A Developer's Guide to Passive House Buildings

An industry resource for designing and constructing Passive House (Passivhaus) buildings in Canada.

Build better.

Feel better.

PASSIVEHOUSE CANADA

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Feel better.

Fort St. John Passive House
FORT ST JOHN, BC
Velvet Leaf Photography

Presented by Passive House Canada, the national association advocating for healthier, more comfortable buildings that contribute to a sustainable future.

This guide outlines the process and resources that will enable you to become a successful Passive House developer. Please contact us for further information about training or membership; we are always happy to help.

Email info@passivehousecanada.com or call 778-265-2744.

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For upcoming courses and training go to **passivehousecanada.com/training**

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What is Passive House?

It is a building standard, considered the most rigorous voluntary energy-based standard in the design and construction industry today, resulting in buildings that consume up to **90 percent less** heating and cooling energy than conventional buildings. Applicable to almost any building type or design, the Passive House (Passivhaus) high performance building standard is internationally recognized, science-based and proven.

It is a methodology, a way of designing a building to achieve exceptional energy efficiency and superior thermal comfort. First, one looks to minimize heating and cooling loads through passive measures like massing, insulation, high quality windows, passive solar energy, shading and elimination of thermal bridges. Because a Passive House building is so airtight, it requires balanced and controlled ventilation with high quality heat exchange to provide fresh air at all times. All the building information is entered into a design tool — the Passive House Planning Package (PHPP) — which is essential for designing a Passive House building.

It's not passive and it's not just for houses. The name comes from the German "Passivhaus". It is passive only in the sense that the building envelope does most of the work to maintain comfortable temperatures, permitting simpler, smaller mechanical systems. It strives for simplicity but is hardly passive. "Haus" can in fact mean any kind of building, including multifamily housing, offices and schools. Loosely translated Passivhaus means "super-efficient-comfortable-building."

It applies to new and existing buildings. The EnerPHit certification criteria provide a proven and financially viable methodology for deep energy retrofits.

Generally **any building type can be certified as a Passive House** project. It's not limited to residential buildings.

Bahnstadt Passivhaus
HEIDELBERG, GERMANY
Image courtesy of the Passive House Institute

Alta Lake Passive House
WHISTLER, BC
Photo Credit: David McColm

Rainbow Passive House
WHISTLER, BC

What are the benefits for buyers and occupants?

1 **Comfort,** with unprecedented thermal balance. Because of the thick blanket of insulation and elimination of thermal bridges, there are no cold or hot spots. Temperatures are stable and consistent from floor to ceiling.

2 **A healthy environment,** with great indoor air quality. A heat recovery ventilation system ensures a supply of fresh clean air all year round. A Passive House-certified ventilation system delivers the air silently without drafts to every occupied space, and exhausts stale air where moisture or odors exist.

3 **A quiet setting,** with acoustic separation from the street and neighbors. The thicker insulation, careful sealing and triple glazing cut out a lot of exterior noise.

4 **A well-functioning building, with simplicity of operation.** The need for complex and expensive technology or controls is greatly reduced; it's all about careful design, simple and durable systems, and quality construction.

5 **An affordable home or building**, with significantly reduced maintenance and energy costs. Operating costs are far lower than conventional buildings.

6 **Resilience**, with the ability to shelter-in-place in a power outage in the dead of winter or a summer heat wave. Passive House buildings are resilient in the face of changes in energy pricing, technology and climate, providing a long-term assurance of affordability.

7 **Market value.** High quality, efficient buildings currently have a higher value and, with such buildings becoming more widespread, the resale price of highly efficient buildings will become more obvious.

8 **Peace of mind.** A special comfort is derived from a truly sustainable building. With the knowledge it was built better, buyers and tenants feel better.

What are the benefits for developers and builders?

1 **More saleable floor area.** Municipal governments are aware of the important role buildings play in reducing emissions in their community. Many consider the benefits a Passive House building brings to the community when making density decisions during rezoning or development permitting, and some have explicit policies to encourage such development.

2 **Approvals and permits are likely to be faster**, because Passive House aligns with government policies on energy and carbon reduction. Experience indicates neighbours and neighbourhood associations are often pleased to see high quality and sustainable construction add value to their neighbourhood.

3 **Fewer change orders and construction delays.** A Passive House building requires detailed design and component specification well before a building permit is issued, resulting in more complete contract documents. This detailed work represents an incremental investment in design but avoids problems during construction.

4 **Fewer callbacks and warranty claims.** The level of inspection and documentation during the construction phase is more rigorous than conventional construction, and is likely to catch problems before it is too late to fix them.

5 **A marketing edge over conventional buildings.** Being able to offer seriously lower heating and cooling costs is obvious, but so is **comfort** — no drafts, no hot and cold spots. Those living on busy roads will appreciate the **quiet** provided by triple glazed windows and extra insulation. Higher quality can be marketed based on the obviously better windows, silent ventilation and the level of inspection.

6 **A higher sale price** because of the lower operating costs and perceived higher quality. Hard construction costs are only slightly higher, and the higher cost for windows and insulation is often offset by a more efficient building form and lower costs for heating and cooling equipment.

7 **There are not a lot of expensive green gizmos.** It's not about adding "green bling" but about keeping it simple. If a net zero building is desired, fewer solar panels are required; instead you invest in building better to reduce demand. In the end this costs less and is easier to maintain and manage.

8 **Build bigger and better more easily.** As Passive House design focuses on the building envelope, and in a multifamily building there is less envelope per square foot of floor area than in a single family house, it is actually easier to achieve Passive House performance in multifamily buildings, with a lesser cost premium than in smaller projects.

Fort St. John Passive House
FORT ST JOHN, BC
Velvet Leaf Photography

Appeal to growing markets

Climate change and the state of the environment are critical issues to many buyers, who will appreciate the far lower carbon footprint inherent in a Passive House building. Conventional buildings consume up to 40 percent of global energy use and contribute up to 30 percent of annual global greenhouse gas emissions. Those who care about this issue recognize that the Passive House model is one of the most effective ways of reducing carbon emissions.

Building energy efficiency is valued by buyers, as shown by early Passive House sales and survey data. A 2016 survey, conducted by BC Hydro, of BC residents planning to purchase or build a home found 92-94% consider energy efficiency a marketable feature in a home, 76% agree high performance homes provide high levels of comfort, health and quality. Only 2-3% felt it does not really matter.

Resilience is a consideration for many, with increasing variability in weather and concerns about the security of the electrical grid in the face of natural disturbances. The high level of insulation and air tightness keeps a Passive House building comfortable for far longer than a normal building.

Health and wellness is an important factor, with indoor and outdoor air quality becoming a growing concern. Passive House designs have mechanical ventilation systems that deliver clean fresh air to each individual unit year round.

What does the Passive House Standard actually measure?

Primarily, Passive House limits energy consumption and air leakage. The targets for heating and cooling are up to **90 percent less** than average buildings in Canada, and total energy consumption is often **50 percent less** than average. However, it's not just about energy; Passive House buildings must also meet specific ventilation and comfort criteria. The Standard is designed to ensure certified buildings perform as expected, providing exceptional comfort, air quality and efficiency while also avoiding condensation. Ventilation equipment must operate silently, and provide simple controls and servicing.

Space Heating Energy Demand: 15 kilowatt hours per square meter of Treated Floor Area demand per year or 10 Watts per square meter peak load.

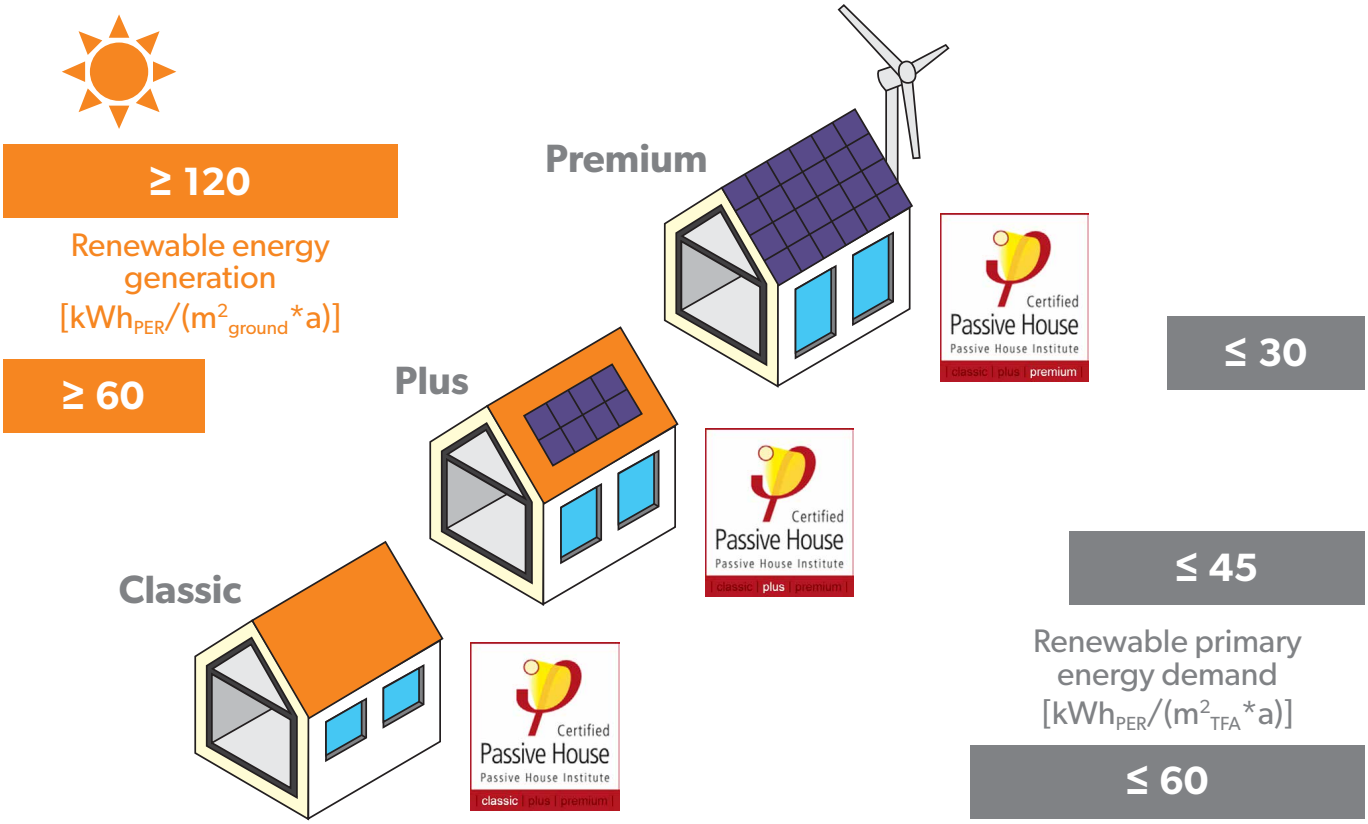
Space Cooling Energy Demand: matches the heat demand/load requirements but with a small additional allowance for dehumidification.

Primary Energy: total energy to be used in the building operations (heating + cooling + lighting + equipment + hot water + plug loads, etc.) is limited to a specified number of kilowatt hours per square meter of Treated Floor Area per year, varying with the level of certification and use of renewable energy.

Airtight Enclosure: Allowable limit of 0.6 air changes per hour at 50 Pascals pressure (ACH50) that is verified with an onsite blower door test (pressurized and depressurized)

Retrofits: Performance criteria are modified for retrofits and certification can be based either on performance or prescriptive measures. A long term retrofit plan can be developed at the outset, enabling step by step retrofits as building components require renewal. This is often the most economic approach, and enables long term planning with measurable goals.

Passive House Classifications (see details on Page 10)



Alta Lake Passive House
WHISTLER, BC
Photo Credit: David McColm

Designing and building: Key steps for success

1. Become informed

An understanding of the principles and practices of high performance building design and construction enables better decisions. Continue your education with a course appropriate for your needs. Passive House Canada offers a full range of courses from a one day introduction to multi-day design and construction training, and specialized master classes. Information on our educational program can be found at www.passivehousecanada.com/training

2. Keep it simple

Constructing a Passive House building successfully and economically requires commitment from the beginning, and it does affect the design. For example, an essential factor in designing a Passive House building is developing a simple concept for a compact building form. A simple thermal envelope that is easy to build offers the greatest opportunity for cost savings and efficiency gains. Every jog, every bump is another opportunity for a thermal bridge, which will add complication and costs. Windows have to be used carefully and selectively to frame views and optimize solar gain; they are not walls.

3. Use the Passive House Planning Package software

The designer puts the building design information into the PHPP model, which is essentially an advanced spreadsheet containing location specific climate data where everything connects, so if a window gets bigger here, then you need to add more insulation there; it is all about finding the right balance.

Passive House buildings consume

up to 90% less

heating and cooling energy than conventional buildings.

4. Hire professionals who "get it"

The architect, engineers and contractor must all see the value and understand the consequences of being hired to design and build a Passive House building. More in Passive House design than anywhere else, less is more. That's why it is important to hire professionals right down the line who are Passive House trained. Passive House Designers and Consultants are essential to the design process, and contractors should have a Certified Passive House Tradesperson on staff. They know what is critical to hit the numbers on a blower test, and such a team can be more united than might be expected on a traditional project — seeking common and measurable goals, for profound results.

A directory of Passive House professionals in Canada can be found at www.passivehousecanada.com/certified-professionals

5. Use Certified Passive House products and components

Where available, certified components provide assurance your performance goals will be met.

A good example is the window; a relatively expensive component in Passive House construction. The interior surface temperature of the window should not be more than 3°C cooler than the interior air temperature; data including U-value of both frame and glass, solar heat gain coefficient (SHGC), Psi-value of both the glazing spacer bar as well as the install detail and the width of the frame for top, side and bottom have to all be supplied. It is simply easier and cheaper in the end to use a certifed product than provide testing and data yourself.

For approved Passive House components see www.passipedia.org/certification/passive_house_suitable_components

6. Build it right

Introduce your construction team to the reality of airtightness at the construction start. Have a meeting of key personnel to clarify all questions regarding the air barrier: its components, its installation, protection, testing and repair. Run a blower-door test and have the carpenters, plumbers, electricians and duct installers feel air leaks. Air leaks are easily understood and can unify the many trades in common cause to build high quality.

7. Certification for quality assurance

What gets measured, gets managed, so stick to it and apply for building certification. When you build to the specifications calculated using the Passive House Planning Package (PHPP) energy model, you can achieve a highly predictable result, and this is where you will save on changes, call backs and warranty claims. There are several building certifiers in Canada and engaging them at the start of a project reduces the risk of compromises, which can result in poorly working systems, moisture damage, tenant dissatisfaction, a loss of predictability and failure to achieve the project goals.

For the building certification process and Canadian certifiers see www.passivehousecanada.com/passive-house-building-certification

The Heights
VANCOUVER, BC

Why the International Passive House Standard?

With over 50,000 Passive House buildings completed around the world, and 25 years of monitoring and verification of thousands of units, the performance of Passive House buildings is trusted by developers, lenders and government. Its genesis was an academic research project to determine an optimal level of efficiency of a building, and to this day the Passive House Institute in Germany remains a building science institute, committed to the advancement of building performance and quality. Continuous science-based development and improvement keeps the Standard on the forefront, offering reliable performance and affordability. As a result, agencies and governments around the world are calling for the construction of Passive House buildings to meet our climate change commitments.

A proven track record. Passive House buildings are becoming more common in Canada, with a growing variety of residential and institutional buildings, with exponential growth in some markets. The pattern of development typically begins with a few houses, then some MURBs followed by an escalating pattern of diverse building types and sizes. As members of an international building standard, Canadian designers, builders and policy makers have access to a global pool of experience and expertise in relation to all building types. It's tried and true.

It was designed for our climates. In 1977, our federal and Saskatchewan governments supported a demonstration project in Regina, Saskatchewan that contributed to the development of the science behind the Passive House Standard. The Saskatchewan Conservation House has demonstrated consistent performance in Canada over the past 40 years.

There are serious software tools, all designed to make it easier. The Passive House Planning Package (PHPP) includes powerful algorithms that determine the energy balance of heating, cooling, dehumidification and primary energy, but it can also provide analysis of multiple assembly approaches regarding their energy effectiveness and their financial feasibility. Other tools include **Design PH**, based on the popular Sketchup drawing program that allows designers to quickly determine the suitability of design options.

A BIM interface is being developed, and common thermal and moisture modeling tools integrate with PHPP to make the job easier.

Choice of certification classes. The Passive House Standard now looks towards an energy system based on renewable sources, with certification coming in different flavours: **Passive House Classic** focuses on energy efficiency using the time tested metrics of performance and quality. **Passive House Plus** reduces the primary energy consumption and relies on some renewable energy generation. **Passive House Premium** is even more ambitious, further limiting primary energy use and requiring more renewable generation.


Salus Clementine: Karen's Place
OTTAWA, ON

For existing buildings, **EnerPHit** is the deep energy retrofit standard providing certification of such buildings, recognizing the reality that retrofits can often not achieve the same level of performance as new buildings.

In addition to these classes of certification, a building can be recognized as a **Low Energy Building** if it does not fully comply with all Passive House criteria.

There are lots of options for building certifiers with three in Canada, more in the USA and 34 internationally.

Resources and next steps

Build better.
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Passive House Canada provides a full curriculum of Passive House training for developers and designers, a directory of Passive House professionals across Canada, and an online resource centre containing research and a project database www.passivehousecanada.com

iPHA

The International Passive House Association — a global network advancing the Passive House Standard and connecting stakeholders — offering Passpedia, a database of Passive House research, scientific articles and other online resources www.passipedia.org

naphn
North American Passive House Network

The North American Passive House Network (NAPHN) fosters a vibrant and open Passive House community of member organizations, sharing resources and information www.naphnetwork.org

For more information about Passive House design and construction please contact us at info@passivehousecanada.com or 778 265 2744. We look forward to working with you in building the future.

"After significant cost comparisons, benefit analysis and constructability evaluation the Peak Construction Group and Eighth Avenue Developments chose to build our 85 unit rental apartment building in Vancouver to the Passive House Standard. The concept makes logical sense, does not rely on complex HVAC systems, is relatively simple to construct and ultimately, we believe, will provide a better living environment for our future tenants."

DOUG WILSON
President, Peak Construction Group of Companies

"In the beginning, we honestly didn't know much about Passive House design but our curiosity to understand this method of building, which has been successfully adopted in Europe for over 20 years, lead to our decision to step outside the box and challenge ourselves. Our core value to "Create What Matters" has always pushed us to raise the bar and to elevate our standards in order to become market leaders in the real estate industry."

LAWRENCE GREEN
President, Spire Development Corporation

Additional information

Windows and Doors

Comfort is central in Passive House buildings, including avoidance of radiant temperature asymmetry. Passive House windows are specified to provide high thermal comfort even during the most severe weather events without the need for compensatory radiators underneath. Using certified Passive House windows designed for your climate will ensure that surface temperatures of the window will not drop more than 3°C compared to the indoor room air temperature. Furthermore, such windows will avoid the commonplace complaint of homeowners getting "cold feet" in winter, which is when the difference in temperature between ankles and head in close proximity to windows is > 2°C. In summary, the science behind certified Passive House windows assures high thermal comfort for occupants in all seasons.

Ventilation

Ventilation is an essential component for health and comfort in a residence, office or public building. The objective is to avoid temperature asymmetry from cold surfaces and inadequately tempered fresh air, and also to minimize CO_2 and humidity levels to 35 – 55% RH.

All Passive House projects have mechanical ventilation systems, typically referred to as HRVs or ERVs (H/ERVs). The heat ('H') or enthalpy ('E') recovery efficiency of the H/ERV has a significant influence on the overall space heating demand and cooling demand. The quality of H/ERV used in the project also has a significant influence on both temperature and air quality (including pollutant levels in supply air stream due to internal leakage in the H/ERV).

Lower efficiency machines will not only significantly increase space heating demand but they also require the use of a heater upstream to the H/ERV to ensure that fresh air delivered to living and work spaces is adequately tempered at all times. To ensure occupant acoustic comfort, maximum noise levels in living and sleeping rooms must be < 25 dBA in a Passive House building. Passive House certified ventilation units must meet rigorous efficiency, acoustical and commissioning requirements. They must also provide conveniently located, simple controls for consumers and it must be possible to change the filters without tools after the building is occupied.

Multi-use Buildings

Generally all building types can be certified as Passive House projects, however for some complex non-residential uses a more detailed design and certification is needed. Dental surgeries, retail stores, swimming pools, research labs and many other complex types have been built both as stand-alone Passive House projects as well as integrated into multifamily buildings. Complex Passive House projects ensure the building meets the required quality and efficiency criteria by accurately modeling for actual building loads. As with any complex building, the model will include more extensive use of calculated values rather than default values commonly used in more common building types. For some special use buildings an allowance is made for unavoidable energy loads, with the intent of making the building as efficient as possible. Your Passive House Consultant or Designer, in conjunction with your Certifier, can provide more information on complex buildings.

Lost Lake Passive House
WHISTLER, BC

Special Thanks

We'd like to thank the City of New Westminster, the City of North Vancouver and the City of Vancouver for their generous support in making this publication possible.

Each of these cities have policies to support high performance building. More information is available at:

City of New Westminster www.newwestcity.ca

City of North Vancouver www.cnv.org

City of Vancouver www.vancouver.ca

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