A continuous layer of rigid insulation on the exterior façade of the walls (no. 4, examples B and C) significantly reduces heat losses through the studs. This second layer **greatly increases the thermal performance** of the assembly as a whole.

What the experts are saying...

"I put R-20 inside and R-5 rigid insulation on the outside. It's really easy to sell to my clients because it costs me $2,000 to $5,000, depending on the size of the home."

Example C

R value: 37.21
RSI value: 6.56

1. Exterior air film
2. Vinyl siding
3. Asphalt paper
4. 4" rigid extruded polystyrene insulation board, type 3/4
5. 1/2" plywood siding
6. 16" c.c. 2x6 studs / R22 semi-rigid insulation
7. Smart vapour retarder
8. 1/2" gypsum board
9. Latex paint finish
10. Interior air film

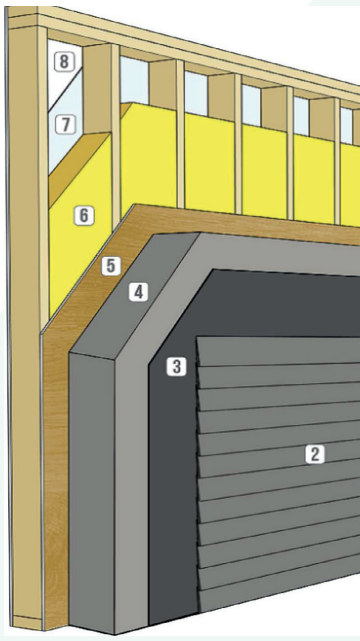


IMAGE: CWC, Effective R Calculator, wall I.D.: 12578

ATTIC AND ROOF

An energy-efficient attic

The attic, like all the other components of the building envelope, has to be adequately **insulated and airtight** to minimize heat losses.

However, it's essential to make sure that the attic is **ventilated properly** because it is much more susceptible to **leaks of water and dampness** than the rest of the building envelope.

Accumulated dampness in the attic, due to rain and water vapour getting in, can cause **mould** problems, reduce the effectiveness of insulation and damage the wood structure. **Example D** shows how a roof can be ventilated yet remain airtight and properly insulated.

Example D

An energy-efficient roof

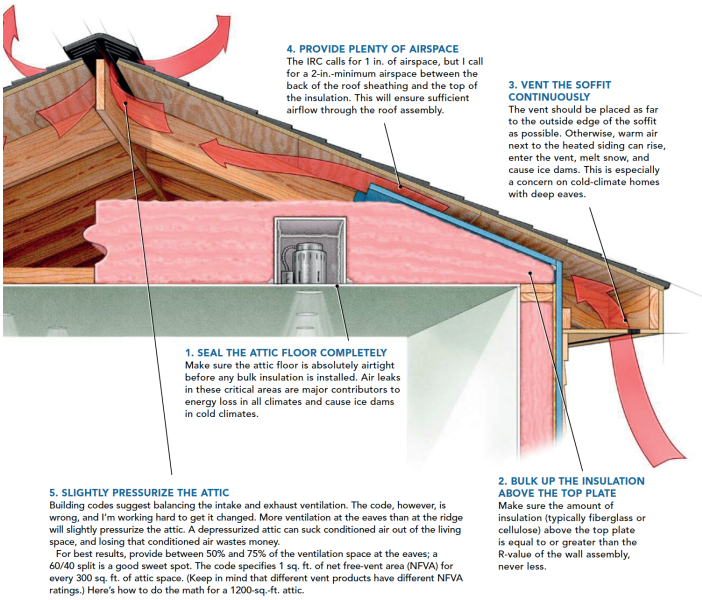


IMAGE: Hartman, J. (2011)

Plan for solar panels

As **solar panels** are frequently installed on the **roof**, it is important to consider several factors when planning the home in order to **optimize** the **performance** of the renewable energy system.

1. To maximize exposure of the solar panels to the sun, they must be oriented to the **south**, at an angle of between **15°** and **56°**.
2. In order to ensure that the **roof** can **accommodate** a **system** able to meet the building's energy demand, it is important to perform energy modelling allowing you to estimate the **number of solar panels** required. Then the roof can be designed to accommodate the necessary number of panels.
3. The **shape** of the roof has to be fairly **simple, minimizing the number of roof ridges** to avoid creating shaded areas on the roof.

With a new construction, do what needs to be done to **install ducts and an electrical panel** designed for photovoltaic solar panels, even if you only intend to install the system at a later date. A duct that passes through the roof and attic to the electrical panel is **easier to install** when the walls and attic are still open.

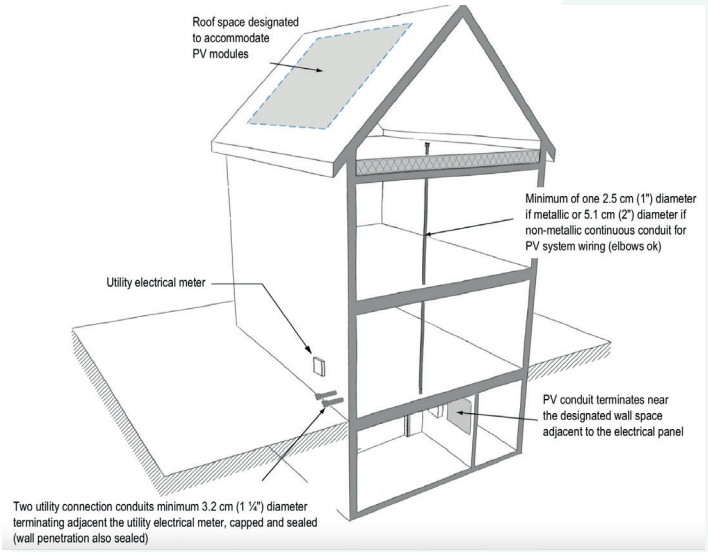


IMAGE: Natural Resources Canada, (2018)

DOORS AND WINDOWS

The importance of energy-efficient doors and windows

Doors and windows are the weakest points in the building envelope and may account for about 35% of heat losses in a typical home. **Heat losses** occur in different ways through the components of a door or window, such as the **frame** or **glass**.

Energy-efficient doors and windows minimize heat losses with **well-insulated**, **airtight frames** composed of **non-conductive material**.

Heat losses through a typical window

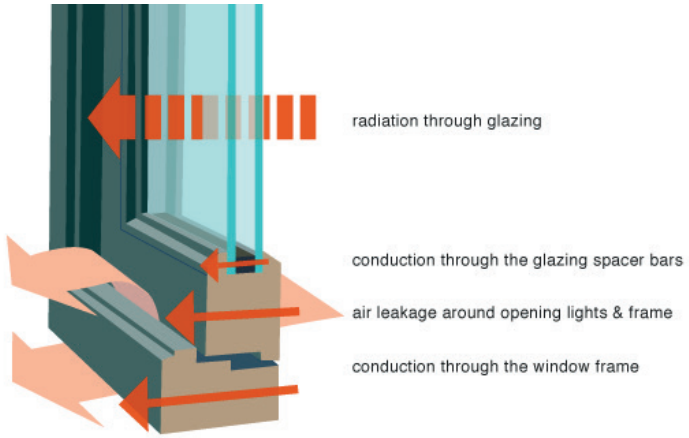


IMAGE: GreenSpec, (s.d.)

How do I choose?

It's important to select **energy-efficient windows** and to make sure that they **are properly installed**. Otherwise you risk **neutralizing all your efforts** to increase energy efficiency in your building.

Today there are a number of types of windows, each with its own advantages and disadvantages. Double- and triple-glazed windows that contain **inert gas between the panes** have a higher insulating value. **Low-emissivity** films can be applied to windows to limit the amount of heat that escapes through the windows by reflecting it back inside.

The **choice** of windows may be **dictated by their location** on the home. For example, **triple-glazed** windows on the **north** side of the home can limit heat losses because they have a high-insulating value.

On the other hand, you can take advantage of **passive solar energy** by placing **low-emissivity** windows on the **south** façade to retain the heat inside the building.

Finally, the recommendation is always to consult with a **specialist** and explain the project objectives and the features of the home so that you can make an **optimal choice**.

It is also important to note that careful installation of doors and windows is essential if you want to minimize heat losses.

ENERGY STAR doors and windows

When choosing doors and windows that meet the requirements for NZE homes, you have to be sure that they achieve optimal energy performance. Fortunately, the ENERGY STAR label on doors and windows indicates that they meet strict energy efficiency standards.

MECHANICAL SYSTEMS

How do I heat my home?

Homes in cold climates, like what we have in New Brunswick, spend a lot of energy for heating, and NZE homes are no exception. Even though the energy demand for heating is drastically reduced in NZE homes due to their airtight, super-insulated envelope, you still need a **heating system** to keep the interior at a **comfortable temperature**.

To achieve net zero annual energy consumption, you have to have a heating system that is **as efficient** as possible. There are different ways to heat a home, but the most common ones in energy-efficient buildings are **air-to-air heat pumps** and **geothermal heat pumps**.

IMAGE: Geo Cool, (2016)

Air-to-air heat pumps

Instead of generating heat from electricity or a fuel, a air-to-air heat pump **extracts the heat** present in the outside air. With advances in technology, air-to-air heat pumps can even operate at low temperatures. In summer, air-to-air heat pumps can draw heat from the indoor **air** and expel it outside.

Today, ductless mini-split heat pumps have been adopted widely in the field of construction. They are **efficient**, easy to install and relatively **affordable**, and they can increase the energy efficiency of homes that already have a heating system. This makes ductless mini-split heat pumps ideal for **renovations**.

What the experts are saying...

"The advantage of a geothermal pump is that there are no mechanical or electrical components outdoors. Everything is either indoors or buried in the ground, so the system has less of a tendency to break down."

Geothermal heat pumps

A geothermal heat pump is a heating system that uses the **heat in the ground** to heat your premises in winter. In summer, the system can draw heat from the home and store it in the ground. Geothermal pumps have two main parts:

1. A network of **underground pipes** outside the home and;
2. A **heat pump** inside the home.

Geothermal heat pumps have a number of advantages, the main being its high level of energy efficiency. Since the **temperature of the ground fluctuates less** in winter than the temperature of the air, the system operates much **more consistently**. Geothermal heat pumps are extremely efficient and can make it easier to achieve net zero energy efficiency.

MECHANICAL SYSTEMS

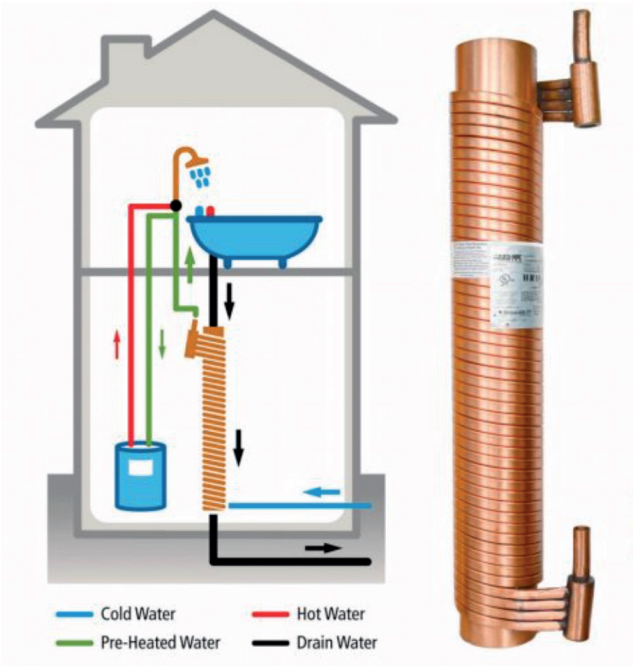
Reduce to gain

The mechanical systems in an NZE home have to operate optimally to minimize the building's energy demand. However, ventilation or heating systems are often oversized and so consume much more energy than the building would necessarily demand.

Since **NZE homes** are super-insulated and airtight, it is essential that you **calculate the energy demand** in order to **right-size** the mechanical systems. A right-sized system operates more consistently, is more efficient, lasts longer and is more affordable.

IMAGE: Delbert, C. (s.d.)

Example F
Drain water heat recovery system



Simple additions that save a lot

Today there are mechanical systems that can easily be added to a home to increase its energy performance. Here are a few examples:

1. You can **recover heat** from wastewater and use it to **heat cold water** (example F) with a drain water heat recovery system. This spiral of copper pipe can be added to the plumbing system. It costs between $600 and $800 and **reduces the demand** in energy to heat water by **20%**.
2. Certain ventilation systems can also **recover heat** in order to **heat the cold air** coming into the home. A heat-recovery ventilator (HRV) in an NZE home should attain **67%** to **84% efficiency**.
3. A **heat pump hot water heater** uses warm indoor air to heat water. This type of hot water heater has to be installed in a mechanical room with a fairly large open space, but can be up to **61% more efficient** than an electric hot water heater.

RENEWABLE ENERGY

How do I choose the optimal system?

While numerous sources of renewable energy are applicable in a residential situation, **solar energy** has certainly become the standard for NZE homes in Canada. Despite the obstacles encountered during the winter such as the cold, shorter days and accumulations of snow, solar energy systems can generate so much energy during the rest of the year that the **energy consumed from the grid in winter is quickly recovered**.

If your solar energy system is going to be able to meet the demand of the building, you have to **thoroughly understand the building's energy consumption profile**. The energy requirement profile can be modelled by professionals using specialized software such as HOT2000, but the most reliable way is to measure energy consumption for a year when the home is being lived in.

IMAGE: Voyer, (s.d.)

Photovoltaic solar energy (PV)

The capacity to generate your own clean electricity from renewable sources is what distinguishes NZE buildings from other types of green construction. **PV solar panels** generate electricity by **converting energy from the sun** into an electric current that can be used by the building.

Batteries can be used to store a portion of the **electricity generated**. At night or on cloudier days, the electricity stored in the batteries can supply the home. However, depending on batteries to meet energy needs demands **sacrifices from the occupants**, such as limiting the use of nonessential devices like the television or avoiding taking hot showers. Also, a battery system can be a **major financial investment**.

It is, however, possible to install a **batteryless** renewable energy system, and these are significantly **less costly**. During periods when there is less light, the energy required by the home comes from the electrical grid. When the home generates a surplus of electricity, this energy can be sent to the grid. NB Power's **net metering** program offers **credits** on your electricity bill for energy fed to the grid.

What the owners of green homes are saying...

"Batteries are a big investment that is never going to pay for itself, no matter what conditions prevail. Batteries may be useful during power outages [...] and also perhaps if energy prices fluctuate with the time of day, but that is not the case now."

OCCUPANT LOAD + ENERGY MANAGEMENT

The impact of our habits

Even after putting significant effort into minimizing a building's energy demand using various strategies, attaining annual net zero energy consumption demands that **occupants participate actively** in **managing** their **energy** consumption. The **occupant load** represents over **60%** of an NZE home's energy consumption, so **occupants' habits** have a **significant impact** on the building's energy demand.

Recent research has shown that an NZE home **can only achieve net zero energy consumption** if the occupants adopt **energy-saving habits**.

IMAGE: EdelmanInc. (2018)

Energy-efficient advice

Managing energy consumption can be made easier if you install **smart** systems. In a smart home you can control the temperature, lighting, locks and even some appliances from a smartphone or tablet. Different parameters can be programmed to enable you to **automatically adjust** temperature and lighting to match the occupants' needs.

Besides trusting the automatic systems to manage energy, it's important to have **eco-friendly habits** like these:

1. It's important to **trust** your **mechanical systems**. For example, even with a built-in home ventilation system, some people open the windows to bring in fresh air. This can reduce the indoor temperature and make the heating system start up, so it is important to **understand the role and operation** of all the components so that our habits don't reduce the home's energy efficiency.
2. **Hot water** also consumes a lot of energy, even if you use energy-efficient systems. It is recommended that you **limit your usage:** take shorter, cooler showers and do laundry in cold water.
3. Even energy-efficient appliances can consume **lots of energy,** so it's important to reduce how often you use them. Just run the dishwasher when it's full and let the dishes air dry. Do full loads of laundry and use the clothesline whenever possible.

What owners of green homes are saying...

"We really like the thermostat that came with our heat pump. It shows us exactly how much energy we're consuming in kWh. It's a bit like watching your woodpile get smaller as the year progresses."

USEFUL RESOURCES

Here is a bank of **essential resources** that will **increase your knowledge** of the different aspects of energy-efficient construction:

Natural Resources Canada

Natural Resources Canada offers useful resources on planning and building net zero homes. Their site includes different reports on residential energy efficiency. The case studies for the R-2000 net zero pilot project are an excellent resource because they present designs for various NZE homes and the different components used.

https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-homes/buying-energy-efficient-new-home/netzero-future-building-standards/20581?_ga=2.104998657.382149728.1619021164-1353687096.1617024801

Natural Resources Canada - ENERGY STAR Products

This page displays a bank of ENERGY STAR products tested in Canada and approved for use in NZE homes. These products (from windows to appliances) are guaranteed to achieve a high level of energy efficiency.

https://www.nrcan.gc.ca/energy-efficiency/energy-star-canada/energy-star-products/12519?_ga=2.261359375.382149728.1619021164-1353687096.1617024801

Canadian Wood Council - Design tools

The Canadian Wood Council's website offers very **useful design tools** for building designers, homebuilders and interested members of the public. The **"Effective R Calculator" calculates the insulating value** of different wall assemblies. Based on the desired parameters, users can choose their ideal assembly. This tool gives the insulating value of the chosen assembly and determines whether it meets the NBC requirements for different regions in Canada.

https://cwc.ca/fr/design-tools-2/effective-r-calculator/

Canadian Home Builders' Association (CHBA) - NET ZERO HOME

The Canadian Home Builders Association (or CHBA) has a whole **section on NZE homes**. It recently developed a certification program for NZE homes warrantying the performance of certified homes and it is continually contributing to the advancement of net zero construction in Canada.

https://www.chba.ca/NZE

Building Science

Building Science is a website where you find a **variety of articles and guides** on home building in North America. **Professionals** and **researchers in the field of building construction** contribute regularly, publishing all sorts of interesting articles on various aspects of construction.

https://www.buildingscience.com/

SOURCES OF FUNDING

It usually **costs more** to build an NZE home compared to a typical construction, mainly due to the **additional materials** and **energy-efficient mechanical systems** needed to make the home more efficient. **To reduce the cost of NZE homes**, various organizations and governments offer **incentives** in different forms, such as **subsidies** and **tax credits.** Sources of funding can vary from year to year, so it's important to check regularly before starting a project to make sure that the necessary funding will be available. Here are several potential sources of funding available in New Brunswick:

New Brunswick Power

NB Power offers **various incentives** for energy-efficient construction in New Brunswick. The Total Home Energy Savings Program and New Home Energy Savings Program are the main incentives offered in the province for renovations and new constructions, but there are also other specialized programs such as the one for low-income households. The amount available changes by the **type of renovation**, the elements incorporated into the home and the **level of energy efficiency** reached.

https://www.saveenergynb.ca/en/save-energy/

Canada Mortgage and Housing Corporation

To make energy-efficient construction more accessible, Canada Mortgage and Housing Corporation refunds **15% to 25%** of the mortgage insurance premium when you **build** or **buy** an **energy-efficient home**.

https://www.cmhc-schl.gc.ca/fr/finance-and-investing/mortgage-loan-insurance/the-resource/energyefficient-housing-made-more-affordable-with-mortgage-loan-insurance

Sagen (Genworth Canada)

Sagen, formerly known as Genworth Canada, offers an incentive similar to that from Canada Mortgage and Housing Corporation. On **purchase** or **construction** of an **energy-efficient home**, buyers may receive a refund of **up to 25% on their mortgage insurance**. The amount of the refund depends on the level of energy efficiency reached.

https://www.sagen.ca/products-and-services/energy-efficient-housing/

Your governments

While the governments are not yet offering incentives, funding may be **available soon.** Check with your municipality and the provincial and federal governments regularly to make sure that you take **advantage** of all **available sources of funding.**

Bibliography

Asaee, S. R., Ugursal, V. I., & Beausoleil-Morrison, I. (2019). Development and analysis of strategies to facilitate the conversion of Canadian houses into net zero energy buildings. Energy Policy, 126, 118–130. https://doi.org/10.1016/j.enpol.2018.10.055

Canada Mortgage and Housing Corporation. (2017). Passive approaches to low-energy affordable housing: An introduction to the benefits, technologies, costs and best practices. Canadian Property Valuation, 61(3), 20–22.

Canadian Home Builders' Association. (2013). Builders' manual. Canadian Home Builders' Association.

Doiron, M., O'Brien, W., & Athienitis, A. (2011). Energy performance, comfort, and lessons learned from a near net zero energy solar house. ASHRAE Transactions, 117, 585–596.

Énergie NB. (n.d.). Mesurage net. Retrieved June 12, 2019, from https://www.nbpower.com/fr/products-services/net-metering/

Gupta, R., Kapsali, M., & Howard, A. (2018). Evaluating the influence of building fabric, services and occupant related factors on the actual performance of low energy social housing dwellings in UK. Energy and Buildings, 174, 548–562. https://doi.org/10.1016/j.enbuild.2018.06.057

Hemsath, T. L., & Alagheband Bandhosseini, K. (2015). Sensitivity analysis evaluating basic building geometry's effect on energy use. Renewable Energy, 76, 526–538. https://doi.org/10.1016/j.renene.2014.11.044

IPCC. (2018). Special Report: Global warming of 1.5 degrees Celsius (summary for policy makers). https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf

La Régie de l'énergie du Canada. (2020, September 30). Profils énergétiques des provinces et territoires: Nouveau-Brunswick. https://www.cer-rec.gc.ca/fr/donnees-analyse/marches-energetiques/profils-energetiques-provinces-territoires/profils-energetiques-provinces-territoires-nouveau-brunswick.html

Li, H. X., Chen, Y., Gül, M., Yu, H., & Al-Hussein, M. (2018). Energy performance and the discrepancy of multiple NetZero Energy Homes (NZEHs) in cold regions. Journal of Cleaner Production, 172, 106–118. https://doi.org/10.1016/j.jclepro.2017.10.157

Li, Y., Yu, H., Sharmin, T., Awad, H., & Gül, M. (2016). Towards energy-efficient homes: Evaluating the hygrothermal performance of different wall assemblies through long-term field monitoring. Energy and Buildings, 121, 43–56. https://doi.org/10.1016/j.enbuild.2016.03.050

Lowe, R., Chiu, L. F., & Oreszczyn, T. (2018). Socio-technical case study method in building performance evaluation. Building Research & Information, 46(5), 469–484. https://doi.org/10.1080/09613218.2017.1361275

Lstiburek, J. (2011). A crash course in roof venting: Understand when to vent your roof, when not to, and how to execute each approach successfully. Fine Homebuilding, 68–72.

Maruejols, L., Ryan, D. L., & Young, D. (2013). Eco-houses and the environment: A case study of occupant experiences in a cold climate. Energy and Buildings, 62, 368–380. https://doi.org/10.1016/j.enbuild.2013.03.018

Meline, L., & Kavanaugh, S. (2019). Geothermal heat pumps—Simply efficient. ASHRAE Transactions, 125(2), 576–586.

Oh, J., Hong, T., Kim, H., An, J., Jeong, K., & Koo, C. (2017). Advanced strategies for net-zero energy building: Focused on the early phase and usage phase of a building's life cycle. Sustainability, 9(12), 2272. https://doi.org/10.3390/su9122272

Bibliography

Ressources naturelles Canada. (2008, December 1). Maison à consommation énergétique nette zéro (CENZ). Ressources naturelles Canada. https://www.rncan.gc.ca/energie/efficacite/donnees-recherche-et-connaissance-sur-lefficacite-energetique/innovation-du-secteur-residentiel/maison-consommation-energetique-nette-zero-cenz/5132

Ressources Naturelles Canada. (2009a, April 20). Pompes géothermiques: Systèmes à énergie du sol. Ressources naturelles Canada. https://www.rncan.gc.ca/efficacite-energetique/propos-denergy-star-canada/annonces-relatives-au-programme/publications/le-chauffage-le-refroidissement/pompes-geothermiques-systemes-energie-du-sol/6834

Ressources Naturelles Canada. (2009b, April 20). Thermopompes à air. Ressources naturelles Canada. https://www.rncan.gc.ca/efficacite-energetique/propos-denergy-star-canada/annonces-relatives-au-programme/publications/le-chauffage-le-refroidissement/thermopompes-air/6832

Ressources Naturelles Canada. (2012). Emprisonnons la chaleur (p. 156). https://www.rncan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/habitations/Emprisonnons-la-chaleur_F.pdf

Ressources Naturelles Canada. (2013, December 13). Caractéristiques principales et conseil pratiques pour les fenêtres, les portes et les puits de lumière. Ressources naturelles Canada. https://www.rncan.gc.ca/efficacite-energetique/efficacite-energetique-pour-les/information-sur-les-produits/portes-fenetres-puits-de-lumiere/caracteristiques-principales-et-conseil-pratiques-pour-les-fenetres-les-portes-et

Ressources Naturelles Canada. (2016). Évolution de l'efficacité énergétique résidentielle de 1990 à 2013 (p. 57). https://www.rncan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/evolution2013.pdf

Ressources Naturelles Canada. (2018, February 2). Projet pilote sur le rendement énergétique net zéro R-2000. Ressources naturelles Canada. https://www.rncan.gc.ca/efficacite-energetique/efficacite-energetique-pour-les/acheter-une-maison-ecoenergetiqu/net-zero-futures-normes-matiere-construction/20582

Ressources naturelles Canada & CanmetÉNERGIE. (2018). Prêt pour le photovoltaïque: Lignes directrices (p. 23). http://epe.lac-bac.gc.ca/100/201/301/weekly_acquisitions_list-ef/2018/18-17/publications.gc.ca/collections/collection_2018/rncan-nrcan/M154-122-2018-fra.pdf

Scarwell, H.-J., Leducq, D., & Groux, A. (2015). Réussir la transition énergétique. Presses universitaires du Septentrion.

Thomas, W. D., & Duffy, J. J. (2013). Energy performance of net-zero and near net-zero energy homes in New England. Energy and Buildings, 67, 551–558. https://doi.org/10.1016/j.enbuild.2013.08.047

Udovichenko, A., & Zhong, L. (2019). Application of air-source heat pump (ASHP) technology for residential buildings in Canada. IOP Conference Series: Materials Science and Engineering, 609, 052006. https://doi.org/10.1088/1757-899X/609/5/052006