

**PASSIVEHOUSE**  
**CANADA** Build better.  
Feel better.

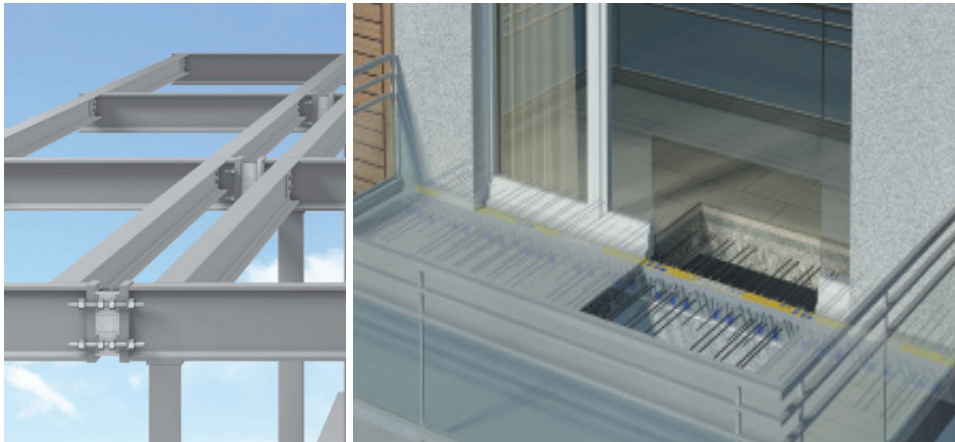
Passive House Buildings in Canada

# Transforming How We Build



## Schöck Isokorb® Structural Thermal Breaks.

Prevent condensation and mould, cut heat loss.



- ▶ Prevent condensation and mould
- ▶ Reduce heat loss by up to 90%
- ▶ Reduce heat energy usage of the building by up to 14%
- ▶ Increase warmth of interior floors by up to 15°C/ 27°F
- ▶ Comply with building code requirements for continuous insulation

Uninsulated balconies, canopies, slab edges and parapets penetrating insulated building envelopes create thermal bridging between the cold exterior and the warm interior structure that supports them, causing heat loss, condensation and mould.

Schöck Isokorb® Structural Thermal Breaks prevent thermal bridging by insulating the building envelope at the penetration, while supporting loads equivalent to conventional concrete and/or steel structures, offering multiple benefits.

*Isokorb® structural thermal breaks for concrete construction (left): contain engineered stainless steel rebar for casting into interior and exterior sides of the penetration. Isokorb® structural thermal breaks for steel construction (right): bolt interior steel structures to cantilevered balcony supports, canopies or rooftop connections.*



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performance standards

### And so do our building partners.

The new Defender 88PH System combines decades of fenestration knowledge to deliver a robust window system that exceeds the industry's toughest performance criteria. Manufactured in Canada, the Defender 88PH System is a PHI Certified Passive House Window that is engineered and tested for single family, low to high-rise multi-family, and commercial projects in the Pacific Northwest.

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# Passive House Canada

## Transforming How We Build

**JUST A FEW SHORT YEARS AGO**, it seemed that very few people understood the solutions Passive House professionals were offering the community. With few high-performance resources in Canada for the community to rely on; an emerging policy environment that was ready to drive forward high-performance buildings; a sector of the construction industry that wanted change (and needed resources); and the weight of a warming planet, Passive House Canada saw an opportunity to develop a national organization to advocate for market transformation.



The successes that we have experienced are directly attributable to the dedication of industry professionals and elected officials who are passionate about sustainability. Their momentum and drive have given us the privilege of assisting all levels of government in building policy development; of supporting the growth of a national membership of over 800 members (in eight provinces and two territories); and of delivering hundreds of trainings, with over 4,000 registrations across Canada.

This appetite for a higher standard of building forged partnerships, resulting in the launch of Canada's first Zero Emissions Building Exchange and a successful inaugural national conference with over 350 delegates in attendance.

Transforming Canada's market for buildings is not easy, and in the face of the work ahead, it is important to stop and celebrate why so many of us invest in this process. While the initial driver is, of course, environmental, and the common goal is to mitigate climate change, this alone does not catalyze market transformation, represent the motivation of everyone involved, or simplify the process of managing change.

For many, the primary motivation is a desire to have better buildings. The unparalleled comfort, health,

durability, resilience, and affordability of buildings offering Passive House levels of performance are reasons enough to make the choice. Affordable housing advocates may focus on the reduced costs of ownership, operation, and utility cost to tenants; homeowners may dwell on the comfort; while absolutely everyone craves a constant supply of filtered fresh outdoor air.

Some professionals, developers, and trades are attracted by the quality of work such buildings entail and enjoy the pride of workmanship. Others know



high-performance building regulations are coming and are looking for a competitive advantage, a market differentiator, in establishing their company brand. Increasingly, some are simply responding to the developing market for Passive House buildings and their components, which they know will grow.

Regardless of the reason for your interest in buildings delivering this level of performance, we are pleased to have you join us in achieving our mission.

During our 2018 conference, the federal government took the opportunity to say it is probable that the final tier of the Net Zero Energy Ready Code will be very close to the Passive House performance targets. While it might not seem so, this is a significant win for Canada and a clear result of our national buildings strategy, with its planned reliance on expanding upon the experience in leading cities and provinces.

We know our role will change and likely diminish as building codes and standards approach Passive House performance levels, and we can't think of a better reason to become redundant.

Taking a mission-first approach enables us to make more rapid progress, facilitating collaboration with industry and consumers in addition to government. We can best achieve our mission by collaborating with aligned groups and individuals, and we invite you to do the same.

Whatever the reason for your interest in high-performance buildings, we hope you find this publication helpful, and that you connect with each other and our organization to support your Passive House high-performance building goals. In the end, it does not matter to us why people want better buildings—we simply wish to see them become the norm.

**ROB BERNHARDT**, CEO of [Passive House Canada](#)



# Zero Emissions Building Exchange



## THE ZERO EMISSIONS BUILDING EXCHANGE (ZEBx)

is a collaborative platform and a catalyst for market transformation in buildings. Our mission is to accelerate the implementation of attractive and exemplary zero-emissions buildings at scale. We are a trusted advisor that connects industry to solutions, increases capacity, and drives economic growth in “clean” buildings. We leverage our network and partners to offer opportunities for knowledge exchange, research, and training through a neutral, coordinated lens, from single-family homes to high-rise residential, institutional, and commercial buildings.

Over a decade of working with project teams as a consulting engineer (prior to joining ZEBx), I learned that while homeowners and designers are eager to consider zero-emissions building strategies, they are often restricted by two things: a lack of municipal policies to catalyze innovation, and limited industry knowledge of successful projects locally and globally.

In 2017, on the road to becoming the greenest city in the world, the city of Vancouver implemented a Zero Emissions Building Plan to support and accelerate the implementation of zero-emissions buildings in a way that prompts project teams to actively pursue low-carbon solutions. The new policies by the city require most new buildings be built and designed to near zero emissions by 2025, and zero emissions by 2030.

With a strong regulatory environment in place, the community needed a centre to convene a community of professionals working in high-performance buildings to address industry knowledge and capacity building. This need was acknowledged by a group of passionate organizations whose efforts later formed the ZEBx.

With seed funding from the city of Vancouver, the Vancouver Regional Construction Association joined as program host, and OPEN and Passive House Canada signed on as strategic founding partners. ZEBx gained international support from the United Nations Economic Commission for Europe (UNECE) and became part of an international network of high-performance building centres under the UNECE umbrella as the second Centre of Excellence to operate within this network, joining the Building Energy Exchange in New York City, with additional centres under way in Wexford, Ireland; Pittsburgh, Pennsylvania; and Brussels, Belgium.



Photo by Zack Embree

Our organization’s focus is to support the rapid implementation of zero-emissions buildings through technical workshops, dialogue sessions, project tours, technology demonstrations, disseminating research, and compiling case studies.

In our first year, we organized 60 industry-serving events engaging over 2,000 industry professionals in collaboration with our delivery partner Passive House Canada; collaborated, and established working relationships, with 50 industry influencers; organized an international zero-emissions buildings project tour for industry executives and decision makers in the global leader of high-performance buildings, Brussels, Belgium; and through a research partnership with the University of British Columbia, developed a suite of standardized case studies, all of which take a deep dive into the region’s leading high-performance projects.

The conditions surrounding high-performance buildings are ripe. We have a policy to help industry build high-performance buildings and a community of early adopters who are eager to implement building innovation. Having an organizing hub, such as ZEBx, create a central space to show case studies and to share experiences and lessons learned will not only rapidly optimize and scale solutions for zero-emissions projects, but will accelerate implementation, practices, and projects.

By bringing together the community of those who are working in high-performance buildings to share ideas and engage in dialogue on a recurring basis, we are creating an interdisciplinary and holistic approach to building industry capacity. In essence (and in practice) we develop a community of people who can learn from each other to figure out the most cost-effective, efficient, and best practices to building zero-emissions buildings. Collaboration is crucial, and how we choose to gather and learn from our leaders today will determine what we are able to accomplish ten years from now.

CHRISTIAN CIANFRONE, *Executive Director, ZEBx*

# Building the Pathway to Net Zero Ready



**ZGF ARCHITECTS** is a design firm with an intentionally diverse portfolio that includes health care and research facilities, academic buildings, mixed-use developments, corporate campuses, museums, transportation facilities, and ecodistricts. A practice with more than 700 professionals and offices in Vancouver, British Columbia; Portland, Seattle, Los Angeles, Washington, D.C., and New York City, it has an ethos of collaboration, design excellence, stewardship of our natural and built environment, and exceptional client service. The following is an interview with **IAIN MACFAYDEN**, *associate principal of ZGF Vancouver*.

## Why Passive House?

Our investment in private Passive House training is part of a larger ZGF initiative called Building and Project Performance (BPP). BPP was established in response to the city of Vancouver’s Zero Emissions Building Plan, the 2032 changes to the province of British Columbia’s building code, and the developer-driven market that has evolved over the last 15 years in Vancouver.

The challenge with a developer-driven market is that it commodifies services; reduces the value of architectural design and consultants; and pushes everyone to reduce innovation, prices, and the ability to strategize building innovation over the long term. In a developer-driven market, the focus is on the next project at the best cost.

We decided that we did not want to operate in this space. Our vision and practice are to operate in the margins, creating opportunities and taking on the most challenging projects. As municipal and provincial policy changes began pointing the building industry toward zero emissions and net zero ready buildings, we saw an opportunity to position ourselves in the marketplace, establish specific goals, and continue our legacy of high-performing buildings.

Under the Building Performance stream of BPP, we partnered with Passive House Canada to develop private trainings with the goals 1) to have 40 Certified Passive House Designers in-house by the end of 2019, and 2) to ingrain the principles associated with high-performing buildings into our daily architectural practice.

## Who are you educating?

Our private trainings have been developed to include our staff, consultant partners, government officials, and clients. We have brought these groups together via our training because we understand the necessity of knowledge dissemination, transparent learning, and interdisciplinary practice to embed the principles of Passive House in ZGF and in our projects.

We are clear that if we want to make transformational change in the local industry, we must approach this from a non-siloed approach. By gathering stakeholders to share in the learning process, we all garner more from that learning. We learn more from what others do not know than we would learn by just focusing on what we don’t know.

By having a multidisciplinary approach to learning, the questions that consultants pose trigger new thoughts and new ways of thinking about the projects in our staff, and the presence of government officials provides insight into industry challenges related to policy change.

From a client perspective, we can then understand their perceived limitations of Passive House and high-performance buildings and can better develop strategies to highlight the values of these approaches. From this understanding we can overcome barriers and boundaries and help clients understand high-performance buildings and add market value to these buildings.

## What has this allowed you to do, and how does it set you apart?

One of the biggest benefits has been the way we work with consultants on projects. Historically, consultants are not brought in until the later stages of a project, with the result commonly being a total redesign. Now we bring consultants in earlier in the process—not to ask them for drawings, but rather for them to contribute their expertise and experience. Unlike the developer-driven model, which limits expertise and silos experience, learning from each other is a different way of thinking—one that helps us innovate to deliver to our clients the best projects at the end of the day. This is a change in the marketplace, and the developers we work with have seen a distinct difference in the projects we deliver. This has allowed us to develop lasting partnerships, design better buildings, and establish long-term working relationships with industry stakeholders.

As a firm, we have a culture of continuous improvement. Our approach to transparent learning has given us an opportunity for market differentiation, positioning us as thought and practice leaders in the field. We are in a position where we understand the long-term directives of the government and are responding now. And because we can see where we must get to, we are now better able to help clients navigate this new era of buildings and open doors to new and exciting projects that are challenging.

## How has this made you better?

To begin, we’ve future-proofed our staff with the tools needed to design and construct resilient and high-performing buildings. We’ve ensured that they have the training they need to rely on themselves (rather than exclusively on consultants), self-govern, and experience excitement about the jobs they do and the projects they attract. This gives staff confidence, and ultimately translates into our relationships with clients—building on that ethos of being a trusted client advisor—because our staff are equipped with the tools to act in our clients’ interests when working with consultants. Additionally, our staff feel valued, trusted, and empowered, fuelling their enthusiasm for the work.

Our trainings have also helped us to address the question: How do you make high-performance buildings relevant in a market that doesn’t care?

One part of addressing this question is having more than one person in the office who is responsible for answering all the questions. Sharing knowledge across the firm breathes life into our work, and that knowledge becomes a living organism that you can draw experiences and perspectives from, and grow new value into these buildings with. This builds initiative, becomes personal, part of the firm's culture, and informs how we interact with clients, increasing the value proposition we bring our clients. In this way you can move your building from a class B to a class A just from the perspective of value that you are able to bring the client.

### What is next for ZGF?

The ultimate goal on a project-by-project basis is to achieve higher levels of building performance at no additional cost, while meeting the same delivery schedule. Our innovative approach to firm-wide knowledge dissemination is combined with additional training, and what we call Construction Innovation—a stream under BPP designed to evaluate our delivery process, available materials, and construction methods to further enhance the high-performance-buildings narrative.

We've designed training that leverages the knowledge from Passive House Canada that is relevant, is immediately applicable, supports a more-efficient project delivery process, and informs a set of design tools and design performance pathways for our architectural team, while instilling a design practice culture that revolves around high-performance buildings. From this we have grown to include dynamic modelling to evaluate cooling, look at realistic end-user plug loads, and use real-time and projected climate data.

In Construction Innovation, we commit to finding efficiencies across the board. By understanding the design goal with an attention to finding efficiencies in the way we deliver on projects, we find ways to reduce time lines and add value to high-performance buildings at no extra cost.

This kind of philosophy and approach to buildings is a way of thinking, and a complete cultural shift in the British Columbia construction industry. We are creating the future now, and that is hugely invigorating for me. This change is creating opportunities at two levels. We see a change in our opportunities in the industry in terms of what we are trying to do. And on a personal level, it's an opportunity to work with dynamic and collaborative individuals, which means we get to learn, and all be part of this amazing process.

Change may not be easy, but embracing change allows you to take control, and having control allows you to envision the future.

## Five Principles of Passive House Design and Construction

### PASSIVE HOUSE IS CONSIDERED THE MOST RIGOROUS VOLUNTARY ENERGY-BASED STANDARD IN THE DESIGN AND CONSTRUCTION INDUSTRY TODAY.

Consuming up to 90% less heating and cooling energy than conventional buildings, and applicable to almost any building type or design, the Passive House high-performance building standard is the only internationally recognized, proven, science-based energy standard in construction delivering this level of performance. Fundamental to the energy efficiency of these buildings, the following five principles are central to Passive House design and construction: 1) superinsulated envelopes, 2) airtight construction, 3) high-performance glazing, 4) thermal-bridge-free detailing, and 5) heat recovery ventilation.

All these key principles are linked to and impact each other in the design. No one principle can be neglected without having a negative impact on the rest. To effectively create a Passive House building, the design should be looked at holistically to incorporate all five design principles.

### Superinsulated Envelopes

The building envelope is what separates the interior of the building from the exterior; it consists of outside walls, roofs, and floors. In cold climates like Canada, where inside air is heated to keep the building comfortable, some of that heat will be lost as it moves through the envelope (via the process of conduction). In order to reduce this heat loss, insulation made of low-conductivity materials is installed within the wall and roof assemblies.

Passive House makes the most of the envelope by superinsulating the building in order to minimize the heat loss. For a Passive House, the aim is to use assemblies with enough insulation to double or triple the heat resistance compared to what is required in current Canadian building codes. The result is a significant increase in the thermal performance expected from the building envelope. Insulating to Passive House levels has the added advantages of greater soundproofing, improved durability, and greater building resiliency—including the ability to maintain interior comfort for extended periods even if there is a power failure.

Achieving Passive House levels of heat resistance is not just about how much insulation you have, but whether that insulation is used effectively. Insulation is most effective when it wraps the building uninterrupted by other materials, but there will always be areas where this is not possible, such as around components used for structural reasons. When a material bypasses the insulation, it is known as a thermal bridge and can significantly reduce the effectiveness of insulation, especially if that material is very conductive, like metal.

Minimizing repeating thermal bridges and aiming for continuous insulation where possible, as in the assemblies shown in Figure 1, helps make the most of the insulation within the building envelope.



Photo courtesy of the Passive House Institute

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## Airtight Construction

Heat can also be lost through the envelope via air leakage. A building's air barrier is a layer of material (membrane, tape, seals) around the envelope that restricts the movement of air in and out of the building. Gaps in the air barrier can allow air to move in and out of the building uncontrolled; they occur when there is insufficient detailing during construction, when there are numerous ducts or other penetrations in the air barrier, or when construction is of generally poor quality.

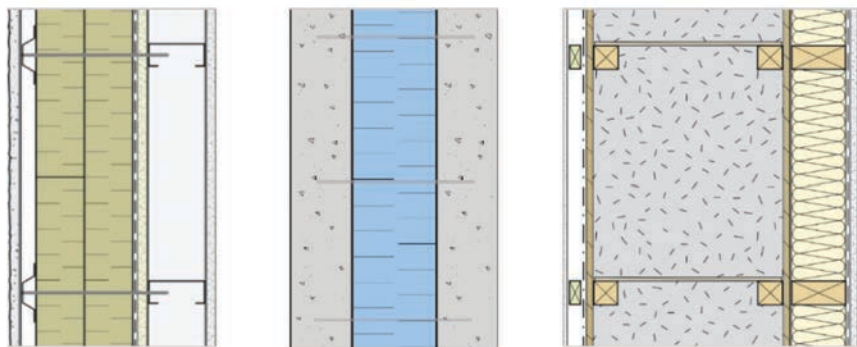
High volumes of uncontrolled air exchange with the exterior can lead to a whole host of problems, including increased energy use from having to repeatedly reheat the air, discomfort from cold air drafts near the walls, and localized moisture and condensation problems. While air exchange is necessary for ventilation and providing fresh air, it is far more effective to control air exchange by tightening the envelope and using mechanical ventilation.

There are strict design and construction requirements for a Passive House project to be certified airtight. Quantitatively, this means that when tested the building needs to have less than 0.6 air changes per hour ( $ACH_{50}$ ) to achieve Passive House certification. This stringent value can be compared to other high-performance building standards, such as the R2000 program, which allows up to 1.5  $ACH_{50}$  from air leakage. As additional quality assurance for a Passive House project during construction, at least one on-site air leakage test must be completed to demonstrate that the building meets the airtightness requirements.

Achieving this degree of airtightness requires careful planning in the design stage, including making sure that the air barrier is continuous and evident on drawings, that effective air barrier materials are used, and that clear detailing for penetrations and terminations is provided. Construction quality with thorough quality control, from the contractor down to the trades, in the installation of the air barrier is critical. The entire construction team should be aware of the important role that airtightness plays in a Passive House project.

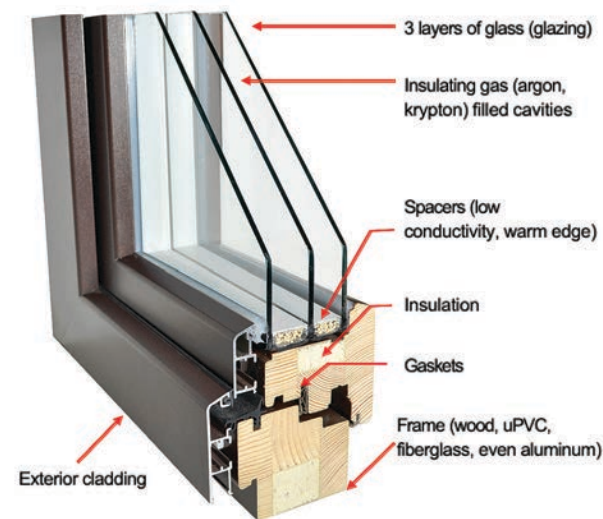
Airtight construction on a Passive House project will further reduce space-heating costs and localized condensation problems and will provide better comfort inside the building. In a Passive House building these advantages cannot be achieved

**FIGURE 1. EXAMPLE BUILDING ASSEMBLIES**



(left) Exterior insulated steel stud wall. (middle) Precast insulated sandwich panel. (right) Larsen truss wood-framed wall. (Courtesy of the Passive House Institute)

**FIGURE 2. EXAMPLE FEATURES OF A PASSIVE HOUSE WINDOW**



Courtesy of Zola Thermo Plus Clad Window Profile

by tightening the building envelope alone but must be coupled with a suitable ventilation strategy to deal with excess humidity in the building.

## High-Performance Glazing

While the walls typically make up the largest area of a building's façade, the glazing systems (windows and glazed doors) can play an even bigger role when it comes to contributing to space-heating energy. Due to their function (providing light and visibility), glazing systems cannot be insulated to the same degree as a wall, resulting in the windows being the weakest areas of the envelope in terms of heat-flow resistance. Therefore, it is very important that high-performance glazing systems, such as Passive House-certified windows, are used to reduce that heat flow as much as possible.

Some key characteristics of a high-performance Passive House glazing system, as shown in Figure 2, include nonconductive framing or large thermal breaks; insulated framing; double- or more likely triple-glazed units; argon or krypton gas fill; multiple low-e coatings; and warm-edge or nonconductive spacers.

It is important not only to make sure to specify high-performance windows, but also to carefully consider how they are incorporated into the building design. Passive House designs take advantage of free passive heating from the sun. Solar heat gain through appropriately placed windows can help offset the amount of heat a building needs during colder months. During the summer months, this needs to be counteracted with shading to prevent too much heat from the sun from getting into the building, causing overheating. For each Passive House project, there will be an ideal number of windows that can balance the advantage of free heat from the sun with minimizing the heat loss from having too many windows.

The final consideration for glazing systems is surface temperatures. When outside temperatures are low in winter months, the inside surface temperatures



**FIGURE 3. EXAMPLE BUILDING INTERFACE DETAILS**

(left) Cantilevered balcony. (middle) Window sill transition. (right) Wall corner.  
(Courtesy of Morrison Hershfield Ltd)

on low-performing windows can also be quite cold. Low temperatures around the window can result in a higher risk of condensation (and potential mould growth) and feeling colder when you are close to the window because of radiant heat loss or from temperature-induced drafts. To reduce these risks, certified windows must be assessed according to hygiene and comfort criteria that set minimum allowable surface temperatures around the window.

### Thermal-Bridge-Free Detailing

The last envelope consideration is the minimization of thermal bridging. This was discussed earlier for repeating thermal bridges in the general wall and roof assemblies, but Passive House designs also aim to be thermal-bridge-free when it comes to architectural interface details. These are parts of the building where different architectural features meet that require additional attention in construction. Examples include how a window is attached to the walls, how a wall meets a balcony, and how walls meet at corners, as shown in Figure 3. The way these building features connect and are designed can also introduce thermal bridging that's not always easy to recognize.

Thermal bridging from interface details can have numerous effects on building performance. For highly insulated envelopes like those in Passive House projects, thermal bridging can significantly reduce the benefits of superinsulating by allowing heat to flow around the insulation and out of the building, and can also create localized cold spots, increasing the risk of condensation and mould growth around these details.

The easiest way to avoid thermal bridging is by making architectural design changes (where possible), such as using self-supported decks and canopies for low-rise buildings or reducing the number of cantilevered balconies and articulating architecture (lots of corners) on larger buildings. This is not always realistic or achievable, and in these cases, special attention needs to be paid to these interfaces. Reducing direct conductive connections between the interior and exterior is important. Examples include installing intermittent connections for shelf angles, overinsulating in front of certain connections around the foundation, wrapping insulation around protruding details, or using special materials such as thermal breaks.

While it may not seem obvious, the thermal bridges caused by window-to-wall interfaces can have a very large impact. The total perimeter of all the window-to-wall connections can add up to several kilometers on some projects, so how a window is installed into an opening plays an important role in minimizing the heat flow. Reducing thermal bridging at this connection involves positioning the window to line up with the insulation layer, overinsulating in front of the frame, and minimizing how far closure flashings penetrate the rough opening while still maintaining adequate drainage paths. Eliminating or minimizing thermal bridging on Passive House projects helps ensure the effectiveness of the envelope performance in reducing space-heating energy use.

### Heat Recovery Ventilation

Since Passive House projects are airtight, a ventilation system is needed to bring in fresh air and exhaust out built-up pollutants, odours, CO<sub>2</sub>, and moisture. During winter, this means dumping out warm air and bringing in cooler air that needs to be heated up again, which increases the heating energy. A Passive House ventilation system uses a heat recovery ventilator (HRV) to continuously remove stale or moist air and deliver fresh air. During this process, it extracts heat from the exhaust air and puts it into the incoming air without directly mixing the airstreams together. This way, all the heat in the exhaust air is not completely lost to the outside. For a Passive House HRV, at least 75% of that heat needs to be recovered.

For warmer summer months, most Passive House-certified ventilation systems also feature a summer bypass damper that diverts air around the heat recovery core. That way the system can still bring in fresh air but doesn't recover heat when it's not needed.

In dry locations, like the prairies, buildings without humidification in winter can leave the interior spaces at low interior humidity (under 30% RH), which leads to discomfort, potential health issues, and damage to interior materials. In these cases, an energy recovery ventilator (ERV) can be used. Unlike HRVs, which only transfer heat, ERVs can also transfer moisture from the outgoing exhaust to help maintain more-comfortable moisture levels in interior spaces. Occupants can also utilize natural ventilation (using cool summer breezes) from opening windows to exchange stale air by nonmechanical means and are encouraged to do so when it makes sense. Passive House designs utilize both methods to keep ventilation energy to a minimum. While Passive House projects can still be fitted with a heating system (such as air source heat pumps, electric baseboards, or boilers) having heat recovery in ventilation can greatly reduce the size, capacity, and maintenance needs of this equipment, shifting project costs from the mechanical systems to a superior building envelope.

### Summary

The incredible year-round fresh indoor air quality and stable temperature, the substantial reduction in energy use and operating costs, and the quiet atmosphere that the Passive House standard delivers are directly attributable to these five principles and the way they are integrated into a Passive House building. By following a holistic approach with these five principles through the design and construction on any project, owners, designers, and builders can be confident that they can achieve a truly high-performance building.

NEIL NORRIS, *senior industry consultant, Passive House Canada*



# BUILD LIKE THE FUTURE DEPENDS ON IT

The Smart Enclosure offers a 21st century guide to advanced high-performance building assemblies. It's a toolkit to maximize the positive impact of your building projects, providing optimized comfort, safety, energy efficiency, and negative carbon emissions.



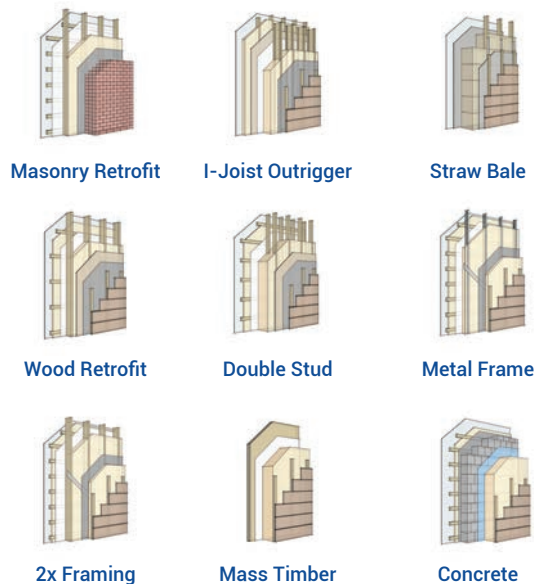
Download free details and guides for all Smart Enclosure assembly types at [475smartenclosure.ca](https://475smartenclosure.ca)



## WHAT IS A SMART ENCLOSURE?

### NINE ASSEMBLY TYPES

This isn't a one size fits all prescription, but a range of strategies that can be adapted for each project and site. It can be applied to any wall assembly, including:



### SEVEN PRINCIPLES

While the construction context may vary, in each case, the solutions are guided by seven principles:

1. Lower embodied carbon
2. Greater carbon sequestering
3. Lower toxicity
4. More natural materials
5. Smart vapor, air, and thermal control
6. 100+ year durability
7. Fully integrated performance

### THREE TIERS

To help architects and other professionals make choices and take action, the Smart Enclosure System is broken into Three Tiers of performance:

- TIER 1 Modified Default (good)
- TIER 2 Simplified and Improved (better)
- TIER 3 Optimized Performance (best)

# Peel

## Passive House Consulting

**PEEL PASSIVE HOUSE CONSULTING** was founded to support the development of the Passive House building standard in Canada and internationally. The firm's vision is rooted in fostering the mainstream adoption of this world-class building standard throughout North America. Peel Passive House Consulting works with developers, architects, self-builders, consultants, contractors, governments, building departments, and manufacturers to support the design, construction, and certification of Passive House and low-carbon buildings, both residential and nonresidential. Their clients benefit from a unique combination of deep European experience and Canadian construction and market knowledge.



Peel Passive House Consulting staff have a combined 27 years of experience delivering Passive House consultancy, training, and certification services across three continents. They pride themselves on their responsiveness, rigour, and consistently thorough research, while delivering maximum value for clients. These qualities have contributed to their deservedly outstanding reputation within the Passive House industry, as evidenced by the types of cutting-edge beacon projects that they are invited to work on.

“We excel in a collaborative team environment and prefer being directly integrated into the design team,” says Andrew Peel, principal of Peel Passive House Consulting. The firm routinely works with other Passive House professionals to expand their capabilities and support delivery of their projects. Indeed, seasoned professionals often engage the company to provide highly technical advice that they would struggle to find elsewhere, particularly assistance with the Passive House modelling software—PHPP—which the firm helped develop. “We have an intimate knowledge of PHPP and can readily adapt the calculation engine to the specific needs of each project,” Peel says.



Photos by Greg West, Gwest Building Services

In addition to consulting on building projects, the firm offers a variety of related services, from manufacturer consulting to education and advocacy. The staff work directly with manufacturers and suppliers to assess the performance of their products and technologies and guide them through the Passive House component certification process. They develop education curricula and deliver professional training both publicly and privately. “We have developed North America’s first online training platform for Passive House education, available at [www.passivehousetraining.ca](http://www.passivehousetraining.ca),” says Peel, who adds, “Our employees regularly volunteer to support various Passive House initiatives and advocacy work.”

The strong relationship that Peel Passive House Consulting maintains with the Passive House Institute in Germany keeps the firm’s staff abreast of leading-edge Passive House research and developments in advanced markets. Their diverse work with different stakeholders uniquely positions the company to advance the various approaches, techniques, and products being adopted throughout the industry. Drawing on this fountain of knowledge allows them to provide clients with unparalleled advice and support on their most challenging projects. “Our comprehensive advice routinely saves clients more money than our fees, making our services cost positive,” Peel concludes.



# The Living Libations Headquarters

HALIBURTON, ONTARIO

Nestled on a south-facing hillside overlooking rolling hills of Ontario boreal forest, the Living Libations headquarters is a gleaming example of what Passive House design consultation and today's innovative building methods can achieve. The four-level 1,974-m<sup>2</sup> production lab and office facility starts from a structural floating slab on a continuous R-50 layer of high-density EPS unbroken around the edges of the floating slab and up the exterior of the first level's 2.7-meter-high concrete walls. This solid foundation thermally separates the building from the exposed Precambrian Canadian Shield on which it is built.

The three stories above are composed of an innovative wood structure of 2 x 8 framed walls and cross-laminated timber (CLT) floor systems that support both the indoor spaces and 260 square meters of rooftop terraces. The 2 x 8 walls are wrapped in a smart air- and vapour-control layer and insulated with mineral wool. The walls are wrapped by a pioneering 20-cm EPS insulation panel with an embedded cladding attachment system, which all but eliminates thermal bridging from the locally manufactured steel siding. This R-48 wall system houses 75 meticulously installed triple-glazed 0.6 W/m<sup>2</sup>K cold-climate Passive House timber windows.

## TEAM

**Designer and Builder**  
[G West Services](#)

**Passive House Consultant**  
[Peel Passive House Consulting](#)

**Passive House Building Certifier**  
[Passive House Institute, Darmstadt](#)

The CLT-supported rooftop terraces have an average insulation value of over R-90 and were constructed with a sustainable bamboo rooftop decking system that had never been used before. The upper roof's 61-cm-deep, open-web wood joists are filled with dense-packed cellulose and further insulated to achieve an average R-90.

The building has ample fresh-air supply from its efficient ERVs and many operable windows. Yet meeting the production lab's critical extract ventilation requirements while avoiding excessive heat losses demanded careful attention. The design team optimized the building layout, equipment selection, and operation schedule to minimize the thermal impact while meeting safety requirements. The building's six air-to-air heat pumps function well at -25°C yet don't have to work hard to keep this building comfortable through -30°C winter nights and 30°C summer days.

The evacuated solar tubes on the roof fully heat water spring, summer, and fall and even prewarm it in winter. A planned PV system is expected to offset all utility bills.

From the locally sourced white pine fourth-level ceiling to the formaldehyde-free interior maple-finished walls and eco-floors throughout, this healthy building provides more than a workplace for the company's 50—and growing—staff. The fourth level houses a kitchen adjoining a south-facing dining area, a 23-meter covered balcony, a beautiful boardroom, and a yoga room that adjoins a southwest-facing 45-m<sup>2</sup> solarium opening onto a 135-m<sup>2</sup> rooftop terrace that has a view of forest in all directions and incredible sunsets daily. The integration of smart design, innovative systems, and skilled building craftsmanship proves that when owners with the courage to try new things hire a team dedicated to achieving the owners' goals, the outcome can be beautiful, healthy, and sustainable.

*Photos by Greg West,  
Gwest Building Services*

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	13 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	3 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	60 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub>



# Passive Auto Dealership

RED DEER, ALBERTA

The world's first Passive House car dealership is opening its doors in Red Deer, Alberta. The new Scott Subaru dealership building is divided into three zones: a showroom, a repair shop, and a car drop-off zone. Each of these zones presented a set of challenges from a Passive House performance perspective. And as this dealership was the very first of its kind, there was no reference to fall back on. The solutions required an exceptionally strong and creative team effort, starting with design and modelling initiatives and carrying all the way through to the implementation of these ideas by the builder.

“We were excited to have the opportunity to build the first-ever Passive House car dealership in the world for Scott Subaru,” says Ron Goss of Black Creek Developments out of Sylvan Lake, Alberta. “The experience has been a lot more complex than we initially anticipated. The key to the Passive House building process was precise execution of the small details.” Goss adds, “Since Passive House is not a standard building practice in North America, we encountered many obstacles during construction that required innovative solutions.”

The initial roadblock to overcome was the corporate design guideline that dictated that 65% of the west-facing storefront be glazing. Various measures were explored to mitigate the predicted solar gains, but the only ones deemed feasible were insulated spandrel panels in the top row of glazing and automated operable internal blinds with manual override.

## TEAM

### Architect

[Cover Architectural Collaborative](#)

[Sublime Design Studio Inc.](#)

### Builder

[Black Creek Developments](#)

### Passive House Consultant

[Peel Passive House Consulting](#)

### Passive House Building Certifier

[Passive House Institute, Darmstadt](#)



Photos by Kevin Clark, Black Creek Developments (left); Andrew Peel, Peel Passive House Consulting Ltd. (above)

However, PHPP modelling by Peel Passive House Consulting showed that these measures would be insufficient to mitigate the inevitable high cooling load. The team decided that the load would be best met by a ducted variable refrigerant flow system. Electric-resistance coils were installed in the supply air of each indoor unit to provide heat during peak heating conditions, when the heat pumps are expected to stop operating due to the very low temperatures.

Another particularly challenging HVAC question was how to remove the car exhaust, which contains harmful pollutants, from the service bays. To meet code requirements, each of the six service bays requires 680 m<sup>3</sup>h (400 CFM) of exhaust. Normally, all bays are connected to the same exhaust fan—which means that all bays are exhausted even when only one bay is in use—but modelling revealed excessive heat losses with the exhaust flows if this standard practice were implemented. For this project, each bay was instead separately vented, cutting the exhaust rate by 83%.

Finding the right building envelope components also took a team effort, particularly the massive overhead doors required for the shop areas and the large curtain wall in the showroom area, which is part of the aesthetic of the car dealership. Peel Passive House was able to find solutions with products sourced from German manufacturers; however, when ordering products from Europe, it is important to be aware of the extended lead times.

The team faced another challenge when local engineering and building inspectors were reluctant to accept Passive House standards and technologies. “There was some scepticism as to whether the system would actually work,” Goss explains. “We are proving these suspicions are unwarranted, as everything is working just the way the system was designed.”

## PRODUCTS

### Ventilation

[Swegon](#)



## PASSIVE HOUSE METRICS

Heating demand	13 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	4 kWh/m <sup>2</sup> a
Primary energy renewable	84 kWh/m <sup>2</sup> a
Air leakage	0.4 ACH <sub>50</sub>



# Cover Architectural Collaborative

**COVER ARCHITECTURAL COLLABORATIVE, INCORPORATED,** was created by three design professionals from Nelson, British Columbia. The principals are passionate about collective thinking, collaborative design, responsible use of resources, and accountability. In their experience, collaboration consistently yields more-successful results than does individual work. This design approach is so central to their vision that they include it in their firm name.



*Photo courtesy of Madden Timber Construction*

The firm is committed to delivering high-quality, cutting-edge architectural services throughout Western Canada. Its clients seek it out for its understanding of local values, community priorities, and available resources. Cover is a multifaceted firm working across a range of scales and disciplines, including architecture, planning, landscape design, interior design, and industrial design.

The three founding principals have a diverse range of experience. Graeme Leadbeater has led the design- and construction-phase services of complex multiphase projects. His work has focused on medium- and large-scale health-care, educational, cultural, and municipal buildings. Lukas Armstrong has a pragmatic approach to sustainability and universal access. He is a Certified Passive House Designer and a LEED Accredited Professional, giving him the knowledge base to create buildings that are healthy, durable, and low impact.

Robert Stacey has a broad understanding of design and technical issues, as well as a strong working knowledge of project management fundamentals. Additional staff includes three architects, two architectural technologists, and one administrator.

The firm's passion and combined skill sets are particularly strong in health and residential care facility design. In the past four years, it has assisted Canada's Interior Health Administration with more than 22 projects, including emergency services, intensive-care units, and MRI facilities. Additional projects include a wide range of commercial and institutional buildings, single- and multifamily residential properties, and sustainable-energy solutions. Two projects in particular showcase its expertise in Passive House design—the first Passive House auto dealership in North America and a Passive House aging-in-place triplex.

# Passive Auto Dealership

## RED DEER, ALBERTA

The Subaru dealership in Red Deer, Alberta, the first of its kind in the world, presented quite a few design challenges: a winter design temperature of  $-29^{\circ}\text{C}$ , extensive glass, multiple service bays, unique mechanical equipment required for vehicle servicing, and Subaru-dictated shell and orientation requirements. It was commissioned by dealership owner Garret Scott, who saw it as an important statement in the home of the tar sands crude-oil industry. The project is also strongly aligned with Subaru's environmental initiatives. Cover enlisted Certified Passive House Consultant Andrew Peel of Peel Passive House Consulting to help resolve the challenges.

The two-storey building houses quite a variety of spaces—a showroom, sales offices, a reception area maintained at  $20^{\circ}\text{C}$ , and a service area that includes drop-off spaces connected to outdoors and yet had to be kept at  $18^{\circ}\text{C}$ . Subaru's design guidelines required 65% glazing on the west façade with no external shading and no significant landscape features to provide shading, creating unusually high solar gains in the showroom area. Because of the glazing, cooling loads dominated the HVAC equipment sizing. The final design uses internal operable blinds coupled with insulated spandrel panels in the top row of the windows to mitigate the solar gains.

The service area poses unique challenges. It requires several doors large enough to accommodate vehicles. This leads to insulation levels lower than desired; heat loss from opening doors, especially in winter; and air infiltration. After the design team agreed to reduce the number of overhead doors from

seven to four, extensive research turned up a high-quality European service bay door that minimizes air leakage with only modest heat loss.

Service equipment presents another set of unusual requirements. For instance, a  $680\text{ m}^3\text{h}$  (400 CFM) exhaust tube needs to be connected to each automobile's tailpipe during testing. Typical dealerships use one large fan to pull the



### TEAM

#### Architect

[Cover Architectural Collaborative](#)

#### Architectural Design

[Sublime Design](#)

#### Mechanical/

#### Electrical Engineer

[908 Engineering Inc.](#)

#### Builder

[Blackcreek Developments](#)

#### Passive House Consultant

[Peel Passive House](#)

[Consulting](#)

#### Passive House Building

#### Certifier

[Passive House Institute,](#)

[Darmstadt](#)



Photos courtesy of Cover Architectural Collaborative

exhaust stream from each vehicle, which would generate significant heat losses. Instead, each of the six service bays is outfitted with a separate operable fan.

The repair shop generates 55% of the building's internal heat gains, 14% of that from running engines. Auto engines entering the service give off heat. Vehicles also have to be running during repairs, generating exhaust temperatures of up to  $343^{\circ}\text{C}$ . All cars are washed with  $60^{\circ}\text{C}$  water after servicing. The heat gains from all these activities, plus the heating-and-cooling loads in the other parts of the building, are handled by a variable refrigerant flow system that can simultaneously heat and cool different areas. Heat losses from the auto washing, which consumes approximately 2,020 liters of water, are mitigated by a drain water heat recovery unit.

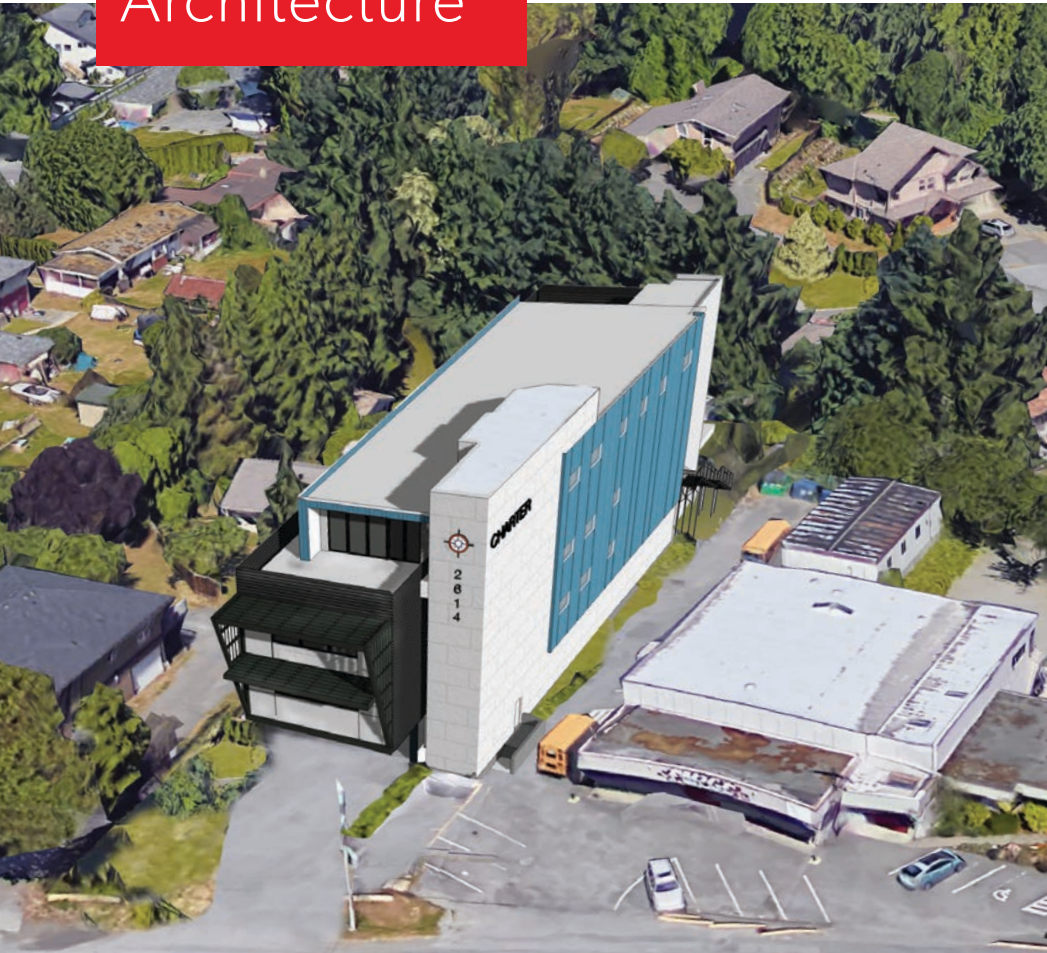
According to Lukas Armstrong, a principal at Cover Architecture, the two biggest challenges were meeting Subaru's design and branding expectations and designing an HVAC system that meets the requirements of both a repair shop and Passive House certification. As this project demonstrates, satisfying all those goals is possible, even in a harsh climate. The building looks like a typical auto dealership, but performs quite differently.



### PASSIVE HOUSE METRICS

Heating demand	13 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	4 kWh/m <sup>2</sup> a
Primary energy renewable (PER)	84 kWh/m <sup>2</sup> a
Air leakage	0.4 ACH <sub>50</sub>

# Waymark Architecture



Rendering courtesy of Waymark Architecture

Architects Graeme Verhulst and Will King have lofty ambitions when it comes to interweaving sustainability and high-performance goals into their project deliverables. To turn these ambitions into actions and then into buildings, Verhulst and King teamed up in 2015 to form **WAYMARK ARCHITECTURE**, based in Victoria, British Columbia.

“Sustainability is the central focus of our firm,” says Verhulst, who is a Certified Passive House Designer. They aspire to push all of their new-build projects to Passive House levels of performance. “We are not yet at 100%, but we’re not far off,” he adds.

Staffing has doubled since this firm’s inception, adding expertise in engineering, modelling, and construction management. These ramped-up proficiencies allow the team to get immediate feedback on the energy impacts of design tweaks to a building, ensuring that a project always stays within its energy budget.

While these in-house skills make attaining Passive House targets easier, some clients are still reluctant to leap into what might be a big unknown to them. Verhulst says that the new BC Energy Step Code, which Victoria has adopted, has facilitated conversations about Passive House. “When we build to Passive House levels now, we are building a code-minimum building just 15 years early,” he points out. That approach makes embracing Passive House a little easier, even for hesitant clients.

Waymark has worked on a variety of design projects, from commercial buildings to community centres to single-family homes. “We bring long-term value to projects that have ambitious sustainability goals,” says King, who adds, “These buildings have real impacts on people’s quality of life.”

Improving its own quality of life, the Waymark team has undertaken an ongoing retrofit of its rental office space. It is improving the space’s performance from an energy and materials selection point of view—setting a goal of Living Building Institute certification in the materials petal—while also optimizing the space’s layout. The team crafted the interior staircase that is visible from the street from mostly recycled materials, and it has received much praise even from passersby. “Creating this staircase is a good example of the persistence and detail that we bring to every project,” says Verhulst, laughing a bit at the time the firm invested in this effort. Still, the staircase symbolizes the quality of attention and skills the team brings to every project, along with the joy and commitment to Waymark’s core values.



# Charter Telecom National Headquarters

LANGFORD, BRITISH COLUMBIA

When developing a new, roughly 1,500-m<sup>2</sup> office building to house its growing staff, Charter Telecom enumerated several priorities: occupant comfort, a high-quality work environment, low operating costs, and of course, reasonable construction costs. Many of the employees have been there for 20 years or more, and their well-being is an ongoing priority. After discussions with Graeme Verhulst of Waymark Architecture, Passive House seemed a good fit for meeting Charter Telecom's objectives.

The site was a bit narrow—less than 20 metres—and had to accommodate the office plus parking. Raising the building and providing surface parking underneath proved the most cost-effective solution. No columns could interrupt the drive aisle, and zoning setback requirements only allowed enough space for a row of columns on the west side, which couldn't interrupt access to the parking stalls—a structural challenge, especially for this seismically active area. The shear forces in this configuration were too large for light wood framing, but instead of using high-embodied-energy steel or concrete, engineered mass timber was chosen as the primary structural material.

The design solution that Waymark Architecture arrived at involved creating three masses. A long, skinny block extends the full height of the four-storey building and does most of the seismic heavy lifting, relying on thick, tightly spaced shear walls. The electrical and plumbing services fit within this block, as well as the washrooms, elevator, and fire exits.

The main office space is a two-storey block that spans the structure, providing flexible open offices that can be subdivided with temporary partitions for privacy. A stairway in the middle of this block creates a feature and a connecting element, making possible casual conversations in midtransit; the stairway doubles as bleacher seating for gatherings of 60 or 70 people. The final, smaller mass on the fourth level houses a multipurpose space that will be used for training events and holiday parties, and an executive hospitality suite.

Verhulst notes that an important consideration in moving from design to cost-effective construction was planning the sequencing of the envelope system so that coordination among the trades was optimized. The wood structure—built using cross laminated timber, glulam beams, and sections of light wood framing—was prefabricated off site. Once it was assembled on site, the envelope crew had a flat surface ready for the installation of the air barrier and a Larsen

## TEAM

### Architect

[Waymark Architecture](#)



Rendering courtesy of Waymark Architecture

truss stuffed with cellulose. The cladding crew finished off with a mix of fibre-cement and metal siding.

Although the climate on Vancouver Island is heating dominated, this building type is dominated by the cooling demand, because of the density of employees and office electronics. To determine the precise loads, the mechanical designers used a dynamic energy model that allowed them to model setpoints, schedules, solar gains, and overheating risk on a zone-by-zone basis. Cooling and heating needs are being met by a variable refrigerant flow heat pump system. To meet specific fresh-air needs in the different spaces, four separate ventilation systems were chosen: two commercial-sized HRVs with one on each of the main office floors, a residential-sized HRV for the hospitality suites, and another one for the main meeting room.

## PASSIVE HOUSE METRICS

Heating demand	7 kWh/m <sup>2</sup> a	
Cooling and dehumidification demand	5 kWh/m <sup>2</sup> a	
Primary energy	106 kWh/m <sup>2</sup> a	PER 47 kWh/m <sup>2</sup> a
Air leakage	0.6 ACH <sub>50</sub> (design)	

# Tantrum Urban Commercial Infill

REVELSTOKE, BRITISH COLUMBIA

The Tantrum building is a commercial infill Passive House project that will demonstrate the benefits of exceeding design and code minimums in what is typically an overlooked building typology. The narrow 7.6-metre by 39.5-metre site sits in Revelstoke's downtown core amidst heritage-era low-rise buildings. The three-storey building will house a ground-floor retail unit with offices above. To contend with the region's short building season, construction options were short-listed to either prefabricated or modular systems. Ultimately, floor and roof panels using cross-laminated timber for the shear walls and wood fibre insulation were utilized to increase build speed and help achieve the Passive House performance goals.

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	7 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	45 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)

## TEAM

**Architect**  
[STARK Architecture Ltd.](#)

**Builder**  
[Tree Construction Inc.](#)

**Mechanical, Electrical,  
and Plumbing**  
[WSP](#)

# FENSTERTEK

## Scott Subaru Passive House Car Dealership

Red Deer, Alberta, Canada



Located in Red Deer, Alberta; The Scott Family took an evolutionary approach in embarking upon a Passive House design for their new Subaru Car Dealership facility. With winter temperatures able to reach lows down to 45 celsius, this project was a challenge to say the least. The building systems were designed in collaboration with Cover Architecture, Andrew Peel, as well as Passive House consultants from Germany.

When the fenestration design of this building came up for debate; Fenster Tek Ltd answered the call with the WICONA WICTEC 50 HI Passive Performance Curtain Wall System, as well as the WICLINE 95 Passive House Window System. The Blower door tests resulted in values that exceeded their already stringent requirements for this most challenging design. We are proud to have been chosen by Cover Architecture and Black Creek Developments to fulfill the necessary design requirements for this Passive House project. Scott Subaru has become the first car dealership to have been built to the Passive House standard.

At Fenster Tek we strive to meet your every need; whether it be through energy performance design, aesthetic considerations, or custom fabrication solutions not available through conventional means. As proud representatives of the product lines: WICONA, Gaulhofer, Aluprof, and Sierra Pacific; we have a multitude of product solutions available to design professionals and owners alike; whether it be for Canada's Energy Code, B.C.'s Stepped Energy Performance Codes, or a myriad of Passive House and Net Zero design considerations. Fenster Tek can bring you optimized value for all your commercial and residential fenestration needs.

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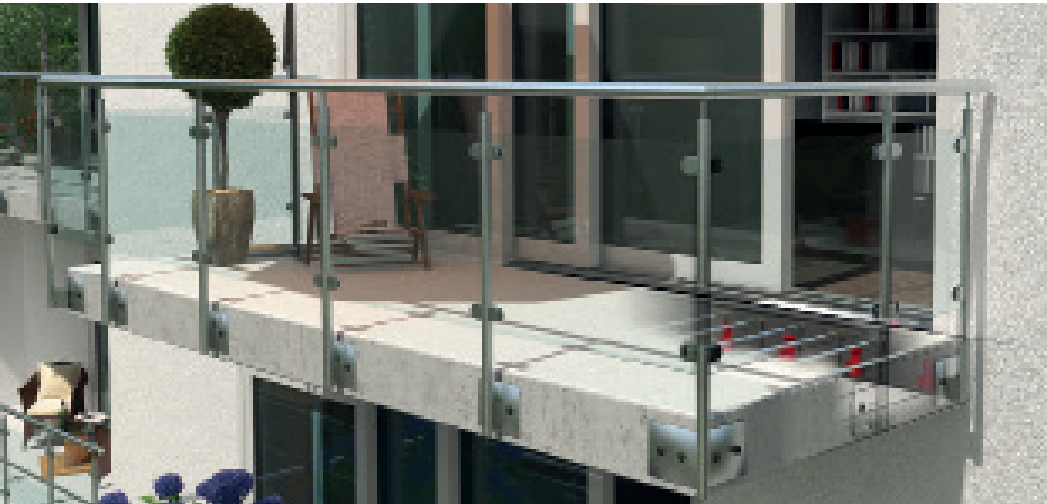
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**SIERRA  
PACIFIC**  
WINDOWS

Rendering courtesy of STARK Architecture



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As an advocate of socially and environmentally responsible design concepts, the company is committed to sustainable design, and is a member of the Health Product Declaration Collaborative. It has multiple Passive House Institute certified products including the HIT Structural Thermal Break. HIT is an ideal solution to eliminate thermal bridging as well as increase the overall energy efficiency and comfort of a building.



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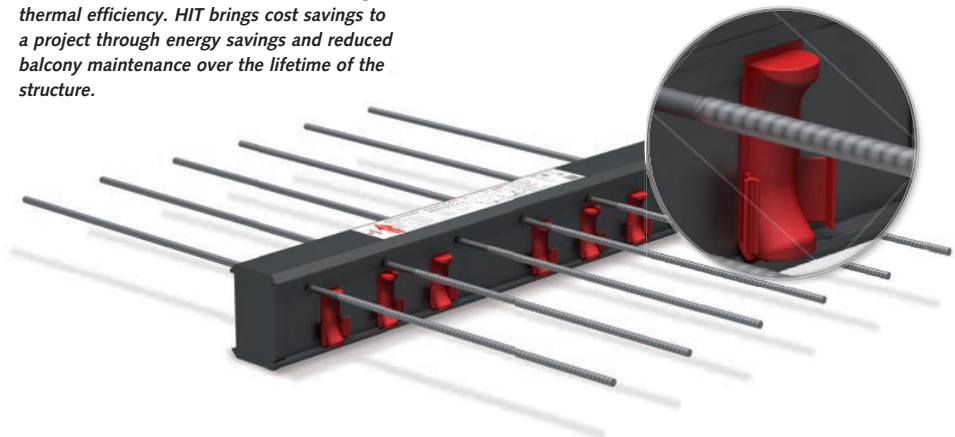
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# Kearns Mancini Architects

**KEARNS MANCINI ARCHITECTS INCORPORATED (KMAI)** is an award-winning architectural practice based in Toronto, composed of around 30 design professionals. Since its inception in 1984 KMAI has striven to deliver environmentally friendly buildings that delight and enhance user experience. It is no surprise, therefore, that when one of the principal architects learned of Passive House at a conference, the ideas found fertile ground.



Rendering courtesy of KMAI; Photos by Tom Ridout

KMAI has been working formally with Passive House design since 2009. The firm's first completed project to meet Passive House standards was the Reach Guesthouse, a small retrofit that is designed to meet the EnerPHit standard, and like most renovations, this project was a journey. KMAI managed to create a systematic combination of archaeological discovery, preservation, encapsulation, and architectural reinterpretation. An electric "hair dryer" (actually a tiny electric heater purchased at a yard sale) maintains comfortable winter temperatures, despite its being  $-25^{\circ}\text{C}$  outside.

Another key project for KMAI was Endymion House, a 316-m<sup>2</sup> multigenerational house that enables four families to occupy the building at once. This was a new-build project and so allowed new opportunities for its design. Generating an efficient form and orientation became paramount, as did material selection; the structure is an R-43(effective) ICF with large-format porcelain ceramic tile cladding. The result is an elegant three-level house, with upper floors facing south over lavender gardens.

Nearly ten years have passed since those early ideas found genesis; now many projects are under way, from the very small to the very large. Passive House design has steadily grown within the practice, which now employs six trained professionals solely dedicated to implementing Passive House methodologies. As collective project experience has increased, this knowledge has spread throughout the wider team. KMAI has learned that each project has its own unique operating logic and therefore contains fresh challenges to overcome. This is fascinating to the designers, who relish the task of developing innovative schemes for building typologies not normally associated with the ideology. Two such examples are the designs for the University of Toronto Scarborough student residence and the YWCA community centre and women's refuge in Hamilton, both featured case studies.

KMAI now seeks to integrate Passive House principles into all future projects, even if designing to meet the thresholds in their entirety is simply not feasible. The intention is to partner with clients and construction industry professionals to help establish beautiful, high-performance buildings that both respect and remain in tune with the natural environment.





# YWCA Housing and Community Centre

HAMILTON, ONTARIO

The Young Women's Christian Association (YWCA) Hamilton aims to transform the lives of marginalized and disadvantaged women. It provides services in the areas of employment support and leadership development while also providing housing options and shelters. Kearns Mancini Architects (KMAI) envisioned synergies between the Passive House requirements and the YWCA's key organizational and development goals. Of central importance was securing enhanced comfort levels and long-term viability and efficiency. This project has become an ideal showcase of the benefits of Passive House design, most notably demonstrating climatic resilience, occupant health, comfort, reduced energy poverty, and lower operating costs, which are common issues in many current affordable housing facilities.

The YWCA Hamilton has been mapped out over many years through careful analysis of existing community needs and municipal housing policies. Located on a main thoroughfare in Hamilton, the new design will reintroduce the YWCA to the Crown Point neighbourhood, an ideal location for an affordable housing project. Ease of access to services and transit, reduced reliance on cars, and a higher potential for social integration will all aid in fostering social equality and help establish the residents as a key part of society.

## TEAM

**Architect**  
[Kearns Mancini Architects](#)

**Mechanical and Electrical**  
[Integral Group Inc.](#)

**Structural Engineer**  
[Read Jones Christoffersen Ltd.](#)

The building consists of a variety of community centre spaces within a podium level, designed to respond to the surrounding contextual fabric. This level provides the key connection between the community programming and the street. A five-storey residential component consisting of 50 units of affordable housing sits atop the podium. A balanced approach to the materiality of the envelope has been taken to ensure that optimal energy performance of the building is maintained. Careful consideration has been given to the orientation of the spaces, as well as to the thermal properties of the external walls, allowing consistency through the varying climatic conditions of the Hamilton calendar. The interior spaces are designed with clarity and simplicity, punctuated with moments of colour and texture.

KMAI warned the YWCA of a potential construction cost increase of up to 10%, which was to be offset over time through building marketing opportunities and reduced operating costs. Interestingly, one of the primary reasons for this higher build cost was limited product availability, especially when compared to European markets. However this cost increase was all but mitigated and is currently estimated to be only 0.18%; given the expected 90% reduction in energy usage, this extra cost would be recuperated in just two months.

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	12.8 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	4.6 kWh/m <sup>2</sup> a
<b>Primary energy</b>	90 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	49 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)

Renderings courtesy of KMAI and DoHere



# Cascadia Architects

Led by principal architects Peter Johannknecht and Gregory Damant, **CASCADIA ARCHITECTS** is a 12-person firm based in Victoria. Johannknecht and Damant joined forces in 2012, after a combined 40 years of architectural practice, to be able to focus their work on sustainable design. Staff experience encompasses designing commercial, residential, education, and health care buildings, with a particular specialty in urban and infill projects.

One of Cascadia Architects' first commissions was a multigenerational home that was the first Certified Passive House building on Vancouver Island. Both Johannknecht and Damant were energized by this opportunity; they see the Passive House standard as a practical means of reducing greenhouse gas emissions and fighting climate change. Each had been frustrated previously by other green building standards that hadn't prioritized energy efficiency.

"One thing we both like about Passive House is how clear and singular its focus is," says Damant. "You can layer on other green criteria if you want to extend its sustainability impacts, but the starting point is always Passive House." Damant adds that the certification process is fairly manageable compared to those of other rating systems. Johannknecht, who hails originally from Germany, also appreciates

that as Passive House has a long history in Europe, he can profit from the learning curves of architects there when applying the standard to a range of building types in Canada.

More and more of the firm's clients come to them specifically for their Passive House expertise. Having a clear Passive House goal from the start of a project certainly smoothes the implementation process. However, the clients who are undecided about their performance goals still benefit from the technical understanding that the staff collectively embody. The firm has two Certified Passive House Designers on staff and others who have undertaken various Passive House courses.

The firm's Passive House experience has enhanced Damant's and Johannknecht's appreciation of the importance of the team approach, especially the partnership with the builder. "In addition to having a design team that understands the implications of Passive House, you need to have a contractor who is meticulous and very good at quality assurance," says Johannknecht. "No single person is responsible for the entire scope of work required to create a Passive House."

Creative collaboration is a key principle of Cascadia Architects' practice, as is weaving together the needs and resources of the client, the community, and the natural environment to create spaces that are elegantly functional and uplifting. Johannknecht and Damant believe that architecture has its role to play in enriching the human experience, and that includes designing buildings that contribute positively to our changing climate.

*Rendering courtesy of Cascadia Architects Inc.*



## Nigel Valley

VICTORIA, BRITISH COLUMBIA

### TEAM

**Architect**  
[Cascadia Architects](#)

The Nigel Valley project consists of a series of buildings on a 9-acre parcel owned by five housing and care operators. Many of these buildings require significant renovations, and the operators recognized that together they could realize a more-cohesive neighbourhood plan than they could do by proceeding individually. For this five-storey building—part of the first phase of the overall redevelopment—the Nigel Valley steering committee is targeting net zero energy ready and Passive House certification. This building is owned and operated by the Greater Victoria Housing Society, with a portion of funding coming from BC Housing. The ground floor features commercial units, with 70 residential units above, ranging from bachelor to four-bedroom layouts. Increased insulation, triple-pane windows, and HRVs are some of the strategies being used to achieve the targeted performance.

### PASSIVE HOUSE METRICS

<b>Heating demand</b>	15 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	120 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)

*Rendering courtesy of Cascadia Architects Inc.*



## Goldstream Avenue

VICTORIA, BRITISH COLUMBIA

Owned and operated by the Greater Victoria Housing Society, this six-storey wood-frame building will be providing 102 affordable housing units plus supporting space to low- to moderate-income families, seniors, and working adults. The building will include underground parking. The project is striving to meet Passive House standards within a very tight budget, leading the design team to prioritize solutions that are durable, low maintenance, and cost-effective. Wood framing was chosen for its sustainability and familiarity to local trades. Exterior insulation and thermal-bridge-free cladding attachments, along with a vapour-permeable air barrier and exterior sun shading, are helping this building to achieve the highest possible performance.

### TEAM

**Owner**  
[Greater Victoria Housing Society](#)

**Architect**  
[Cascadia Architects](#)

**Structural Engineer**  
[RJC Engineers](#)

**Mechanical/  
Electrical Engineer**  
[Williams Engineering](#)

**Building Envelope  
and PHPP Consultant**  
[RDH Building Science](#)

### PASSIVE HOUSE METRICS

<b>Heating demand</b>	12 kWh/m <sup>2</sup> a
<b>Primary energy</b>	120 kWh/m <sup>2</sup> a
<b>Air changes per hour</b>	0.6 ACH <sub>50</sub> (design)

*Rendering courtesy of Cascadia Architects Inc.*

# Ken Soble Tower

HAMILTON, ONTARIO

The Ken Soble Tower Transformation is a ground-breaking project to modernize a postwar apartment tower to the EnerPHit standard—one of the first such retrofits in North America.

The building's rehabilitation will modernize 146 units of affordable senior housing, while reinvigorating community spaces and outdoor gathering areas, planning for aging-in-place and barrier-free living, and providing high-quality, safe, and healthy housing for another generation. With Hamilton's wait list for affordable housing of over 6,000 households, it was urgent that this housing asset be brought back online.

Built in 1967, the Ken Soble Tower is the oldest high-rise multiresidential building in CityHousing Hamilton's portfolio and has been in decline for several years. After a study of several options, including sale, rebuild, capital repair, and rehabilitation, CityHousing opted to retrofit the building, making significant improvements at a cost substantially less than that of a new build. Following its modernization, the Ken Soble Tower will be a model for housing quality and energy performance for thousands of similar postwar apartment towers across the country.

At 18 storeys and more than 7,400 square metres, the Ken Soble Tower will be one of the largest EnerPHit projects in the world. The retrofit is designed for

## TEAM

**Owner**  
[CityHousing Hamilton](#)

**Architect**  
[ERA Architects Inc.](#)

**Mechanical Engineer**  
[Reinbold Engineering Group](#)

**Building Envelope Engineer**  
[Entuitive Corporation](#)

**Passive House Consultant**  
[JMV Consulting](#)



Renderings courtesy of ERA Architects

a changing climate, using 2050 temperature projections to test thermal comfort in all seasons. The project, slated for completion in 2020, will provide residents with improved comfort and control of their indoor environment, with the ability to withstand extreme climate events. Modelling has demonstrated a projected reduction of greenhouse gas emissions by 94%.

The design tackled several challenging technical issues common to residential apartment towers, including the modernization of ineffective ventilation systems; replacement of aging mechanical, plumbing, and electrical distribution systems; and elimination of thermal bridging at balconies. An R-38 overcladding assembly was added to the existing masonry façade, using mineral wool insulation to minimize the carbon footprint of the airtight envelope. Innovative approaches to vertical services were used to minimize stack effect and mitigate thermal bridging through sanitary stacks, garbage chutes, and roof drains. All interior finishes were selected to ensure healthy indoor air quality, and all planting at the green roofs and ground plane was selected to be native to the Hamilton region.

The Ken Soble Tower will be one of the most ambitious social-housing transformations in the country, paving the way for the nation's aging housing supply to secure a healthy, resilient future for thousands of Canadians.

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	19.5 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	2.4 kWh/m <sup>2</sup> a
<b>Primary energy</b>	117 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)







## Putting Faith into Action

### HAMILTON, ONTARIO

When Hughson Street Baptist Church was founded in 1883, it was in the heart of Hamilton's blue-collar industrial neighbourhoods. Over 130 years, the church met the needs of its community with spiritual and practical assistance. In recent years, Hamilton has experienced a cultural and economic renaissance, and with it, a rapidly appreciating housing market. This led the church to realize that affordable housing was becoming a major concern for many neighbours living in poverty. To explore solutions, it turned to Indwell, a local charity with decades of experience providing affordable housing. Hughson invited Indwell to join forces on redeveloping an underutilized site in North Hamilton, building a large contemporary church and 45 new affordable apartments. The entire development is targeted for Passive House certification—a reflection of the commitment to stewardship of resources—environmental and financial—for both organizations.

Youth sports programs and mentoring have been central to Hughson Street Baptist's ministry for decades, so the facility will include a full gymnasium that can also be used for the congregation's worship services, special events, and

#### TEAM

##### Architect

[Invizij Architects](#)

##### Mechanical and Electrical

[CK Engineering](#)

##### Structural Engineer

[Kalos Engineering](#)

##### Construction Manager

[Schilthuis Construction](#)

##### Passive House Consultant

[Peel Passive House Consulting](#)

community gatherings. Large glulam beams span the gymnasium, supporting the roof, and high-performance skylights bring in diffused daylight. There is a café-style gathering hall, a prayer chapel, and Sunday school classrooms for up to 300 people, meeting the church's need for everyday programming.

Indwell brought extensive development experience to the project and helped inform the design team led by Invizij Architects. The entire team of consultants, owner-developers, and Schilthuis Construction attended a Passive House training course at the beginning of the project. As a result, they could all speak to the Passive House aspects of the project throughout the design process. The four-storey building's 5,800 square metres of space are efficiently laid out to maximize function while minimizing the exposed building envelope. The 45 one- and two-bedroom apartments are on the second through fourth floors, over the church's gathering hall, community kitchen, and office pods. Tenant activity rooms, bike storage, staff offices, and other amenity spaces augment the fully accessible residential floors, with nine of the apartments being fully barrier-free.

Passive House design elements include a compact building massing, R-55 roofs, R-35 (effective) walls, and an R-43 foundation assembly. Careful detailing of window placements, overinsulated frames, and stringent glazing specifications helped to meet Passive House targets. The building's comfort will be ensured using a high-performance HRV and a variable refrigerant flow heating-and-cooling system.

The building's superior energy performance wasn't the church's only goal; Hughson wanted a building that would endure for future generations and would aesthetically uplift the neighbourhood. Emma Cubitt of Invizij Architects undertook considerable research comparisons for attaching the brick, aluminum composite panels, and steel cladding in cost-effective ways to minimize thermal bridging. "We detailed a fibreglass girt system that attaches the various claddings back to the structure, allowing 15 cm of mineral wool over a continuous air-vapour barrier," Cubitt notes.

The project was built by Schilthuis Construction, emerging Passive House leaders. "We have four Passive House multiresidential, mixed-use projects completed or under construction at the moment," says Beth Schilthuis, project manager. "We are finding our trades are on board with new approaches that lead to much higher quality while still being straightforward to construct. This isn't rocket science; it's feasible for everyone who takes the time to pay attention to the details."

Hughson's Pastor Dwayne Cline concludes, "We are thrilled that our new church facilities can not only meet our congregation's needs, but also serve our neighbourhood and tenants with an environmentally hopeful building. We're putting our faith into action."

#### PASSIVE HOUSE METRICS

<b>Heating demand</b>	14.8 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	4.8 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	106.5 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)

Rendering courtesy of Invizij Architects

# Parkdale Landing EnerPHit

## HAMILTON, ONTARIO

Indwell, a Christian charity that creates affordable housing communities for people seeking health, wellness, and belonging, bought a deteriorating building in East Hamilton with the goal of creating affordable apartments with support services and a community hub. The site was first developed in the 1880s and included retail, a tavern, a banquet hall, and rooming house additions over the past 100-plus years.

The finished project transformed the building into 57 studio apartments, including eight barrier-free units. The ground floor includes a community restaurant and food-service training facility, two retail storefronts, and offices for Indwell staff.

The renovation retained roughly 60% of the original building, while the remainder was rebuilt due to poor structural conditions. “We went through many different scenarios for the building envelope, but all included keeping the majority of the masonry structure,” says Emma Cubitt, a principal with Invizij Architects. “We needed to enlarge and standardize the window openings, which we did at the outset. Keeping the masonry walls and insulating on the outside allowed us to minimize the thermal bridging, unify the façade elements, and retain the maximum interior space for apartments.” The building’s HVAC was also designed to provide all the heating and cooling to the apartments through the building’s two rooftop heat recovery units, along with supplemental electrical heating that will likely not be needed.

### TEAM

**Owner**  
[Indwell](#)

**Architect**  
[Invizij Architects](#)

**Mechanical and  
Electrical Design**  
[CK Engineering Inc.](#)

**Construction Manager**  
[Schilthuis Construction Inc.](#)

**Passive House Consultant**  
[Peel Passive House  
Consulting](#)

The building was less than 12 inches from the property line, so the exterior insulation options called for close consideration. The team found a locally manufactured spray foam with a very low global warming potential (GWP) of 1, and an R-value of 6.6 per inch. The existing masonry façades were topped by a sheet-type air-vapour membrane to ensure continuous airtightness; the spray foam is being relied on solely for its insulative value. Fibreglass clips were used to minimize thermal bridging and attach the new corrugated metal cladding.

Subslab insulation under the existing foundation was not feasible, but 10 cm of XPS board was installed outside the existing foundation walls to 0.6 metres below grade. This was overlapped internally with spray foam up to the basement ceiling. Where there was new construction, 20 cm of XPS was installed under-slab and up the foundation walls to complete the thermal envelope.

Renovating buildings to the EnerPHit Passive House standard is challenging enough, but this project was even more complex due to the building’s programmatic uses. Though the design criteria on usage are feasible, the primary energy targets may prove difficult to achieve, due to a combination of the high ventilation rates for commercial gas appliances in the restaurant and the electrical loads for the walk-in refrigeration and the retail activities of the convenience store and pharmacy.

Schilthuis Construction was committed to the project’s success from the outset, despite this being the firm’s first Passive House build. “We knew that we were learning together with the design team, owner, and trades, so we took our time and didn’t rush any Passive House-related critical stages,” says Beth Schilthuis, project manager. “We’re very happy with the results, especially the airtightness we achieved of 0.3 ACH<sub>50</sub>.”

The Passive House features were immediately apparent to tenants who moved in in September 2018. The constant suite ventilation means high air quality, and the triple-pane certified Passive House windows make the building very quiet. Despite a very cold first winter, tenants didn’t need to use their in-suite electric heating, relying solely on the high-performance ventilation system and other solar and internal heat gains.

This Passive House approach is maximizing tenants’ comfort, energy efficiency, and cost savings, creating long-term benefits for everyone involved.



### PASSIVE HOUSE METRICS

<b>Heating demand</b>	19.3 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	4.9 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	226 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.3 ACH <sub>50</sub>

Photos by George Qua Enoo

# Blossom Park

## WOODSTOCK, ONTARIO

Providing people with safe, comfortable, and affordable housing is the primary mission of Indwell, a Christian charity that has committed to incorporating Passive House principles into its developments. As the owner of an outdated group home in Woodstock, Indwell seized the opportunity to redevelop the site, creating a new 2,434-m<sup>2</sup> housing complex with 34 apartments and a community hub that will be shared with other nearby tenants. All tenants will have access to a meal plan and other supports to maximize their ability to remain in stable housing.

Common spaces in the complex include a large community kitchen, a dining area, a laundry room, a lounge, meeting rooms, storage space, and offices for Indwell staff. Each apartment has a bedroom, washroom, kitchenette, and living area in an efficiently designed, roughly 34-m<sup>2</sup> space. Most units will be single occupancy.

The design team, led by Invizij Architects, opted for a prefabricated wall system built off-site in Kansas that would deliver the required performance and shorten construction time. The walls are designed to achieve an effective R-value of 49,

including 14 cm of mineral wool batts between the studs with an additional 19 cm of EPS on the exterior. Triple-glazed PHI-certified windows were preinstalled and air sealed off-site.

“We have one of the most challenging climates, because it is heating dominated but we also have stringent cooling requirements,” says Greg Leskien of Zon Engineering, who consulted on the project. Low-solar-heat-gain glazing units will help to balance these demands. Operable windows with insect screens that will be added on-site will aid in reducing the cooling demand when

the weather is favourable. Large evergreen trees on the south and west sides of the complex should help reduce solar gains in summer.

Continuous ventilation is being supplied to each apartment by a centralized system composed of three commercial-size ERVs. A fourth ERV will bring fresh air to the kitchen and common areas.

Heating and cooling will be provided by a variable refrigerant flow (VRF) heat pump system. This system’s condenser units are housed in an unconditioned mechanical room located in the basement, outside the thermal envelope, so that these

### TEAM

**Owner**  
[Indwell](#)

**Architect**  
[Invizij Architects](#)

**Mechanical Design**  
[C.K. Engineering Inc.](#)

**Construction Manager**  
[Trigon Construction Management](#)

**Passive House Consultant**  
[Zon Engineering Inc.](#)



Photos by Greg Leskien, Zon Engineering



units will extract or reject heat from or to the outside air that moves through this room when conditions are favourable. When outdoor temperatures drop, and the VRF systems lose efficiency and capacity, outdoor dampers to the room close, and heat is extracted from the ground through the slab and walls. If the temperature in the room continues to drop, additional heat is added by a natural-gas furnace.

To allow for the use of just one wall-mounted VRF fan coil to deliver the conditioned air in each unit, the architectural team redesigned the apartments’ bedroom walls and doors so that they stop short of the ceiling and air can circulate freely. Attractive sliding barn-style doors screen the bedroom from the rest of the unit.

Great efforts were made to reduce the energy used by appliances and other equipment. The common kitchen will have highly efficient residential-style electric ranges, and a commercial-grade dishwasher, freezers, and walk-in coolers. Direct-vent range hoods are interlocked with the kitchen’s ERV to increase the supply airflow to automatically deliver balanced makeup air whenever an exhaust hood is operating. An efficient hybrid elevator and lift was selected to further reduce energy use.

A 58-kWac PV system will help offset most of the electricity used annually.

### PRODUCTS

**Ventilation**  
[Swegon](#) 

### PASSIVE HOUSE METRICS

<b>Heating demand</b>	14 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	1 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	120 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)



# Harding Heights Independent Living Facility

## SMITHERS, BRITISH COLUMBIA

Completed in the summer of 2018, Harding Heights is a 19-unit residential building for seniors and adults with learning difficulties. This three-storey development features a mix of studio and one-bed suites with shared common and program spaces on the ground floor. Harding Heights is BC Housing's first Certified Passive House development. The agency is looking to Harding Heights as a model of an efficient, cost-effective Passive House building that can serve as a template for its future residential developments throughout the province.

This project was designed in a contemporary style and with a language that aimed to fit within the town of Smithers's Alpine theme. The building utilizes a simple and efficient rectangular plan and features dominant roof forms and large overhangs. It is clad with a simple palette of durable cementitious materials that embrace both the visual and the climatic context. Large tilt-and-turn windows are featured on the south elevation to utilize solar gains, while smaller windows were placed on the north, east, and west façades to balance solar-energy gains and losses.

Located in PHPP's climate zone 2 (cold), the building envelope is highly insulated on all sides. An internally insulated raft slab with 30.5 cm of EPS insulation achieves an R-value of 50. The above-grade wood-framed sandwiched double-wall assembly

### TEAM

**Architect**  
[Cornerstone Architecture](#)

**Passive House Consultants**  
[RDH Building Science](#)

**Structural Engineering**  
London Mah & Associates  
Ltd.

**Mechanical & Electrical  
Consultant**  
[Smith + Andersen](#)

**General Contractor**  
[Yellowridge Construction Ltd.](#)

includes a 2 x 6 batt-insulated exterior structural wall, 15 cm of rigid EPS insulation in the centre, and a 2 x 4 batt-insulated service wall to the interior, together delivering an R-value of 56. The R-86 roof assembly relies on 61 cm of blown cellulose. Cornerstone Architecture specified overinsulation of the triple-glazed window frames and exterior solar shades to control solar gain in the warmer seasons.

Six highly efficient HRVs with up to 93% efficiency are arranged with two units serving each floor, providing 24/7 ventilation with a boost option for the common areas and suites. The air delivery in the suites utilizes a cascade ventilation strategy, supplying fresh air to the living rooms and bedrooms and extracting exhaust air from the washrooms, kitchens, and bathrooms.

Simple maintenance-free user-controlled electrical baseboards provide the in-suite heating. CO<sub>2</sub>-based heat pumps provide the primary source of hot water with traditional electrical tanks as backup.

The design team and the client required the general contractor to participate in the Passive House Trades Training program to ensure familiarity with the Passive House standard and understand the methodologies behind the wall and envelope construction and the window install strategy.

At the commissioning stage, an airtightness test of 0.44 ACH<sub>50</sub> was achieved, approximately 30% better than the air infiltration rate permitted by the Passive House standard. The building will be highly monitored over at least its first two years of operation

to assess its energy use and indoor air quality. The building's latest monitoring data indicate a projected yearly average total energy use intensity of 50 kWh/m<sup>2</sup>/yr. The project received its Passive House certification in November 2018.

### PRODUCTS

**Ventilation**  
[Zehnder America](#)



### PASSIVE HOUSE METRICS

<b>Heating demand</b>	11.7 kWh/m <sup>2</sup>
<b>Primary Energy Renewable (PER)</b>	58.8 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.44 ACH <sub>50</sub>

*Photos courtesy of Camus Photography*





## Karen's House

### OTTAWA, ONTARIO

The four-storey, 42-unit Karen's House, also known as Salus Clementine, represents the highest quality in affordable housing, having met the international Passive House standard. Designed to serve people living with serious mental illness, this innovative residence was constructed in an established inner suburb of Ottawa to provide housing to people who would otherwise be homeless.

To eliminate potential thermal bridging from the ground, the foundation dispensed with conventional strip or deep footings in favour of a well-insulated proprietary raft slab, consisting essentially of a concrete slab encapsulated by a thick layer of EPS foam. The above-grade walls used insulated wall panels composed of vertical I-joists infilled with EPS insulation and OSB sheathing secured to the exterior of the building frame, providing a total R-value of 34.6.

*Photo courtesy of Taplen Construction*

#### TEAM

**Owner/Operator**  
Ottawa Salus

**Architecture**  
CSV Architects

**Certified Passive House Designer**  
Sonia Zouari

**Building Services**  
Smith + Andersen

**Contractor**  
Taplen Construction

#### PASSIVE HOUSE METRICS

<b>Heating demand</b>	15 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	2 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	119 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.4 ACH <sub>50</sub>

## Arlington Apartments

### OTTAWA, ONTARIO

After the success of the Karen's House project, the architect and builder went on to construct a second similar project on Arlington Avenue. This project, also a low-income multi-unit apartment, incorporated some changes to the envelope that came with knowledge gained from the first project. This envelope started with the specialized insulated foundation product used at Karen's House and added several other specialty products, including an engineered solution for insulating doorway thresholds and a new R-28 external insulated wall panel specifically designed for Passive House enclosures. This wall panel covered the building from the edge of the slab to the underside of the roof, providing a very straightforward installation and addressing potential thermal-bridging issues.

*Photo courtesy of Taplen Construction*

#### PASSIVE HOUSE METRICS

<b>Heating demand</b>	15 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	10 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	120 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.5 ACH <sub>50</sub> (design)

#### TEAM

**Architect**  
[CSV Architects](#)

**Contractor**  
[Taplen Construction](#)

**Mechanical and Electrical**  
[Geo-Energie](#)



#### PRODUCTS

LEGALETT

**Insulation**  
[ThermalWall PH Panel by Legalett.ca](#)

[ThermaSill PH by Legalett.ca](#)

[GEO-Passive Super Insulated Slab Foundation by Legalett.ca](#)

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# Integral Group

**INTEGRAL GROUP** was founded by Kevin Hydes in 1992 with three values in mind: trust, nurture, and inspire. Now a firm of over 500 employees, with locations worldwide, its mission has evolved to address the increasing vulnerability of our world, with a focus on accelerating change toward low-carbon buildings.

Over the years the firm has grown from its roots in the San Francisco Bay Area to its current global reach by joining with other firms with a like-minded vision. By bringing small niche firms into its fold, Integral Group helps them to leverage their expertise to accelerate change.

The firm's work covers ten areas of expertise, ranging from mechanical engineering and energy modelling to health and wellness and community and district planning. Its design projects vary in size from large student housing projects, to mid-size civic centers, to small pilot single-family residences. This span from the technical and quantitative to the social, aesthetic, and qualitative is a hallmark of its creative and empathetic approach to solving design problems.

The firm was immediately attracted to the Passive House approach, with its emphasis on building envelope quality assurance as a means of downsizing the mechanical systems. It helped to spearhead Passive House training for nonresidential buildings in 2014, in cooperation with the Vancouver office of Perkins+Will.

The firm's broad expertise across energy-modelling platforms allows the design teams to take best advantage not only of PHPP, but also of TAS and IES models, to accurately assess the full range of scenarios. In the process it is leading the way on such topics as overheating criteria, the critical significance of solar shading, and the use of more-aggressive weather data that look beyond historical data to our future climate. (See the white paper presented by Integral Group at the North American Passive House Network conference in Pittsburgh in 2018.) Integral Group also helps to develop energy-modelling guidelines for building codes that would be enforceable without placing an excessive burden on project teams. Integral Group was instrumental in the creation of the city of Vancouver's Step Code, in which the final Step 4 is equivalent to building to the Passive House standard. Currently the Step Code provides incentives for early adapters; within ten years Step 4 will be the minimum code standard for all. This kind of careful thinking regarding feasible options for increasing mainstream building performance is another indicator of Integral Group's focus on accelerating change.



*Photo by Stuart Hood*

The dominant carbon-mitigation strategies of Integral Group's projects vary across different regions. While the firm sees many Passive House projects across all of its Canadian offices—including student residences at the University of Toronto and the University of Victoria, the Valleyview Town Hall in Alberta, the Clayton Heights Community Center in British Columbia, and the Charter Telecom Headquarters building on Vancouver Island—in Los Angeles the projects tend to emphasize net zero energy and photovoltaics, as different climates and contexts yield different cost-benefit ratios. With the variety of its projects, Integral Group offers to set new standards across building sectors for a multipronged push to improve our world.

# Clayton Community Centre

SURREY, BRITISH COLUMBIA

With its proven energy performance outcomes, Passive House certification was a natural choice for the Clayton Community Centre. Scott Groves, manager of civic facilities with the city of Surrey, had been frustrated with the often-mediocre energy and comfort performance of projects with other certifications. Due to the centre's siting in an extensive forest beloved by its community in British Columbia, aesthetics was an equally strong

priority. With its broad expertise encompassing both quantitative and qualitative values, Integral Group was brought in to ensure a well-coordinated engineering approach.

As with many non-residential buildings, the mixed-use program of the Community Centre—including a community workshop, kitchen, and fitness centre—led to both high energy loads and high internal heat gains. This in turn led to a cooling demand higher than the heating demand, despite

the Canadian climate. In response to this project's programmatic and budgetary goals, Passive House modelling combined with life cycle cost assessment led to the implementation of various strategies. These included

- more-moderate levels of insulation;
- no photovoltaics, which were still priced too high;
- a focus on natural daylight and light-fixture efficiencies to reduce the lighting loads;
- radiant ceiling heating and cooling panels;
- highly efficient Passive House-certified HRVs; and
- optimized natural ventilation with mixed-mode operation.

The HVAC systems for the project combine radiant ceiling heating and cooling panels with balanced heat recovery ventilation and natural ventilation. The choice of radiant ceiling panels was critical to avoid components that detracted from the exposed wood beams, a primary feature of the architectural character of the space. Beyond the aesthetic benefits, the radiant system is more

## TEAM

### Architect

[HCMA Architecture](#)  
+ [Design](#)

### Mechanical Engineer

[Integral Group](#)



Photo by Stuart Hood

compatible with the anticipated mixed-mode operation with natural ventilation than a more-conventional ducted air system would be.

The specifications for the balanced heat recovery system required extensive collaboration and owner review to arrive at a solution that met the functional, operational, procurement, and energy requirements. An HRV certified for Passive House, was selected; however, there were no equivalent alternates, which are generally required for public projects. The facility maintenance department voiced concerns regarding the reliability of the unit's heat recovery wheel versus a heat recovery core. These concerns were satisfied by requiring extended warranties and the provision of spare wheel motors and belts. The additional cost of this system was balanced by oversizing the units enough to provide free cooling, reducing the higher cooling loads produced by the internal heat gains both in shoulder seasons and, occasionally, during the winter.

Integral Group used TAS software with the European CIBSE standard TM52 to augment the PHPP modelling, so as to accurately evaluate thermal comfort and overheating potential. Calculations of multiple scenarios indicated that natural ventilation, even in the depth of winter, can provide a major energy benefit in cooling commercial buildings along the West Coast of the United States, and even in southern British Columbia. The final design took advantage of the stack effect between low and high operable windows in the library and fitness centre. In the library, with high solar heat gains due to south-facing glazing, the natural ventilation reduced the cooling load of the space by more than 60%.

For 80% of the spaces in the building, the natural ventilation is designed to complement the radiant heating-and-cooling system through mixed-mode operation. A mix of manual and automatic controls for the windows provides some level of control to users. Since effective operation is key to energy performance, user education and user-friendly traffic-light-coloured backlit thermostats help occupants to make decisions that take into account actual conditions as well as their perceptions of comfort.

This mixed-mode approach, however, was not possible for the fitness area, where high latent loads required fan coils rather than the radiant panels. The fan coils automatically shut down through actuators and an automated control system when windows are open.

The building includes centre areas far from the building envelope, where natural ventilation would not be effective. In all modes, 100% of the building has constant mechanical ventilation. A heating-and-cooling coil pretempers the incoming ventilation air.

The Clayton Community Centre will be the first building in the city of Surrey's portfolio that has no natural-gas consumption.

Careful collaboration between engineers and architects led to a finely tuned design responsive to program, to energy targets, and to its beautiful forested setting.

## PASSIVE HOUSE METRICS

Heating demand	0.3 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	2.1 kWh/m <sup>2</sup> a
Primary energy demand	125.8 kWh/m <sup>2</sup> a
Air leakage	0.6 ACH <sub>50</sub> (design)





Rendering courtesy of HCMA Architecture + Design

# Clayton Community Centre

**SURREY, BRITISH COLUMBIA**

## TEAM

**Architect**  
[HCMA Architecture](#)  
[+ Design](#)

The Clayton Community Centre will unite under one roof many of the community's previously separate services, including the library, visual and performing arts, and recreation. It also physically occupies a prominent site for the Surrey neighbourhood of Clayton Heights, much loved for the forested trails it offers. So the centre's design was a focal point for community input and a major initiative for the city. Setting a high standard for the building in terms of both aesthetics and sustainability, the city approached HCMA Architecture + Design, asking it to design a building that not only would meet the Passive House standard but would do so beautifully. The 7,000-m<sup>2</sup> centre demonstrates that environmental performance and high design are very compatible partners.

In its initial design concept, HCMA was expressing its synthesis of the neighbourhood's values. Community input had reported a strong appreciation for the surrounding forest and a fear that rapid development would deprive

the community of this easy connection to the trees. The centre's atrium pays homage to a forest canopy, with its ceiling of honeycombed exposed glulam beams suffused by dappled light. The glulam structure wraps down the exterior walls, creating openings that angle across the building, much as branches slant across a forest. The extensive glazing in both the roof and the walls—much of which is triangular—maintains the centre's connection to the nearby still-thriving forest. Exterior insulation is superimposed on the glulam structure, creating a classic Passive House thermal envelope.

Inside, the mix of uses extends the interconnected ecosystem feel and invites cross-fertilization among patrons. Music studios, recording studios, and a community rehearsal hall branch off from social spaces that also afford access to a library, a gymnasium, and a fitness centre. These key services are supported by a unique mix of supplementary uses, imagined and developed in close engagement with the community and designed to allow for community-led programming to occur. These include a community kitchen and associated community garden, a tool-sharing centre with a community workshop, a café, and various preschool and child care rooms.

Early in the design process, HCMA came to realize that Passive House objectives would be a significant driver of the building's form and layout.

For each space, occupancy patterns and anticipated equipment loads were estimated, to help the team to develop a rough PHPP model. Several of these areas—including the community workshop, kitchen, and fitness centre—had atypically high energy loads and internal heat loads. Lighting loads, especially for the double-height spaces, were also exceptionally high. The team realized that the biggest challenges for this building would be minimizing the cooling loads—not heating, as had been anticipated—and meeting the overall primary energy requirement.

The centre is expected to operate from 6 am until 11 pm daily, with an average of more than 650 people per hour using the facility. This intense usage inevitably produces high internal heat gains, pushing up cooling loads. To reduce these loads, HCMA re-evaluated the thick building insulation layer typically prescribed for Passive House projects. Lowering the R-value of the opaque envelope to roughly 22 reduced the cooling loads, but not enough. The addition of a passive ventilation system combined with strategic solar shading brought the cooling loads into conformance with Passive House requirements.

The mild climate in southern British Columbia means that civic and commercial buildings can often benefit from controlled passive ventilation—opening windows when conditions are favourable—even on the coldest days. Different combinations of windows were modelled using specialized natural ventilation software, and their impact on thermal comfort and energy reduction was evaluated. “Finding operable triangular windows that were Passive House certified was a challenge,” says HCMA principal Melissa Higgs. The window manufacturer was very collaborative. “We discussed our design needs, and they came up with solutions,” says project architect Aiden Callison.

Two of the areas that benefited greatly from operable windows were the library and the fitness room, which was moved to the centre’s north side to reduce solar gain and minimize potential overheating. Both spaces have windows at occupant level and high-level clerestory windows. The elevation difference between these openings drives air infiltration. On peak days, occupant comfort will still rely on the mechanical cooling system, but the considerably fewer hours that the mechanical system will be required results in significant energy savings.

The simplicity of the building form, which is at heart two stacked boxes, meant that external shading was not only helping to control solar gain but also adding expression to the building. The upper level provides more than 2 meters of overhang for the lower level. Shading for the upper level is supplied by articulated fins that are 0.15 to 0.5 metres deep and are attached to the curtain wall by a thermal break system so as to not reduce the frame’s performance.

With so many people expected to be coming to and going from the facility, figuring out a workable entranceway that wouldn’t result in excessive uncontrolled infiltration was another big challenge for HCMA. Traditional double-door vestibules have been found to be ineffective, because under heavy usage both sets of doors often open simultaneously, causing drafts within the building. Revolving doors are the logical alternative to reduce this problem, but Passive House revolving doors are not yet available in the market. So



Rendering courtesy of HCMA Architecture + Design

the team developed a combination vestibule designed to reduce infiltration. A Passive House-certified door as the exterior entrance provides the thermal performance; it leads into a 3-meter-long vestibule, at the end of which is a revolving door. The large airport-style revolving door will afford easy access for high occupant traffic and can be folded aside in shoulder seasons, when infiltration is not a concern.

In the end, HCMA managed to successfully marry the centre’s architectural and Passive House requirements, creating a lasting tribute to beauty and efficiency. “The Passive

House envelope will continue to educate people, we hope, about its environmental benefits,” says Higgs. “That’s where the magic is.”

#### PASSIVE HOUSE METRICS

<b>Heating demand</b>	0.3 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	2.1 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	125.8 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)

# Wood Innovation Research Lab

PRINCE GEORGE, BRITISH COLUMBIA

The master of engineering in Integrated Wood Design program at the University of Northern British Columbia (UNBC) equips design and construction professionals with knowledge of wood use, building science, and sustainable-design principles. As the program grew, the need for increased laboratory space became apparent. First conceived of in spring 2016, UNBC's new Wood Innovation Research Lab (WIRL) opened its doors in April 2018 and received Passive House certification in July 2018.

The WIRL is a 10-metre-tall single-storey mixed-use building with a large two-bay lab space, a separate classroom, and office spaces. It is being used for research and testing related to wood construction and Passive House. The lab is equipped with a concrete strong wall and floor, complete with hold-downs for three-dimensional testing of wooden structures. An overhead crane runs

## TEAM

**Architect, Engineer  
and Passive House  
Consultant**  
[STANTEC](#)

**Specialty Engineer**  
[ASPECT](#)

**Builder and Team Leader**  
[IDL Projects](#)

**Passive House Certifier  
and Consultant**  
[Herz & Lang](#)

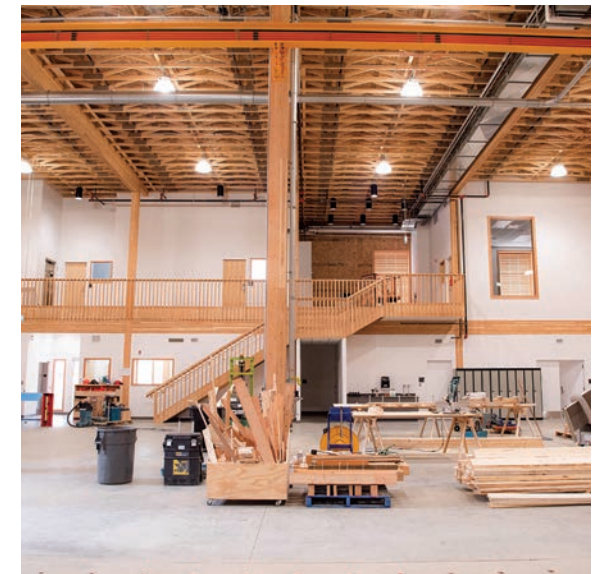
**Client**  
[UNBC](#)

the length of one bay for the manoeuvring of large specimens. The shop also includes three universal testing machines, a CNC cutting machine, and a 34-m<sup>2</sup> wood-conditioning room that is equipped with ventilation and humidification to create an ideal environment for normalizing wood specimens to a consistent moisture content.

Meeting the Passive House standard was particularly challenging, for three reasons. First, temperatures in Prince George swing from 30°C to -30°C during the year, with 234 heating or cooling days per year. Second, because of the need for a very tall lab space, the building envelope area is rather large compared to the small thermally treated floor area. Third, the building's program requirements created complex challenges. A large bay door was needed to afford access for semi trucks. The cutting machinery throws off significant dust volumes, which require a large dust extraction system, posing significant airtightness challenges. And the hydraulic pumps for the structural testing equipment generate massive interior heat gains.

The superstructure is composed of mass timber glulam columns and beams on a 6-metre grid. The building envelope was framed using dimensional-lumber trusses that were prefabricated into one-side-open 10-metre-tall wall panels. These were over 500 mm thick to meet the thermal performance requirements; framing them with upright trusses accommodated this thickness in a cost-efficient way.

Photos by Bree-Ann Orser



The shipped panels consisted of OSB on the inside, followed by a smart air- and vapour-barrier membrane for airtightness and vapour diffusion control, and then the truss structure. Once the panels were craned into place, the builder sealed the seams of the airtight layer by reaching through the wall to the membrane. Then the panels were closed from the bottom up with another layer of OSB on the outside and filled with blown-in mineral fibre.

Exterior to this OSB was a layer of building wrap, then strapping to form a rain screen gap, and the mostly painted metal siding. The interior layer of OSB was left exposed as the finishing for the lab portion of the building.

Most of the windows are located on the south-facing wall, and their sizing was optimized to allow for sufficient daylight while limiting overall frame length. Heat losses through the roof were managed by applying an average thickness of approximately 610 mm of sloping EPS insulation.

A layer of 215 mm of EPS was applied continuously under much of the foundation. However, a portion of the 30-metre by 30-metre concrete raft slab foundation is a strong floor: a high-capacity 1-metre-thick section of reinforced concrete that will be used for structural testing. Reducing thermal losses through this section required a special-ordered high-strength EPS.

As for airtightness, careful design and meticulous implementation during construction resulted in an impressive achievement: 0.07 ACH<sub>50</sub>. “The compactness of the building and the simplicity of the envelope worked in our favour,” says Guido Wimmers, chair and associate professor of UNBC’s Integrated Wood Design Department. “But there were also significant pitfalls.”

An overhead shop door was a lab requirement that presented a logistical challenge, as these doors aren’t typically airtight. The solution was a German-manufactured door that fully seals, thanks to rubber gaskets pressed airtight between each panel and the surface where the door meets the floor, and to an ultrahigh-molecular-weight polyethylene profile and track that reduces friction when the door is being opened or closed.

Wood dust is unavoidable when working with wood, but it can represent a significant health risk, as the particles can be small enough to irritate the respiratory system. Removing dust involves moving large volumes of air, leading to heat losses. To reduce these, a dust-extraction system with a recirculating function was installed. The air is transported out of the building, and the dust is removed through a large cyclone filter. Then the air comes back into the building, passes through very large 1-micron pocket filters, and is eventually distributed back into the laboratory. The system can be operated in bypass mode, in which case the exhaust air is not recirculated. This mode is only used when cedar or hardwoods are processed. As the volume of extracted air is very large, a door must be opened to allow for enough airflow. Consequently the lab users agreed to process these woods only during the summer months.

For continuous ventilation the WIRL relies on an HRV with a heat recovery efficiency of 80%. The building’s small heating requirement of only 9.8 W/m<sup>2</sup> is met using a 35-kW gas-powered furnace—roughly the same capacity as a furnace serving a code-compliant single-family house. The heat is distributed using in-floor radiant heating with a low-flow temperature of approximately 22°C.



Photo by Bree-Ann Orser

A comparative life cycle assessment was conducted to estimate the impact of the materials’ embodied energy versus operational energy on the overall building emissions over its lifetime. Generally, operational energy impacts far outweigh the embodied energy of the materials used in the building. However, in Passive House buildings that ratio can shift as operational energy is minimized. “We were surprised to find that the ratio of operational to embodied energy over the lifetime of the WIRL would be roughly 60-40,” says Wimmers. These results emphasize the importance of first reducing the operational energy of a building. Once high-performance standards have been achieved, the selection of materials for the superstructure and the building envelope becomes increasingly important.

After the first 12 months of occupancy, the building’s actual energy use is very close to what the PHPP modelling predicted, according to Wimmers.

“Accounting for the differences between the actual weather and the PHPP climate data and the fact that not all the equipment was installed, the error is definitely less than 10%,” he says. “The WIRL is another proof of the high level of accuracy you can achieve with PHPP.”

#### PASSIVE HOUSE METRICS

<b>Heating demand</b>	12 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy (OR PER)</b>	116 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.1 ACH <sub>50</sub>



# Valleyview Town Hall

## VALLEYVIEW, ALBERTA

Completed in the summer of 2018, Alberta's Valleyview Town Hall is the result of extensive collaboration among the municipality, the contractor, and a skilled team of designers and consultants, including Scott Builders and Flechas Architecture. These parties worked together to achieve Passive House Plus certification for a commercial building in a northern climate—a first in many respects.

The town of Valleyview experiences long, cold winters and short, mild summers, with temperatures ranging from  $-20^{\circ}\text{C}$  to  $22^{\circ}\text{C}$ . When the original town hall was approaching the end of its life, running it became too expensive in these harsh environmental conditions. After considering all options, the town council decided to build a new structure that would bring down operation and maintenance costs and reduce greenhouse gas (GHG) emissions.

Marty Paradine, Valleyview's town manager during the procurement process, had participated in the development of the city of Fort St. John's Passive House, an award-winning demonstration project in northern British Columbia. Learning from that experience, the council opted to have the new town hall meet the Passive House standard.

The Valleyview Town Hall design emphasizes flexibility, functionality, accessibility, comfort, and sustainability. The main entrance offers a welcoming

### TEAM

**Architect**  
[Flechas Architecture](#)

**Builder**  
[Scott Builders](#)

**Passive House Consultant**  
[Marken Design + Consulting](#)

**Mechanical and  
Electrical Engineer**  
[Integral Group](#)

**Structural Engineer**  
[Laviolette Engineering](#)

presence, framed by a human-scaled canopy with a raised roofline. The main exterior finish of the building is high-pressure compact laminate siding on the visible south and east elevations and prefinished metal siding on the north elevation.

With the main entrance located on the west side of the lot, the rectangular massing extends eastward and exposes the long side of the building to the south, where all high-traffic working areas are located, maximizing the benefits of natural light in the workplace and providing views of the green area south of the building.

This orientation and simple layout optimize sun exposure in the winter but can create challenges in the warmest days of summer. Having specified Passive House-certified windows with a G-value of 0.57 to control heat loss, the design team—which also included Kobayashi + Zedda Architects Ltd., ReNu Building Science, and Williams Engineering—specified Passive House-certified windows and 91.4-cm fixed solar shades to control summertime heat gains.

The structure is encased in a 235-mm full-perimeter blanket of insulation and 140 mm of insulation within the cavity walls for a total R-value of 58. The ventilation system includes a mix of outdoor variable refrigerant flow systems for cooling and heating and a high-efficiency ERV.

This high-performance structure and high-efficiency mechanical equipment allowed for 28 kW of solar panels to meet the building's total energy needs. The system is expected to generate almost 27,000 kWh per year, maximizing operational savings and reducing GHG emissions by 17 tonnes per year.

### PASSIVE HOUSE METRICS

<b>Heating demand</b>	12.9 kWh/m <sup>2</sup>
<b>Cooling and dehumidification demand</b>	0.1 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	46.8 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.42 ACH <sub>50</sub>

*Photos courtesy of Flechas Architecture*



# McGill University's School of Environment

## MONTREAL, QUEBEC

The 134-year-old, four-storey, historic masonry building currently housing McGill University's School of Environment was long due for a renovation. Setting an ambitious goal, the university is targeting EnerPHit<sup>+</sup> certification, with completion slated for the fall of 2020. Once renovated, the building will include a student lounge area and conference rooms, as well as closed and open office spaces. The street-facing façade will maintain its appearance and heritage character, while the south-facing façade will benefit from an abundance of glazing to help achieve the targeted heating demand and improve day lighting.

The constraints of working with a historic structural-masonry building in a cold climate forced the project team to develop details to superinsulate the building envelope from the interior without risking its structural integrity. The design strategy relies on the integration of architectural details and systems to draw humidity out of the wall assemblies. The approach was based on

hygrothermal modelling of capillary active materials, dynamic vapour retarders, and the use of hygroscopic versus anhygroscopic insulation materials.

In order to validate modelled results, continuous monitoring of the hygrothermal performance of the envelope assemblies will be carried out for several years after construction ends. The results are intended to serve to refine and adapt construction materials, insulation strategies, and hygrothermal-modelling software to the limitations posed by historic masonry retrofits in cold climates.

Another innovative approach being used in this project is greatly reducing, and potentially

### TEAM

#### Architect

[Figurr](#)

#### MEP Engineer

[Charland Dubé](#)  
[Robillard](#)  
[Experts-Conseils](#)

#### Passive House Consultant

[Philippe St-Jean](#)



Photo courtesy of McGill University; rendering courtesy of Figurr

eliminating, the need to bring fresh air in from the outdoors—while maintaining excellent indoor air quality. This energy-saving strategy involves continuously drawing the building's stale indoor air through the root zone of a specially designed green-wall system, allowing the micro biome present in the soil to remediate contaminants and restore air quality. Real-time air-quality analysis will modulate the inclusion of outdoor fresh air to the building's ventilation system as needed, depending on the efficiency of the phytoremediation process.

In alignment with the academic and research mission of the university, the project is intended to contribute to the transition to ultra-energy-efficient building practices, both on and off campus, through the documentation and dissemination of the project's design approach and performance results.

### PASSIVE HOUSE METRICS

Heating demand	29.7 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	15.0 kWh/m <sup>2</sup> a
Primary energy demand	TBD
Air leakage	0.6 ACH <sub>50</sub> (design)



## University of Toronto Scarborough Campus

### SCARBOROUGH, ONTARIO

The University of Toronto Scarborough (UTSC) recognizes the Passive House standard as the future of sustainable architectural design and is aiming to enhance student experience by collaborating with innovative architectural practices in providing state-of-the-art and environmentally friendly facilities. Kearns Mancini Architects (KMAI) was tasked with designing a large student residence in Scarborough that would fully comply with the Passive House standard. The proposed accommodation facility comprises approximately 26,000 square metres and will house a transient population of roughly 1,000 people at any given time. Key facilities include a full commercial kitchen, a large dining facility, and 750 separate student residences, with individual micro refrigerators and computers, as well as 340 washrooms. Ground level will house a proposed retail space, a large food court, and a loading dock.

#### TEAM

##### Architect

[Kearns Mancini Architects](#)

##### Mechanical and Electrical

[Integral Group](#)

##### Structural Engineer

[Read Jones Christoffersen Ltd.](#)

Few Passive House examples compare with this project in scale, energy demand, and climate variation. This made it imperative for UTSC to be able to test the building using an appropriate procurement strategy, so that it could evaluate the building's performance while ensuring that its requirements for a student residence were met. Thus even before construction the project has become a pedagogical model of a high-performance building in the design and construction industry as well as among local government, investors, contractors, and professional building consultants.

Unlike smaller buildings, the facility does not principally rely on solar gain for its heating. Instead, all internal thermal gains—generated within the building by people and equipment—are utilized. Unusually for KMAI, the primary concern was to arrange and orient the spaces to provide sufficient cooling. The building envelope is designed to achieve an R-41 (effective) insulation value, and the utmost care has been taken to ensure that the building is airtight and free of thermal bridging to prevent unwanted heat transfer. Triple-glazed windows with integrated shading devices will limit the heat load, while an ERV system will maintain the air temperature and quality.

#### PRODUCTS

##### Ventilation

[Swegon](#)

[Swegon](#)

#### PASSIVE HOUSE METRICS

<b>Heating demand</b>	9.1 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	5.7 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	71.3 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)

*Renderings courtesy of KMAI and DoHere*



# University of Victoria

## Student Housing and Dining

### VICTORIA, BRITISH COLUMBIA

Designed by the architectural firm Perkins+Will, the University of Victoria's two new student housing buildings will feature accommodations for 783 graduate and undergraduate students, dining services, conference facilities, and classrooms. The area surrounding the buildings will be reenvisioned as a welcoming outdoor space linking to the campus's main pedestrian thoroughfares. A significant program goal for the project is fostering respect and reconciliation with Indigenous communities.

The buildings will be designed and constructed to meet both LEED Gold and Passive House standards—a first for the campus. And in an ambitious goal for any project, the dining hall will be served by a vast Passive House commercial kitchen—among the largest slated to be certified by the PHI.

Perkins+Will's Alex Minard outlined the numerous Passive House challenges: the very large commercial kitchen, stringent seismic design requirements, high ventilation rates, and high plug loads associated with student housing, among others.

Almost every aspect of the project is requiring careful research, with the commercial kitchen posing by far the biggest challenge, according to Minard. The dining hall will have seating for 700 and serve an expected 2,900 meals per

### TEAM

**Designer**  
[Perkins+Will](#)

**Passive House Consultant**  
[RDH Building Science](#)

**Mechanical Engineer**  
[Integral Group](#)

**Foodservice Consultant**  
[Kaizen Foodservice Planning and Design](#)

**Passive House Building Certifier**  
Passive House Institute

meal period. After considering the primary energy impacts of conventional gas-fired appliances, the university is committed to making the kitchen as electric as possible, relying mostly on induction cooktops; exceptions are a Mongolian grill, a broiler, and one type of fryer.

The ventilation and energy demands of the kitchen will be significant. Perkins+Will is working with various consultants on such ideas as recapturing heat from the refrigeration systems to warm the makeup air required for the exhaust equipment. Clustering the cooking devices and surrounding them on three sides by walls, rather than giving 360° access to the grills, will help dampen ventilation airflow requirements.

The project's overall efficiency derives significant benefit from the scale and compact forms of the buildings, although the program areas requiring ground floor access—including food delivery and waste removal—yields disproportionately large footprints. As an added energy hit, the public spaces feature large expanses of triple-glazed, thermally broken curtain walls for a high degree of transparency and continuity of spatial experience.

The buildings' structures will consist of mass timber and concrete columns on concrete footings, some of which are fused together for seismic reasons. To mitigate these thermal bridges, the slab-on-grade will be insulated with 25 to 30 cm of high-density foam, for a total R-value of 50 to 60. The R-value for the roof assembly is targeted to be 78, to offset the heat losses through the glazing.

Minard notes that the project's complexity has given rise to a substantial team effort: "It's challenging, and there are still tough decisions to be made. The university is fully onboard, and everyone is doing their part to get to Passive House."

*Renderings courtesy of Perkins+Will*

### PASSIVE HOUSE METRICS

#### Building 1

Heating demand	15.0 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	2.6 kWh/m <sup>2</sup> a

#### Building 2

Heating demand	14.2 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	2.1 kWh/m <sup>2</sup> a

#### Buildings 1 & 2

Primary energy renewable (PER)	TBD
Air leakage	0.6 ACH <sub>50</sub> (design)







## Gastown Child Care

### VANCOUVER, BRITISH COLUMBIA

Acton Ostry Architects has a reputation in Vancouver for solving challenging problems. This particular project required building a pair of 400-m<sup>2</sup> Passive House walkway-connected child care facilities on top of a pair of parkades separated by an alley. Complicating the matter was the location—the historic Gastown district in downtown Vancouver, a tourist mecca. The modern design, which was created in discussion with the neighbourhood, draws inspiration from the existing parkades and the sawtooth nature of the Gastown street façades.

The unusual location and purpose were born out of the city council's realization that the top floors of parkades are typically underutilized. By encouraging Passive House construction in those locations, the council could increase the use of underutilized real estate and meet the city's green objectives.

#### TEAM

**Architect**  
[Acton Ostry Architects](#)

**Structural Engineer**  
[Fast+Epp](#)

**Mechanical and  
Electrical Engineer**  
[Integral Group](#)

**Sustainability and  
Energy Modeling**  
[Stantec](#)

**Building Envelope**  
[RDH Building Science](#)

Acton Ostry's solution was to create a separate steel plinth raised above the top-floor parking platform. This gave it a level platform for building and for outdoor play spaces, nullifying the sloped parkade surfaces. It also allowed Acton to take advantage of the existing parkade drainage. To minimize the visual impact, the facilities are set back from the street behind the existing rooftop plinths. The primary orientation is to the north toward the best views. This necessitated taking advantage of internal heat gains, not solar gains, to satisfy the Passive House heating demands, using the established precedent of "kiddiewatts, not kilowatts." (This phrase originated with Nick Grant of Elemental Solutions in the United Kingdom. He first coined the term following a study of internal heat gains in a series of school projects.)

Although this is the firm's first certified Passive House project, it has designed many child care facilities, and has staff expertise in both Passive House and panelized construction. The construction atop the plinth consists of prefabricated wood panels. This provides quality control over the air sealing, shortens the construction schedule, and lets the builder lift panels from the street to the top floors via a crane located in the alley, minimizing disruption to Gastown traffic. Overall, strong support from the city of Vancouver from the start of the project has made achieving Passive House certification easier than it might have been otherwise.

Ordinarily, co-location of children and automobile exhausts is a problem. However, the facility's heights provide good natural ventilation for the outdoor play areas. The buildings' ERVs include additional carbon filters for improved air quality, especially during the fire season. Once completed, the Gastown child care facilities will significantly improve the use of the real estate and provide much-needed community services, and the children will have a great view and even better air quality and comfort.

#### PASSIVE HOUSE METRICS

<b>Heating demand</b>	14 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	6 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	64 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)

*Renderings courtesy of Acton Ostry Architects Inc.*



# UBC Okanagan Skeena House

KELOWNA, BRITISH COLUMBIA

Aiming to be a pioneering Passive House-certified student residence, the six-storey Skeena House will provide 220 bedrooms and amenity space to UBC Okanagan students. Completing an ensemble of residence buildings encircling the Commons Field, the project focuses on student life and support services while synching up with the existing campus. The first floor of Skeena House contains communal lounges, activity rooms, and a laundry that encourage happenstance gathering and passive surveillance. To maintain safety and privacy, the upper five floors contain the residence apartments, semiprivate living, and study areas. The design maximizes efficiency through a repeating floor plan of a shared bathroom flanked by two bedrooms.

## PASSIVE HOUSE METRICS

Heating demand	9.4 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	2.4 kWh/m <sup>2</sup> a
Primary energy demand	70.0 kWh/m <sup>2</sup> a
Air leakage	0.6 ACH <sub>50</sub> (design)



Renderings courtesy of Public Design

## TEAM

**Architect**  
[PUBLIC Architecture + Communication](#)

**Certified Passive House Consultant**  
[RDH Building Science](#)

**Builder**  
[Sawchuk Developments](#)

**Mechanical Engineer**  
[AME Consulting Group](#)

**Electrical Engineer**  
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# Cornerstone Architecture

## **CORNERSTONE ARCHITECTURE**

has embraced the Passive House standard as a strategy for increasing occupant comfort and health and reducing energy demand in buildings—a strategy that is predictable, and largely independent of occupant behaviour or complex mechanical systems to deliver performance. The firm encourages all of its clients to consider adopting this approach and currently has more than 16 new projects targeting the standard. These include townhouses, apartments, and mixed-use buildings for both ownership and rental tenure.

Scott Kennedy, principal of Cornerstone Architecture, credits the firm's success in convincing clients to pursue this approach to the following factors:

- The successful delivery of The Heights, for which we must thank Eighth Avenue Developments and Peak Construction for having the courage to reach beyond the minimum building requirements to achieve a high-performance building.
- The city of Vancouver, for its pursuit of regulatory reform using a stick-and-carrot approach. The 5% density bonus for pre-zoned projects has given us an effective tool to start a conversation with our clients.
- The Provincial Government of British Columbia, for the introduction of the Step Code, which introduced the concept of a graduated pursuit of low-energy-consumption buildings.
- British Columbia Institute of Technology, for creating its High Performance Building Lab, where contractors can learn about the science, techniques, and products involved in creating high-performance envelopes.
- Passive House Canada, for promoting awareness and training across the country.
- The Passive House Institute, for its foresight and science that led to the development of the Passive House standard.
- The enthusiasm and willingness of the local community engaged in delivering projects and supplying products to share their expertise.



Meeting the standard has its challenges, in particular balancing winter solar gains and summer cooling, and meeting the stringent primary energy renewable (PER) target. Finding doors and roof access skylights that meet air-sealing, thermal-performance, fire performance, and accessibility standards has been particularly challenging. Solutions, such as double-door and vestibule strategies, can be costly—particularly when viewed as individual measures, but less so in the overall budget.

Early consideration of the effects of form factor, orientation, thick walls, continuous air barriers, thermal bridging, shading systems, ventilation systems, and hot water delivery has been essential to the successful completion of Cornerstone's projects. Worth noting, however, is that the firm has pushed the form factor limits in some of its projects to achieve other design objectives to a degree that is feasible in Vancouver but probably not in harsher climates.

Cornerstone is actively engaged in monitoring the performance of its early buildings to learn what works and what is challenging so it can offer tested, simplified systems and details to its clients in the future. The firm has trained an in-house energy modeller to assist with decisions that will affect the ability to meet the standard earlier in the design process and is actively engaging and challenging its consulting partners to design efficient thermal-bridge details and HVAC and domestic hot water systems that meet the challenge of a Passive House building.

In addition to the projects featured elsewhere in this book, the firm is working on a number of other mixed-use and residential multifamily Passive House projects in Vancouver, District of North Vancouver, New Westminster, Pemberton, and across the Lower Mainland, totaling almost 600 units. Passive House is now Cornerstone Architecture's default performance target for all new projects.

*Renderings: (left) 3729 Rupert Street, Vancouver; (below) 811-819 12th Street, New Westminster; Courtesy of Cornerstone Architecture*





# The Heights

VANCOUVER, BRITISH COLUMBIA

## TEAM

Architect  
[Cornerstone Architecture](#)

When Scott Kennedy, principal of Cornerstone Architecture, was persuading the developer of The Heights, a mixed-use six-storey building, to build it to meet the Passive House standard, Passive House buildings were a rarity in Vancouver. He was convincing—or maybe it was the numbers.

The city of Vancouver gives incentives for rental housing, which this 85-unit building is, allowing developers to build six storeys rather than four. Taking advantage of this incentive, though, requires that the project meet more-stringent energy standards, which usually entails installing a more-expensive heating system than the typical electric baseboard. Kennedy calculated that a gas-fired heating-and-distribution system would end up costing \$450,000. Add in maintenance and fuel costs over 40 years, and you get closer to \$600,000. Upgrading The Heights to the Passive House standard, reducing the heating load, would mean getting to use electric baseboard with a capital cost of \$25,000. Yes, other Passive House upgrades would add costs, but there would be savings overall.

In designing the Passive House details for this building, Kennedy strove for simplicity. The building is wood frame, with a 2 x 6 wall on the exterior and a 2 x 4 service cavity on the interior. Both are insulated with fibreglass batts. An interior taped, 5-cm EPS layer serves as the air barrier, and the whole wall assembly delivers an R-value of 35.

To keep the air barrier continuous, the ends of the floor joists are wrapped with an air barrier membrane that is taped to the EPS. The bricks, stair, and handrails hang off of the exterior wall without interrupting the thermal and air barrier.

The roof also was fairly conventionally constructed, just with batts in the 2 x 10 joist cavity and a little more insulation overall. Tongue-in-groove plywood decking sits atop that cavity, covered by a peel-and-stick membrane that serves as both the air and vapour barrier. Over that is a layer of EPS, sloped for drainage, with 15 cm of polyiso on top and a 2-ply membrane, adding up to a total R-value of 56 for this assembly.

On the lowest floor of the building, reserved for parking, an unusual detail was required to minimize the thermal bridging from the concrete columns supporting the structure. The main floor slab connected to the columns is also concrete. It is insulated on top with 15 cm of EPS that has wood battens built into it and anchored into the concrete slab below it. A plywood subfloor rests on the EPS.

With the extra insulation and attention to airtightness, the heating-energy demand is being easily met with the low-cost electric baseboard. Summer comfort is achieved with the HRV's bypass mode, which brings in cool air at night. Domestic hot water is being supplied by a gas-fired boiler.

## PASSIVE HOUSE METRICS

Heating demand	8 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	0 kWh/m <sup>2</sup> a
Primary energy	119 kWh/m <sup>2</sup> a
Air leakage	0.3 ACH <sub>50</sub>

Photo by Gordan Dumka

# Little Mountain Cohousing

VANCOUVER, BRITISH COLUMBIA

Little Mountain Cohousing, a Passive House project that started construction in early 2019, will include 25 residential units plus a range of common house facilities. The building's opening date is set for early 2021.

The six-storey building's massing was designed to conform to tight rezoning requirements while creating units that responded to the needs of the individual cohousing group members. Common spaces—kitchen and dining, children's playroom, laundry, a central courtyard, and more—were a primary concern. Cornerstone Architecture structured the main common spaces so that they open onto a southwest-facing court at the corner of the lot, which is also overlooked by the common circulation at each building level. Topping the building is a common accessible green-roof area with roof decks and urban farming beds.

## TEAM

**Architect & Passive House Designer**

[Cornerstone Architecture](#)

**Passive House Certifier**

[RDH Building Science](#)

**Structural Engineer**

London Mah & Associates Ltd.

**Mechanical Consultant**

[Dialog](#)

**Electrical Consultant**

[Nemetz \(S/A\) & Associates Ltd.](#)



Renderings courtesy of Cornerstone Architecture



The superstructure is mainly wood-frame construction with a double exterior wall to achieve high insulation and airtightness. The concrete ground floor over the parkade is sandwiched between layers of insulation to minimize thermal bridging around the perimeter and thermal bridging caused by structural members. Roof insulation is installed both in the joist cavity and continuously above the structure. The project incorporates high-performance windows with glazing characteristics varied by orientation and surrounding shading objects to minimize summer heat gain.

Convective heat loss through plumbing stacks is substantially reduced by using exterior air-admittance valves with positive air pressure attenuators. For ventilation, high-efficiency HRVs are located in each residential unit and in common areas. CO<sub>2</sub>-based heat pumps provide the primary source of hot water, and electric baseboard heaters provide additional heat should it be required in the mild Vancouver climate. The project is designed without a gas service connection and will be virtually greenhouse-gas-free in operation.

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	14.9 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	60 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)

# TarsemHaus Townhouses

## SQUAMISH, BRITISH COLUMBIA

TarsemHaus, an eight-unit townhouse development, makes a striking ecological statement from its Passive House goals to its clustered design that enhances social connection and small-community character. Squamish, a former logging town in coastal British Columbia, has seen rapid growth in the last few years due to its proximity to Vancouver and countless outdoor activities on its doorstep. As the first proposed certified Passive House development in the area, TarsemHaus provides a promising precedent of quality design, while achieving calculated high levels of energy efficiency.

The 1,570-m<sup>2</sup> trapezoid-shaped lot was extensively studied to create a unique layout and maximize usability, according to Derek Venter, principal of Derek Venter Architectural Design, Incorporated. The result was eight spacious townhouses averaging 150 square metres that form a horseshoe around a prominent landscaped central courtyard. The courtyard is easily accessed from each unit, promoting safe

### TEAM

#### Developer

Tyler Ovington  
[LTO Developments, Inc.](#)

#### Architect and Passive House Consultants

[Derek Venter Architectural  
Design Inc.](#)

and inviting spaces for children to play and neighbours to interact, while a central stair invites the public into the courtyard. The development provides ample outdoor space for residents; in addition to the courtyard, each townhouse has a private rooftop deck, capturing the remarkable views of the surrounding mountains.

As the Passive House certification goal for this project was a first for Squamish, the project was confronted by all the related firsts associated with a development of this nature. While the municipality and community have supported the project, the learning curve for many involved parties has been a challenge. The unwavering determination of the developer, LTO Developments, Incorporated, to ensure that Passive House standards would be met was largely what made this project possible. The high level of liveability, neighbourhood amenity, and architectural expression—along with the pursuit of the Passive House standard—helped the developer to sell most of the units before they were completed and led to the project winning the Design of the Year for 2018 award in the Residential category by the District of Squamish Advisory Design Panel.

The project's complexity was compounded by the fact that the lot is situated in a floodplain, making it necessary for the living spaces to be elevated. For this reason the ground floor contains only the garages and additional storage space. The thermal envelope of the building begins at the second storey, with most of the mechanical equipment located within the units. To maximize the floor area within the units, the sprinkler system and some electrical equipment are situated

*Rendering courtesy of Derek Venter Architectural Design Inc.*





Rendering courtesy of Derek Venter Architectural Design Inc. (above);  
Photo courtesy of LTO Developments, Inc. (opposite page)

in a ground-level mechanical room that utilizes a watertight submarine door to eliminate any potential damage caused by flooding.

Set over the unconditioned garages at the second storey sits a 46-cm TJI floor filled with dense-packed glass wool insulation for a total R-value of 73. The plumbing and all other services are run through this assembly, eliminating freezing concerns. An air barrier membrane wraps from the bottom of this assembly up to the walls to form a continuous airtight layer.

The exterior wall assembly achieves an R-value of 68 with 2 x 6 framing and a 30-cm TJI installed vertically on the exterior, both filled with glass wool insulation. The insulation on the interior side of the air barrier was specifically chosen for its greater health benefits to the occupants. An air barrier membrane covers the TJIs and is encased by two layers of 1 x 4 treated strapping set at opposing 45° angles to form a rain screen gap. This allows both vertical and horizontal ventilation and accommodates siding materials set at different orientations. Fibre cement panels, corrugated and standing-seam aluminum, and cedar panelling make up the external layer montage, visually differentiating and clearly identifying each unit from the streetscape.

The total roof assembly consists of insulated 41-cm TJIs together with a 2 x 8 overframing layer insulated with an additional 14 cm of mineral wool above the TJI layer. The 2 x 8 layer supports a two-layer torch-on membrane, creating a durable roof assembly with an impressive R-value of 84.

The outstanding R-values reached in the external assemblies allow the mechanical equipment to be as simple as possible. The project boasts the latest generation in ERVs to efficiently ventilate the spacious homes, each of which contains three bathrooms. Heating within each townhome is provided through in-line duct heaters connected to the ERV units, and in-floor electric heating provides additional comfort in bathrooms. The building is cooled in summer through passive cross-ventilation strategies implemented by the residents, which are explained in a detailed user manual supplied with each home. In keeping with the sustainable ethos of the project, all the homes feature electrically powered appliances and equipment, including induction cooktops, ventless condensing dryers, and LED lighting.

The architectural and development team state that their ambition for TarsemHaus is first and foremost that it be a home for families to make memories in and build lasting relationships with their neighbours in a healthy and sustainable environment—and that this experience instills a culture of environmental consciousness in all.

## PRODUCTS

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## PASSIVE HOUSE METRICS

<b>Heating demand</b>	12.4 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup>
<b>Primary energy renewable (PER)</b>	59.6 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)







## Aging-in-Place Triplex

### NAKUSP, BRITISH COLUMBIA

The Bell Passive House in Nakusp is a residential triplex town home, designed to facilitate aging in place. Each unit is 112 square metres on two floors. The self-contained main floor has one bedroom with ensuite bathroom, a powder room, a laundry, and a combined kitchen/living/dining/office space. The smaller upstairs includes a sitting room and a bedroom with ensuite bathroom, as well as the mechanical room.

The modern, wood-clad project, completed in 2017, is situated on the waterfront. The suites are rotated and offset from each other to provide privacy at the front deck and entrance. The south-facing corner of each unit is rounded, with an inset window, providing excellent views toward the river. The garages are detached from the suites but placed to create a weather-protected exterior area that leads to the entrances.

#### TEAM

##### Architect

[Cover Architectural Collaborative Inc.](#)

##### Construction Management

[Madden Timber Construction Inc.](#)

##### Passive House Consultant

[Harrmann Consulting](#)

##### Mechanical Consultant

[Rocky Point Engineering Ltd.](#)

##### Structural Consultant

[SMP - Services Corp.](#)

To meet insulation requirements for Passive House certification in this cold climate, the exterior walls are a triple-framed stud assembly. The outside framing layer is 2 x 6 studs covered with ½-inch plywood sheathing, with taped seams to create the building's air barrier. Inside that assembly there are dual 2 x 4 stud walls separated by ¾-inch plywood covered with a vapour barrier. The roof assembly is 69-cm box trusses. Most framed cavities are filled with cellulose insulation. The rim joists and floor framing are covered with spray foam at the exterior. The foundation is a radon-protected, insulated crawl space with approximately 1 metre headroom. This combination of assemblies eliminated any significant thermal bridges.

Although this project is not as complex as Cover's Subaru dealership, it did have a few challenges. Multifamily housing requires one-hour fire-rated walls separating attached units. The interunit wall has dual 2 x 4 studs with staggered spacing so they are separated by 0.18 metres and then covered with one-hour-rated drywall. According to Armstrong, the biggest challenge was maintaining the continuity of the air barrier at the fire walls. Although this was the builder's first Passive House project, Cover's on-site presence and the builder's attention to detail minimized the headaches.

This attractive project, with great siting, solar-ready roofs, and Passive House performance, demonstrates that it is possible to age gracefully and in great comfort, while making choices that are good for the planet.

#### PASSIVE HOUSE METRICS

<b>Heating demand</b>	12 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	58 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.3 ACH <sub>50</sub>

*Photos courtesy of Cover Architectural Collaborative*



# Radiance Cohousing

## SASKATOON, SASKATCHEWAN

Radiance Cohousing is a nine-unit cohousing complex made up of two buildings—one with four and one with five units—that face onto a common courtyard and garden. The project was initiated in 2012 by a small group of people who pooled their resources, formed a development company, and worked together to plan and manage the development of their own homes. Construction was completed in the fall of 2018.

The cohousing group worked closely with BLDG Studio to develop the overall plan and then customize the individual units, which range in size from 72 to 112 square metres. “There are a few standard footprints, but everyone could shape the interior walls to suit their needs,” says engineer and Passive House Consultant Michael Nemeth of Bright Buildings, who lives with his partner, Shannon, in one of the units. One unit was designed as a common gathering space for meetings, birthday parties, and the like.

Cohousing attracts people who want a housing model that embraces community, and often sustainability as well. Says Nemeth, “For us that sustainability goal was Passive House.”

### TEAM

**Architecture**  
[BLDG Studio](#)

**Passive House Consultant and Mechanical Design**  
[Bright Buildings](#)

**General Contractor**  
[Renew Development Cooperative](#)

**Financing**  
[New Community Credit Union](#)

**Developer**  
[Radiance Cohousing Development Company](#)



Photos by Michael Nemeth (above) and Shannon Dyck (left)

As the climate is quite chilly in Saskatoon, regularly veering down to  $-30^{\circ}\text{C}$ , the wall assemblies were heavily insulated, attaining an overall R-value of 60. The complex was part of a Canada-wide pilot for the use of wood fibre insulation—28 cm of it in this project—exterior to 2 x 6 walls insulated with mineral wool batts. This wall assembly had the merit of simplicity, with long stainless steel screws affixing a 2 x 4 rain screen to the wood fibreboard. The final layer, fibre cement siding, was chosen for its durability.

Passive House-certified windows, the larger ones placed strategically on the south façades in both buildings, completed these assemblies. Nemeth noticed and deeply appreciated the significant solar gain the windows admitted throughout the winter.

The roof assembly achieves an R-100 with blown-in cellulose. The foundation has 30 cm of EPS under a slab-on-grade.

Each unit is serviced by its own ERV for constant fresh air. A centralized air source heat pump system offers heating and cooling for all the units.

Radiance Cohousing incorporates a variety of other environmental features, including rainwater harvesting, a 38-kW PV array owned by the SES Solar Cooperative, and a shared electric vehicle provided by the Saskatoon Carshare Cooperative.

By combining cohousing with environmental design, this project showcases what's possible in terms of quality homes that build community and respond to a changing climate.

### PASSIVE HOUSE METRICS

<b>Heating demand</b>	15 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	57 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub>





# Spire Landing

VANCOUVER, BRITISH COLUMBIA

When Spire Development Corporation decided to extend its expertise from commercial and industrial to residential development, it leapt directly into Passive House construction on a large scale—95 units of rental housing. With the city of Vancouver incentivizing Passive House, says Vice President Peter Rackow, jumping in early made good sense. “In addition to getting a little more density, we feel that operationally we will be creating savings in value, as we will have a better building and lower utility costs,” Rackow says. “We will also be differentiating ourselves considerably in the market.”

Spire Landing provides 71 one-bedroom and 24 two-bedroom units in a six-level structure that steps down the site, which has a grade differential of more than 6 metres. The building sits on a two-level underground concrete parkade that has 76 parking stalls; ample bicycle parking and even a bicycle repair room are also included.

Generous indoor and outdoor amenity facilities are located on the south-facing setbacks of the top two levels, including a usable roof area that will provide unobstructed views. This common space features beds for vegetable gardens, child play areas, BBQs, and plenty of space to simply relax on comfortable outdoor furniture.

## TEAM

**Owner, Developer, and Builder**  
[Spire Development Corporation](#)

**Architect**  
[Cornerstone Architecture](#)

Massing articulation on the façade facing Fraser Street creates townhouse-scale bays, softening the development’s presentation to the street. Wide roof overhangs provide rain and solar protection, while also contributing to the massing articulation. In addition to exterior fixed shading devices on the south-facing façade, the project incorporates high-performance triple-pane windows with glazing characteristics varied by orientation to minimize summer heat gain.

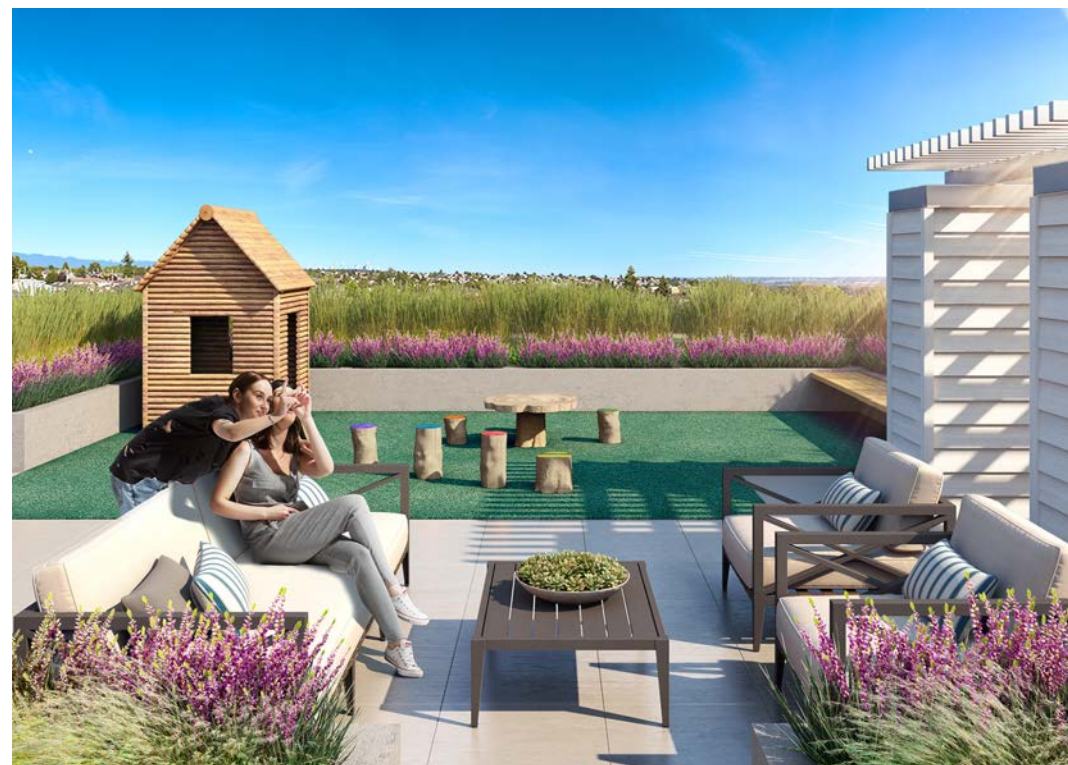
The structure is wood-frame construction. The double-wall assembly includes an added exterior wall to achieve high insulation and airtightness. The floor over the parkade is insulated on the top side to minimize thermal bridging. Roof insulation is installed both in the joist cavity and continuously above the structure.

Unit ventilation is provided by HRVs located along the upper corridors, where maintenance crews can easily access the equipment. Each HRV serves a four- or five-storey stack of units. Electric baseboard units will supply the minimal supplemental heating needed. No cooling demand is anticipated, given the shading and the availability of natural ventilation provided by the operable tilt-and-turn European-style windows.

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	7.4 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	117.7 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)

*Renderings courtesy of Spire Development Corporation*



# Corvette Landing

## ESQUIMALT, BRITISH COLUMBIA

Corvette Landing is a 12-storey mixed-use development designed to transition the low-density township of Esquimalt, which is adjacent to Victoria, to a more urban context. This Passive House project is constructed as a panelized prefabricated mass timber building, combining a low-carbon footprint with expedited construction and resulting in high performing desirable solutions.

Corvette Landing is a permutation of Intelligent City's Platforms-for-Life system, a generative mixed-use urban housing system, with a primary focus on accommodating the evolving desires and needs of individuals, families, and communities while meeting the highest sustainability and livability criteria. The process is systematically driven by digital design, adaptation, and collaboration to produce affordable integrated communities.

*Rendering courtesy of LWPAC/  
Intelligent City*



### TEAM

#### Architect

[LWPAC](#) + [Intelligent City](#)

#### Housing Systems and Mass-Timber Technology

[Intelligent City Inc.](#)

#### Client

[Standing Stone Developments](#)

#### Certified Passive House Consultant

[RDH Building Science](#)

#### Mechanical Engineering

[AME Consulting Group Ltd.](#)

### PASSIVE HOUSE METRICS

Heating demand	13.4 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	0 kWh/m <sup>2</sup> a
Primary energy demand	60 kWh/m <sup>2</sup> a
Air leakage	0.6 ACH <sub>50</sub> (design)



# Monad Rupert

## VANCOUVER, BRITISH COLUMBIA

Monad Rupert is a four-storey affordable housing project with retail at the ground level that is being developed on a single-family lot. This 12-unit project is a permutation of Intelligent City's Platforms-for-Life system, a generative mixed-use urban housing system. The process is driven by digital design, adaptation, and collaboration to produce affordable integrated communities that meet the highest sustainability and livability criteria.

This mass timber Passive House project is designed as a catalyst to activate an area in need of urban renewal. The highly livable courtyard typology has compact units with double-sided aspect to provide ample daylight, cross-ventilation, and operation without any cooling load. Similar to all Platforms-for-Life projects, Monad Rupert is pursuing net-zero energy, carbon-neutral objectives.

*Rendering courtesy of  
LWPAC/Intelligent City*

### TEAM

#### Architect

[LWPAC](#)

#### Housing Systems and Mass-Timber Technology

[Intelligent City Inc.](#)

#### Client

Rejoyce Investment Corp.

#### Mechanical Engineer and Certified Passive House Consultant

[Integral Group](#)

#### Structural Engineer

[Equilibrium](#)

### PASSIVE HOUSE METRICS

Heating demand	14 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	0 kWh/m <sup>2</sup> a
Primary energy demand	60 kWh/m <sup>2</sup> a
Air leakage	0.6 ACH <sub>50</sub> (design)



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# MIZA Architects

**MIZA ARCHITECTS** was cofounded in 2015 by Michael Wartman and David Zeibin. Cultivating a holistic approach to architecture, MIZA brings expertise in high-performance buildings to every project, while also consciously weaving in the social and cultural needs of the clients and the community surrounding the buildings it designs. “For us, high-quality architecture incorporates all aspects from design to materiality to the life the buildings support,” says Zeibin.



MIZA’s diverse portfolio encompasses educational, institutional, and residential projects at all scales—from a community centre renovation to laneway houses. Zeibin had been an early entrant in Passive House design in Canada, having taken Passive House training in 2011. That same year he started work on what would become the first single-family Passive House in Alberta. The experience was a crash course in an incredibly challenging climate.

Since founding MIZA, Zeibin has brought his Passive House expertise to each project he collaborates on. Only recently, though, have clients started asking specifically for Passive House

performance. One such project is a dome-shaped house that is being prefabricated in France and Russia and then shipped to British Columbia for final construction on Salt Spring Island. The client wanted a resilient home that could coast through power outages, and the building inspector required the involvement of a local architect. MIZA was chosen. “We love projects like this that have complex structures and geometry,” says Zeibin.

MIZA is also working on a new 260-m<sup>2</sup> single-family Passive House in Vancouver. The owner is a Vancouver builder who had worked on a few



*Photo courtesy of Domespace International / Bois & Courbes Constructions; Rendering courtesy of MIZA Architects*

Passive Houses for other clients and became impressed enough by these homes’ performance that he also opted for Passive House when it came time to rebuild his own house.

Another project in the works is a design produced by MIZA for a competition hosted by the city of Edmonton to foster infill development. The firm’s 5.2-meter-wide Slimline Ecohouse won first place in the single-family house category and a special citation for best project. Although a developer immediately jumped on the design, financing issues have delayed the project’s construction.

MIZA has tripled in size since its inception, adding two more architects and two intern architects to the staff. One of the recent hires is also a certified Passive House Designer. Zeibin anticipates further growth to accommodate the in-house expertise needed for an even wider range of project types and sizes. Reflecting on the variety of projects the firm has already undertaken, he says, “We resist specialization a little. As a firm, we have broad interests and high ambitions.”

# Cottonwood Passive House

FORT SASKATCHEWAN, ALBERTA

The Cottonwood Passive House sits on a sloping site, enjoying views toward the North Saskatchewan River valley. Designed as a retirement home for an Alberta couple, the house can function on one level, with amenities such as a main-floor laundry and a large elevated deck. Taking up residence in a developer subdivision, the owners and project team hope to demonstrate that exceptional energy efficiency is an achievable goal in a suburban context.

The main floor of the house is roughly organized along a central circulation axis—beginning at the main entry, through a hall into the combined kitchen and living area, and out to a large covered deck. The house's footprint is kept compact to minimize total envelope area and heat loss. Primary living spaces—bedrooms, living rooms, kitchen—are oriented toward the south, with generous glazed openings to capitalize on passive-solar gains.

Targeting the Passive House standard in Edmonton's relatively harsh climate meant surrounding the foundation walls with 30.5 centimetres of EPS insulation. The above-grade 41-cm-thick double-stud walls with an additional 9-cm insulated service cavity interior to the taped OSB air and vapour barrier deliver a total R-value of 73. The R-95 roof has 76 centimetres of loose-fill blown-in cellulose insulation and a carefully taped

## TEAM

**Architect**  
[MIZA Architects](#)

**Passive House Certifier**  
[Peel Passive House Consulting](#)

**Mechanical**  
[ReNü Engineering](#)



Photos courtesy of Yesan Ham

and sealed polyethylene air and vapour membrane. The team designed the structure such that only a single interior column needs to penetrate the basement floor slab, and the roof trusses span full width with no interior supports that otherwise might have interfered with the airtight layer or thermal envelope.

A highly efficient HRV with an electric preheater delivers the fresh air. Space heating is provided by a zoned hydronic baseboard radiator system, with hot water generated by a heat exchange loop from the domestic hot water system, which is driven by a high-efficiency condensing gas boiler. Thermostats with occupant-override controls are located around the house and allow the hydronic system to deliver hot water to the radiators only where needed.

Occupied for three years, the house has delivered superbly on the expected comfort. Occasional overheating during the summer prompted the installation of in-frame user-operable blinds, and now the interior temperatures remain at 25°C even when the exterior temperature rises above 30°C.

On a recent extremely cold winter day, when temperatures outside had dropped to -37°C, the owner noted that it was 20°C inside. He has a strategy for dealing with any slight dip in interior temperatures: Baking a batch of cookies always warms the house right up.

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	15 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	120 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.35 ACH <sub>50</sub>



**VictorEric PREMIUM HOMES** has a long and well-established presence in Vancouver, having been incorporated in 1997. In 2008 it expanded from being a design-only firm to a design-build firm in order to ensure that the company's design vision would be implemented correctly, and that its clients would ultimately receive a premium product and a stress-free, seamless design-build experience. Today the firm has grown to 42 team members and offers a full range of design-build services, including building, interior, and landscape design, and construction management. VictorEric builds on average 12 to 15 custom homes a year and designs another 15.

"We are pushing for excellence in everything we do," says Eric Lee, the firm's owner, "which is why Passive House makes so much sense for us." Once introduced to Passive House, Lee immediately appreciated its performance advantages. He got certified as a Passive House designer and put several key staff members through the designer and trade trainings. Always one to pursue further education, he recently traveled to Switzerland with a site supervisor to participate in an airtightness training put on by SIGA.

When his firm's first Passive House custom home was sealed up enough to complete a very successful airtightness testing, Lee hosted an open house and seminar to demonstrate the benefits of air sealing. The event was packed, with hundreds of people in attendance. "The city of Vancouver sent its inspectors and plan checkers," says Lee, adding that inspectors from surrounding cities also showed up.

In addition to supporting community education, Lee also prioritizes in-house staff development, subsidizing education and trainings, and listening to and learning from his employees. "Our company culture drives innovation, and that is our key differentiating factor," Lee explains. "We are always asking ourselves, How can we do



Photo courtesy of VictorEric Design Group

this better?" *We create amazing . . .* is the company tagline, and that motto applies equally to design expectations and client and staff experiences. VictorEric has twice been recognized as one of British Columbia's Top Five Best Employers.

Leading the charge on Passive House fits neatly with Lee's interests and also responds to the concerns of many of his firm's team members, especially the younger ones, who are passionate about green initiatives. Lee has assembled an in-house Passive House construction team that consists of two site supervisors and three skilled carpenters. "They love what they do and are picky and meticulous about their work," says Lee.

That combination of passion and skills is critical to implementing Passive House design. Understanding just how valuable this expertise is, Lee is once again enlarging VictorEric's scope to include taking on construction roles for architectural firms designing Passive House buildings. With this step Lee is guiding his firm closer to achieving his overarching vision: Make all of his firm's builds meet Passive House targets—or at least very high-performance approximations—long before the city of Vancouver mandates zero emissions buildings by 2030.





# Lai Residence

## VANCOUVER, BRITISH COLUMBIA

VictorEric Premium Homes was approached to build a French Chateau-style family home on a prominent corner lot in Vancouver's Westside neighbourhood. The clients were generally interested in high performance and green technology, and once the benefits of Passive House were discussed, they agreed to set this objective.

The gracious five-bedroom home was designed and sited so as to take full advantage of the corner lot's available views and solar gain. The front door, and much of the glazing, faces north toward the quieter side street. Large windows on the west façade overlook the city skyline beyond. As west-facing windows can contribute to overheating challenges in summer, VictorEric negotiated with the Vancouver parks department to plant additional deciduous trees along the boulevard for shading.

A generous roof deck captures views of both the downtown area and the mountains to the north, thanks in part to city incentives for constructing to meet Passive House targets that allowed the home to be almost 1 metre taller than a code-built house. The deck lies behind nonfunctional dormers that contribute to the home's French Chateau look. Creating a well-articulated, and yet very high-performing, house was challenging.

"This house has more changes in its surface plane than an average Passive House," notes Eric Lee, owner of VictorEric. "To meet this challenge, a very rigorous

### TEAM

**Designer and Builder**  
[VictorEric Premium Homes](#)

**Passive House Consultant**  
[RDH Building Science](#)

discipline of insulation selection, thermal bridge detailing, and air barrier strategy was required."

The entire foundation is wrapped with rigid insulation, including 30.5 cm of EPS under the footings and slab and up the foundation walls. The basement was built using ICFs, with an additional 15 cm of XPS foam on the exterior. A basement workshop and recreation room has the potential to be converted into a two-bedroom rental suite.

The roof assemblies had specific challenges to meet the combined aesthetic goals and Passive House requirements. The main roof was built first, and the dormers, which were designed as cold roofs, were constructed afterward. The sloped roof has 25 cm of insulation: a combination of 10 cm of mineral wool and 15 cm of foam board insulation. The flat roofs are similarly insulated, with the addition of fiberglass batt insulation in the cavity.

The above-grade walls are wood-frame 2 x 6 construction with 23 cm of mineral wool batt insulation. The transition from the walls to the roof deck required some careful air sealing, as did several other jogs in this unboxy home. However, meticulousness paid off, with the final blower door test coming in at a remarkable 0.13 ACH<sub>50</sub>.

### PASSIVE HOUSE METRICS

<b>Heating demand</b>	15 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	78 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	34 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)

*Renderings courtesy of VictorEric Design Group*





# Byng Residence

OAK BAY, BRITISH COLUMBIA

## TEAM

**Architect**  
[Cascadia Architects](#)

**Builder**  
[NZ Builders Ltd.](#)

This 278-m<sup>2</sup> single-family home achieves a seamless integration into its traditional neighbourhood by blending modern design with the familiarity of wood. The exterior material palette is defined by vertical cedar siding. Inside, local walnut brings warmth and texture to the space. The flat roof is prepared for PV panels, which will turn this house into a net-positive energy home.

Windows that extend from the floor to the ceiling of a two-storey great room allow natural daylight to suffuse the space and also provide a direct connection to the patio and rear yard. This west-facing glazing could have created overheating issues, but PHPP modelling showed that exterior shading, in combination with the large deciduous trees nearby, would address those potential issues. Skylights bring additional natural light to the middle of the house, further reducing lighting energy consumption during daylight hours. A punctuated overhang frames the view of the sky from the patio.

This project incorporates a wide range of Passive House features as fundamental components of its core sustainability concept. Its continuous blanket of insulation begins below the 15-cm concrete slab with 20 cm of a specialized EPS intended for geotechnical applications. Mineral wool fills the 2 x 6 wall assemblies, with a 15-cm layer of polyiso and an additional 38 mm of mineral wool exterior to the sheathing, creating a strong thermal break.

The roof assembly, topped with an SBS roofing product, has 30 cm of sloped insulation above the sheathing. The air-vapour membrane is placed over the plywood sheathing and creates a continuous overlap with the wall membranes, creating a very airtight building envelope.

With this envelope, the home's comfort is assured with very little heating and no cooling. An HRV conserves the house's heat while constantly filling it with fresh, filtered air. A heat pump water heater that uses CO<sub>2</sub> as a refrigerant provides hot water for all uses, including heating the home when needed. A variable-speed mixing control pump siphons heated water from the storage tank and delivers it to hydronic piping snaking through the ground-level concrete floor. The thick slab functions here as a thermal buffer in both summer and winter seasons.

A thoughtful three-pronged strategy eliminated any need for mechanical cooling. Liberal use of exterior shading—a design element that Cascadia Architects takes very seriously—is this home's first line of defense against summertime heat.

Night flushing—setting the operable windows in the tilt position during the summer season—provides an exit pathway for excess warmth. Finally, setting the HRV to its summertime bypass mode enables it to draw in and circulate fresh air without conserving heat. Occupied since May 2017, the home has more than delivered on its promised comfort and outstanding air quality.

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	11 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy</b>	43 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	19 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.18 ACH <sub>50</sub>

Photos by Sama Jim Canzian



# Marpole Passive House

VANCOUVER, BRITISH COLUMBIA

Designed by architect Dominic Sy as a home for his family, this Passive House residence started with the advantage of an excellent southern orientation overlooking the banks of the Fraser Valley. Combining proven construction techniques, locally sourced materials, and high-performance mechanical systems, the design of the Marpole Passive House harmoniously combines modern architecture with the material language of the Pacific West Coast.

Pierre-André Santin of MIZU Passive House Consulting was selected to provide the Passive House design consulting services. Sy says the three-bedroom home, occupied since summer 2018, sailed comfortably through the polar vortex with no need to turn on any supplemental heating.

Early collaboration among the team members focused on the Passive House fundamental design principles, including massing, vertical alignment of the bathrooms and kitchen, and other efficiencies. The builder, who was brought in early, was eager to learn new skills, knowing that the experience would be an advantage in Vancouver, where building energy regulations are ramping up. “The sweet spot for me,” Sy notes, “was that I was already passionate about high

## TEAM

### Designer

[Dominic Sy Architect](#)

### Builder

Suvic Homes

### Passive House Consultant

[MIZU Passive House Consulting](#)

### Passive House

### Building Certifier

[CertiPHiers Cooperative](#)



Photos by Dominic Sy Architect

performance and detailing, and Passive House delivers a good bang for the buck in terms of comfort and energy performance.”

This project’s feasibility was ensured by using a traditional approach to assemblies—standard stick-frame construction—and modifying it with a warm jacket of insulation. The framed walls are 2 x 6 with the air- and weather-resistive barrier membrane adhered to the plywood sheathing. These walls are insulated with mineral wool batts between the studs and 6 inches outboard with 2 x 4 strapping to attach the cladding. Airtightness connections between the foundation, wall, and roof membranes were lapped and taped.

Mock-ups were a big key to this project’s outcome, say Sy and Santin. With numerous simple mock-ups, everyone on site could fully understand each assembly, the detailing for the window installations, and the air barrier connection details. The mock-ups fostered the kind of collaborative communication that was essential to the project’s success. As Sy says, “No single individual can think of all the angles. We provided the fundamental detailing, and the builder brought expertise with regard to constructability and sequencing.”

The basement includes the laundry, mechanical, and family rooms, with space for a future suite for the grandparents. The mechanical room houses the heat pump water heater and HRV with its in-line pre- and post-heater. Supplemental heat can be supplied by one electric wall heater on each floor and in-floor electric heat mats in the bathrooms—but neither has ever been turned on. The building is naturally cooled during the summer, with remote-controlled awnings installed above the south-facing openings for additional comfort. Certified to Passive House Classic, the house is net zero ready.

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	11 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	42 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.26 ACH <sub>50</sub>





# Blindheim

## VANCOUVER, BRITISH COLUMBIA

Built in 1932, the original home had been cut up and rented as student housing for many years. The new owner engaged Ian Robertson of ABBARCH Architecture to transform the building into a quiet house with superior energy efficiency and resilience. Passive House design was not an initial goal, as the client was unfamiliar with the standard, but the client's performance requirements dovetailed so neatly with Passive House that certification was set as an objective.

Robertson and Pierre-André Santin of MIZU Passive House Consulting worked closely together, along with builder Erik Olofsson, to create an aesthetic solution that also met the client's performance goals. The numerous challenges presented by the existing structure resulted in a decision by the client to build a new home. The city of Vancouver allows for accelerated permits for Passive Houses, so a compliant design would also provide a benefit by greatly reducing the time to start construction and hence to finish the project.

Designed to intelligently push creative boundaries, the 3,200-ft<sup>2</sup> structure includes a two-level above-ground residence with a basement suite that can be rented as a separate unit. Its design incorporates large north- and south-facing glazing areas to create a seamless connection to the outside, and thick opaque east and west walls to conceal all services, mechanical systems, storage, and neighbours.

Initially, the owner worried that the Passive House requirements might result in limits on the size and number of the windows. A concentrated effort by the architect and consultant retained all the glass contemplated in the concept design. The design

### TEAM

**Designer**  
[ABBARCH Architecture](#)

**Builder**  
[Olofsson Construction](#)

**Passive House Consultant**  
[MIZU Passive House Consulting](#)

**PH Building Certifier**  
[Peel Passive House Consulting](#)

progressed with careful attention to the numerous structural options, in terms of cost, embodied carbon, and aesthetics. Eventually the team selected prefabricated structural insulated panels (SIPs) for all of the envelope.

Preserving the rental-suite option suggested separate, dedicated services for ventilation and water heating, using two HRVs and one heat pump water heater but two storage tanks. In addition to high-MERV filters, the ventilation system is fitted with a carbon filter—a small extra cost that makes a huge difference, especially during the increasingly common wildfire seasons.

The basement-level walls conventionally would have been built in concrete, but SIPs attached to a concrete raft slab cost about the same and result in less embodied carbon. The below-grade assembly includes magnesium oxide board, for its water-resistant properties, and a self-adhering membrane bathtub for waterproofing and airtightness. This membrane is taped to the above-grade air-and-vapour barrier membrane for continuous airtightness.

A long-span mass-timber-concrete-composite floor structure efficiently allows the ground-level space to flow freely from the front yard to the back. Split levels create an open-plan ground floor juxtaposed against a deliberately private second floor with a planted wall shading the roof deck and south-facing bedrooms.

The roof includes German-made tempered glass tiles enclosing PV cells. Currently under construction, the project is scheduled for completion and certification to Passive House Plus in 2019.

### PASSIVE HOUSE METRICS

<b>Heating demand</b>	9.8 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	2.2 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	37 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)

*Rendering courtesy of ABBARCH; Photo courtesy of Olofsson Construction*



# Fung Roberts House

**NORTH VANCOUVER,  
BRITISH COLUMBIA**

Having lived in the original 1912 Craftsman bungalow since 1992, the owners wanted to preserve their home's heritage history while significantly upgrading its performance and functionality. This rebuilt home now marries a heritage façade and modern architecture, retaining its historical character and meeting the stringent performance specifications of the Passive House Plus standard.

Michael Green of MGA Architecture combined the front porch of the original house with a dramatic design for the south half of the building. This new element is a simple, modern volume that complements the form and character of the existing bungalow. A dramatic cantilever roof provides a large covered balcony that wraps the master bedroom. This volume is clad with yakisugi gendai, or charred-cypress siding.

The heritage front porch was preserved, and the north-facing windows and front door refurbished. Behind the porch, a new high-performance envelope

## TEAM

**Architect**  
[MGA Architecture](#)

**Builder**  
[Matt Dowds](#)

**Passive House Consultant**  
[RDH Building Science](#)



*Photos by Ema Peter*



was built with components certified by the Passive House Institute, including Austrian triple-glazed windows and lift-and-slide doors. External shutters were installed outside the south- and west-facing windows, both for privacy and to manage solar-energy gains during spring and fall.

The mechanical systems include a high-efficiency HRV and an air-to-water heat pump. Thanks to the well-insulated and airtight envelope, this equipment is enough to supply both the domestic hot water and the hydronic radiators that help keep the home comfortable in winter. The house has 8.5 kW of PV panels to generate renewable energy and a lithium battery unit for emergency backup.

Half of the main floor's interior has board-and-batten walls with Craftsman features to match the original house. Old-growth fir from the heritage structure was salvaged to create custom millwork, furniture, and a chandelier that complement the open-plan interior.

The home also highlights Vancouver's creative artists, doubling as a gallery for paintings by local artists while also featuring custom work by the city's artisans, such as indoor and outdoor furniture and light fixtures. The owners and their guests enjoy the benefits of excellent air quality, comfort, and soundproofing in an elegant open-plan space that pays homage to the home's Craftsman beginnings. Michael Green of MGA Architecture combined the front porch of the original house with a dramatic design for the south half of the building. This new element is a simple, modern volume that complements the form and character of the existing bungalow. A dramatic cantilever roof provides a large covered balcony that wraps the master bedroom. This volume is clad with *yakisugi gendai*, or charred-cypress siding.

#### PASSIVE HOUSE METRICS

<b>Heating demand</b>	13 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy</b>	91 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	45 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub>

Photos by Ema Peter





# Montréal Retrofit Classic

## MONTRÉAL, QUEBEC

### TEAM

Architect  
Alias Architecture

In this modern house on a quiet street in Montréal, the red front door beckons. Stepping inside, light from the large, south-southwest-facing windows draws visitors into the combined living and dining room with its expansive view of the cultivated backyard. This renovated four-bedroom house was the first certified Passive House in Quebec.

Designed by Lucie Langlois, principal of Alias Architecture, this 264-m<sup>2</sup> house is a classic Passive House in every sense of the word. Thanks to superinsulation and an airtight shell—with a final blower door reading of 0.38 ACH<sub>50</sub>—the house needs very little supplemental heat to keep it warm through wintertime temperatures that average -9°C. The heating system is simple: A geothermal loop wound around the footings prewarms the intake air going to the ERV; when needed, a post heater in-line with the ERV further boosts the temperature of the air supplied continuously to the whole house. As a backup, several small radiant heaters are placed strategically around the house, but are rarely used.

This heating system operates almost automatically, but designing in this level of simplicity was not easy, especially in 2014, when the project first started, says Langlois. Product availability was a big hurdle, particularly when it came to windows. There weren't any with the right performance specifications to meet the Passive House

standard's comfort criterion of no temperature differences greater than 4°C anywhere in the house. To compensate, ERV supply ducts are positioned beside the windows.

Meeting the primary energy target was also a huge hurdle, as at that time electricity—even that generated by hydropower—was slapped with a large source energy penalty; this calculation has now changed with the introduction of the primary energy renewable factors. This home is all-electric, like most homes in Quebec. An electric water heater provides hot water, aided by a greywater heat recovery system that conserves heat from the showers and laundry. The owners are big fans of their induction cooktop, as they are of almost every feature in their home, which they show off regularly during tours.

The home's summertime comfort is the one aspect that has needed improvement. Planned exterior shading over the large south-facing glass door and windows was not installed. When temperatures stayed abnormally hot for a solid week, not even cooling off much at night, the owners installed a small air conditioner in the mud room, and the ERV distributes that cooling throughout the house.

Langlois, who is currently designing another two-story Passive House, says much has changed for the better since this first project. More Passive House-quality products are available, including heat pump water heaters, windows, and ventilation systems. As Langlois says now, “We find solutions more easily.”

### PASSIVE HOUSE METRICS

Heating demand	14.5 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	0 kWh/m <sup>2</sup> a
Primary energy demand	90 kWh/m <sup>2</sup> a
Air leakage	0.38 ACH <sub>50</sub>

Photos by Andre Bazinet



# Wild Leek Farm

GUELPH, ONTARIO

A concern for sustainability and Passive House design go hand in hand. These twin sensibilities are fully embodied at the Wild Leek Farm, a permaculture farm located near Guelph, Ontario, that features a Passive House residence. The idea behind permaculture gardening is to leverage nature to do as much as possible to develop successful gardens. Similarly, Passive House techniques leverage the natural qualities of a building to produce a comfortable, person-friendly living environment.

The residence at Wild Leek Farm is a classic rectangular farmhouse like those that have been built in North America for generations—but with far superior performance. The integrated project team, consisting of architect Graham Whiting; Evolve Builders Group; additional consultants; and the farm's owners, Brett Forsyth and Danie McAren, achieved Passive House levels of performance while keeping the forms and details as simple and straightforward as possible. This approach made the farmhouse more affordable to build and allowed the owners to do much of the interior and exterior finishing.

The house was built using advanced framing—which included precisely aligning every roof truss with wall studs and floor joists—with minimal stud use and thermal bridging. Windows and doors are sized and aligned to fit between stud cavities. The number of windows and their size is minimized for several reasons: Windows are

## TEAM

### Architect

[Whiting Design](#)

### Builder/CPHC

[Evolve Builders Group Inc.](#)

### Mechanical

[Rob Blakeney](#)

### Building Envelope

### Consultants/CPHC

[Passive Design Solutions](#)

### Passive House Rater

[Blue Green Group](#)



Photos by Brett Forsyth

more expensive than walls, are typically the weakest part of an envelope, and they reduce space for storage and furniture.

The team focused on using construction materials with low toxicity, natural sourcing, and local economic benefit. The house is insulated with regionally manufactured dense-packed cellulose, an insulation that is also among the lowest in embodied energy. Domestically manufactured, sustainable FSC wood was used for the exterior siding and flooring; the latter is finished in a natural oil.

The building envelope, including the doors and windows, was fabricated almost entirely with domestic products. Further, the assembly was specifically designed to make use of simple, widely available, off-the-shelf materials. For instance, instead of imported smart membranes and tapes, domestic OSB taped at the seams doubles as the structural sheathing and air barrier. The triple-glazed doors and windows and recycled-content drywall were all made in Canada.

This focus on domestic and regional products sometimes meant that the construction team traded lower material cost for more-labour-intensive installation. While helping to reduce financial outlays, this strategy also eliminated procurement, delivery, and servicing risks that would have resulted from using distant suppliers. In addition, it helped the local trades to develop familiarity with Passive House construction methods and encouraged domestic production of Passive House materials.

The benefits of Passive House construction are evident in the ongoing energy monitoring conducted by the project team. Modeled energy consumption averaged 2,400 kWh per month. Actual consumption so far has been from 800 to 1,200 kWh.

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	18.5 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	107 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.55 ACH <sub>50</sub>










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 Courtesy of Builder 

# Gaspereau Passive House

## GASPEREAU, NOVA SCOTIA

In early 2018, Philip Dennis and his family completed a 250-m<sup>2</sup> single-family Passive House nestled in the heart of the Gaspereau Valley just outside the university town of Wolfville, Nova Scotia. The project was purely a self-build initiative. Philip Dennis acted as primary designer, engineer, and general contractor. His goal was to meet the international Passive House standard, while also honing his understanding of how to build cost-effective high-performance homes in the Atlantic region of Canada. As a full-time resident of this Passive House, he has been systematically evaluating the results, crafting improvements, and sharing the expertise gained from this project.

Photo by Philip Dennis

### TEAM

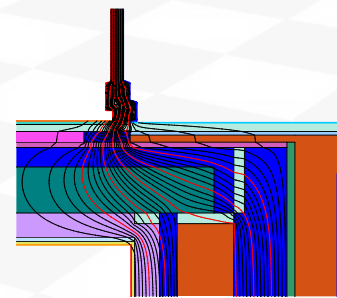
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[Gaspereau Building Science](#)

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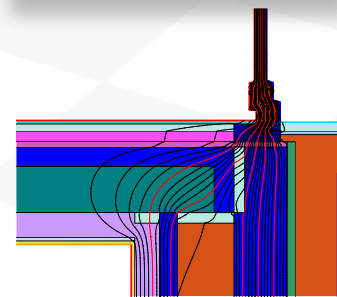
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### PASSIVE HOUSE METRICS

<b>Heating demand</b>	15 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0.8 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	25 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.15 ACH <sub>50</sub>



$$W_{AEC} = 0.109 \text{ W/(m·K)} = 0.063 \text{ Btu/(h·ft·F)}$$



$$W_{AEC} = 0.049 \text{ W/(m·K)} = 0.028 \text{ Btu/(h·ft·F)}$$

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# Affinity

## WASAGA BEACH, ONTARIO

Robert and Koko Saar of Cedar Valley Passive Homes are leading the way in developing Passive Houses in Ontario. Their first project, the Affinity model, is open for information sessions and home tours, demonstrating the many benefits of Passive House to their community. At 140 square metres, plus a generous garage, the open-concept house targets a young-minded, “not ready for a condo” retired couple with a yearning for an active lifestyle. The main-floor master bedroom allows for one-level living, and the two bedrooms and bathroom on the second floor invite friends and relatives to visit. The Saars are targeting PHI’s Low Energy Building certification for this single-family house.

### PASSIVE HOUSE METRICS

Heating demand	24 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	1 kWh/m <sup>2</sup> a
Primary energy renewable (PER)	75 kWh/m <sup>2</sup> a
Air leakage	0.6 ACH <sub>50</sub> (design)

Photos by K. Delano

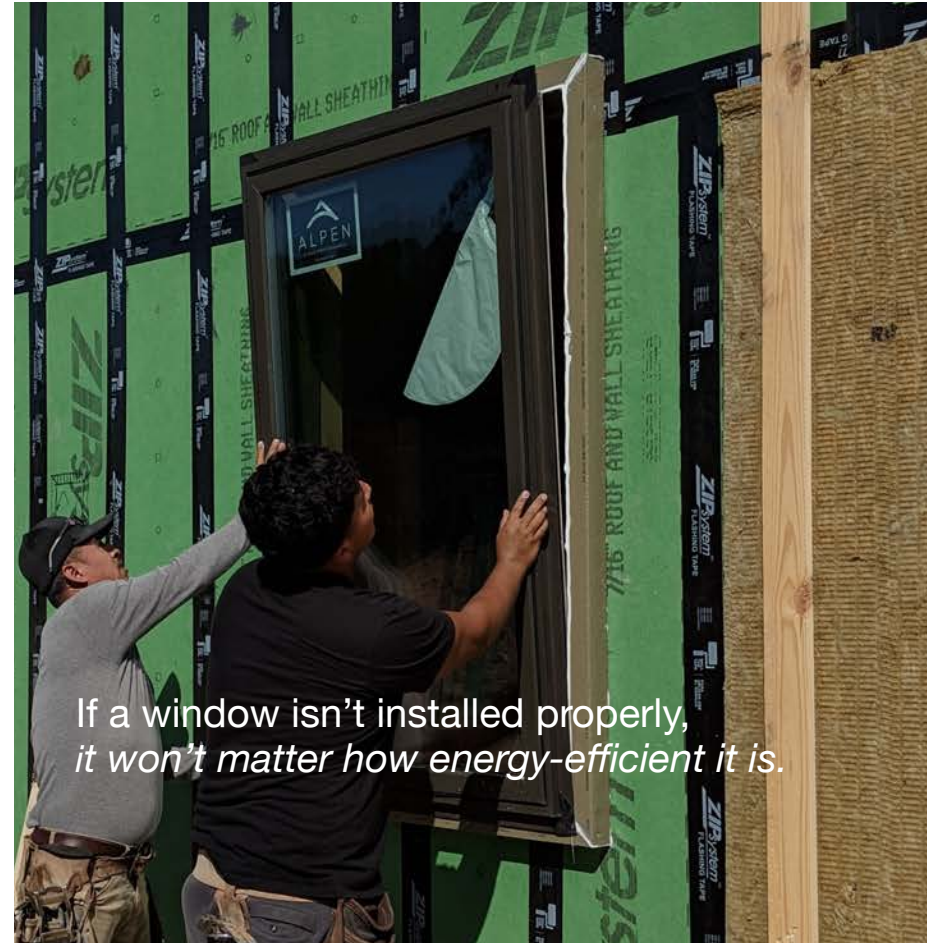
### TEAM

**Passive House Development**  
[Cedar Valley Passive Homes](#)

**Architectural Design, PHPP, and Prefabrication/Construction**  
[Quantum Passivhaus](#)

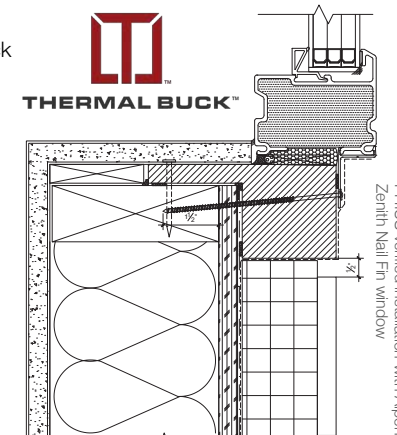
**Passive House Certification**  
[Peel Passive House Consulting](#)

**Mechanical Engineering**  
[ZON Engineering Inc.](#)



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# South Surrey Passive House

SOUTH SURREY, BRITISH COLUMBIA

Of the numerous Passive House projects by the design firm Marken Design + Consult, this duplex stands out for its early embracing of Passive House goals and its use of prefabricated elements. The retired couple who approached Marken Design wanted a sustainable multigenerational home, with ground-level living for them and a separate residence for their daughter's family on the second level. Affordability was an important consideration, as the retirees would be financing the construction costs.

The layout includes a common foyer at ground level with separate entrances to each fully independent unit. Each residence is approximately 185 square metres, with a crawl space below. The lower unit is fully accessible, to anticipate potential future needs. Both levels have their own exterior decks.

Along with affordability and high-quality construction, speed of construction was a major concern for these clients, as they wanted a prompt move-in date. Prefabricated Passive House-quality wall panels provided an obvious solution for all of these concerns. The panelized 2 x 8 stud walls—some of which are more than 7 metres long—allowed the structure to be erected in just five days. These walls are insulated with mineral wool, as is an interior 2 x 4 wall that functions as a service cavity. The Austrian-made triple-pane windows were supplied by the prefabrication company and installed on-site.

### TEAM

- Architect**  
[Marken Design + Consult](#)
- Prefab Builder**  
[BC Passive House](#)
- Mechanical**  
[Viessmann Canada](#)
- Window Supply**  
[Optiwin Freisinger](#)

Principal Alex Maurer notes, “We were careful with the window sizing so as to balance heat gain with avoiding the risk of overheating.” Retractable solar shades on all the windows provide shading and privacy from the neighbours.

The roof and ground-floor assemblies both incorporate prefabricated 36-cm engineered-wood I-joists insulated with mineral wool and 2 x 4 service cavities; these assemblies achieve an R-70 and R-60 respectively. The ground-level floor consists of a lightweight concrete topping, and its thermal mass helps dampen the home's temperature swings.

While the crawl space is exterior to the Passive House envelope, it is nevertheless insulated to prevent the plumbing and rainwater collection tanks that are housed there from encountering freezing temperatures—an unlikely, but not unheard of, condition in Surrey. The owners invested in the rainwater-harvesting system because self-sufficiency and sustainability are important priorities for them. A solar-thermal vacuum-tube collector system supplies 50% to 60% of the annual hot water demand, and the house is prewired for a PV system.

Each level has its own HRV with a dedicated in-line post-heater, the main heating system for the residences. Backup heating is provided by a small gas fireplace that is mostly used for visual pleasure.

The award-winning house has met all of the clients' needs and visions. They say it has been amazingly comfortable, and monthly utility bills are roughly one-third those of comparable conventionally built houses.

### PASSIVE HOUSE METRICS

<b>Heating demand</b>	13 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy</b>	118 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.4 ACH <sub>50</sub>

Photos courtesy of Marken Design + Consult



# Cheakamus Passive House Plus

WHISTLER, BRITISH COLUMBIA

Located in a new subdivision, this single-family home plus one-bedroom suite had access only from the south side, where the attached garage had to be located, restricting the potential solar gain. The nearby mountain ranges further limited the solar exposure of the site. To compensate, parts of the western side of the building were designed on an off angle to allow for extra south-facing windows. The main living areas were placed on the upper floor to capture natural light and views of the surrounding mountains. Thanks to careful design and a 140-m<sup>2</sup> PV array on the roof, the project was certified as a Passive House Plus.

Photo by Dale Mikkelsen



## TEAM

**Design, Construction  
and PH Consulting**  
[Econ Group Ltd](#)

**Certification**  
[Earth Cycle Technologies](#)

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	14.5 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	32 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.25 ACH <sub>50</sub>



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SINGLE-FAMILY | Econ Group

# Colwood Passive House Plus

NORTH VANCOUVER,  
BRITISH COLUMBIA

This intergenerational residence features a combination of concrete, mass timber, and wood frame construction. The elegant design by Randy Bens Architects not only excels architecturally but effortlessly incorporates key Passive House principles like external shading and thermal-bridge-free detailing. A 6.72-kW PV system, which produces approximately 7,632 kWh per year, allows this project to be certified as Passive House Plus. The backyard features an outdoor pool that will be heated without fossil fuels, using a combination of solar hot water panels and an air-to-water heat pump.

Rendering by Randy Bens

## TEAM

**Architecture**  
[Randy Bens Architects](#)

**Construction**  
[Econ Group Ltd](#)

**PH Consulting**  
[RDH Building Science](#)

**Certification**  
[Mizu Passive House  
Consulting](#)

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	11.1 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0.0 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	18.0 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.26 ACH <sub>50</sub>

# David Hill House

COLLINGWOOD, ONTARIO

## TEAM

**Architect**  
[Dewson Architects](#)

**PH Consultant**  
[Peel Passive House Consulting](#)

Amid the forested hills of the Pretty River Valley southwest of Collingwood, Ontario, a 230-m<sup>2</sup> two-storey Passive House emerges that blends the old with the new. Prior to construction, the site housed a 150-year-old pioneer cedar-log house. The owners, David and Peggy Hill, have used the house as a cottage since they were in their 20s. Wanting to keep the existing structure while recognizing that it was too small for their retirement, they decided to take on the challenge of building a new structure that would seamlessly connect to the existing one. They achieved this connection through an angled breezeway. The structure continues through a second breezeway into a garage with a second storey.

The home's layout is simple but elegant, combining Passive House principles of compact form and south-oriented glazing with functional and aesthetic qualities. The main floor comprises an open-plan kitchen, dining, and living room that opens onto a back patio. The upper storey contains three bedrooms. The 4-metre by 1.6-metre master bedroom window offers a beautiful view of the surrounding landscape: a small pond backed by dense forest.

The structural walls are 2 x 8s on 24-inch centres, filled with a novel dense-packed lamb's wool insulation and sheathed with ½-inch plywood. The sheathing is covered by almost 8 cm of wood-fibre insulation, which in turn is covered by a vapour-open weather-resistive barrier. An interior continuous air barrier and 2 x



Photos by William Dewson, Dewson Architects Inc.

4 service cavity insulated with lamb's wool complete the R-50 wall assembly. The aluminum-clad wood-framed windows are aligned flush with the exterior sheathing to allow the wood-fibre insulation to seamlessly overlap the window frames and ensure thermal-bridge-free installation.

Roof trusses filled with 81 cm of fibreglass insulation achieve an R-100. Below the ground-level concrete floor, 30 cm of EPS abut an ICF foundation wall to provide a continuously insulated envelope.

Heating, cooling, and hot water are provided by a cold-climate air-to-water heat pump that operates under most weather conditions. For extremely cold days, electric-resistance backup provides heat. Space heating is distributed via a radiant floor slab. A faux fireplace with mantel was installed for aesthetic value. PV panels, which produce more energy over the year than the house consumes, complete the mechanical systems.

Experiencing the comfort firsthand, both during construction and once the house was occupied, the architect and contractors alike have become enamoured of Passive House. Architect William Dewson, principal of Dewson Architects, says, "I cannot get over how comfortable the building is, both its microenvironment and its aesthetic. You have navigated the Passive House principles beautifully and layered on your own unique style with panache. You stuck to the principles that made sense and massaged the ones that needed refining to create a building that suits its site and shows others how it can be done. I am a convert."

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	15 kWh/m <sup>2</sup>
<b>Cooling and dehumidification demand</b>	4 kWh/m <sup>2</sup>
<b>Primary energy renewable (PER)</b>	51 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.5 ACH <sub>50</sub>



# Win-Win for a Family

VICTORIA, BRITISH COLUMBIA

## TEAM

Architect  
Waymark Architecture

Passive House doesn't necessarily connote modest, but there is no reason the two can't comfortably coexist, as they do in this custom single-family home with suite. "High performance is not just for high-end custom homes," says Graeme Verhulst of Waymark Architecture. "Good design is for everyone."

The clients approached Waymark knowing that they wanted a Passive House and needed their costs to fall within a reasonable budget. Waymark delivered on these goals; the hard costs for the home are comparable to average construction costs in British Columbia. As Verhulst says, Passive House can encourage simplicity. By keeping the science and principles of Passive House design in mind from the beginning, he was also able to keep control of the budget—a win-win for the family.

The 214-m<sup>2</sup> home has three bedrooms in the main house and another two in a deftly designed suite. A home office and an L-shaped great room with plenty of south-facing glazing occupy the ground floor of the primary residence, and all the bedrooms are upstairs. The suite is also two storeys—the layout desired by the clients, who wanted the suite to feel quite separate. "When space is tight, adding a second staircase is challenging," acknowledges Verhulst, "but we made it work."

Keeping the assemblies uncomplicated, the above-grade walls are 2 x 6s sheathed in plywood, with a membrane air barrier outside the plywood. Twenty cm of mineral wool was applied to the exterior, held in place with thermally broken clips, and topped by metal cladding.



Photos and rendering courtesy of Waymark Architecture



The clients wanted a polished-concrete floor, so all of the insulation in the foundation assembly had to be below the slab. Thermally isolating the slab made the foundation-to-above-grade wall details a little tricky. Spray foam was used to create a thermal break there. Intermittent internal shear walls land on thickened slab areas that act as anchors against seismic activity.

Boosting a single-family home's density by adding on a suite is a bonus in terms of increasing a community's available housing options, but adding occupants—and their accompanying appliances and electronics—in a relatively small space led to

challenges in meeting the Passive House primary energy requirements. Surprisingly, this criterion was harder to address than the thermal demand, which is often the focus of Passive House design for buildings this size.

## PASSIVE HOUSE METRICS

Heating demand	12 kWh/m <sup>2</sup> a
Cooling and dehumidification demand	0 kWh/m <sup>2</sup> a
Primary energy	127 kWh/m <sup>2</sup> a
Primary Energy Renewable (PER)	60 kWh/m <sup>2</sup> a
Air leakage	0.6 ACH <sub>50</sub> (design)



# Princess Avenue EnerPHIT

**NORTH VANCOUVER,  
BRITISH COLUMBIA**

Builder Nino Giangrande of Grande Pacific Homes started this project as a straightforward renovation using the current building code as a guide. Once construction started, he decided to take the Passive House training and certify as a Passive House Consultant. After completing the course and passing the Consultant examination, he immediately changed the design and reengineered the project to meet the EnerPHIT standard. The shift inevitably incurred extra costs, but he was committed to achieving what eventually became the first certified EnerPHIT building in Canada.

The original building design complicated the EnerPHIT process. It had three different rooflines: a turret protruding from the centre of the main living area, butterfly wings on two sides, and a flat roof around the perimeter and over the garage. These features required some back and forth with the architect to address the thermal bridging between the many junctions. The air barrier,

## TEAM

**Architect**  
Aform Development

**Builder**  
[Grande Pacific Homes](#)

**Certifier**  
[Peel Passive House Consulting](#)

**Plumbing**  
[BD Plumbing](#)

**Framing and Millwork**  
Elite Contracting

composed of taped exterior sheathing, required integrating three new walls and the existing sheathing. The original slab foundation, which comprised 75% of the final footprint, could only be insulated on the edge.

The building department presented a few challenges as well. The building includes a rental suite with a door that connects to the main house. The city wanted a separate heating source and HRV for the suite. Fortunately, these requirements were eventually satisfied. The jurisdiction also wouldn't allow 4 inches of external insulation on the original foundation walls, as they were infringing on side yard setbacks, requiring that the insulation be placed inside.

The home, with a treated floor area of 326 square metres was completed in 2017. The final blower door number, an impressive 0.68 ACH<sub>50</sub>, is lower than the EnerPHIT maximum threshold of 1.0 ACH<sub>50</sub>. The all-electric house includes two refrigerators, an induction cooktop, a heat pump water heater, heated floors in the two bathrooms, and an HRV with an in-line electric heater. Giangrande eventually sold the house, but while he and his family lived there, the total electricity cost per year was approximately \$200. They never turned on the electric fireplace, and as far as they could tell, the in-line HRV heater, which turns on automatically at 20°C (68°F), was never activated.

During their occupancy, the builder and his family enjoyed the high air quality, the lack of dust, and the comfort. A confirmed Passive House advocate, Giangrande has two new Passive House projects in the works. The features that most interest his clients: indoor air quality and comfort.

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	23 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	38 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.7 ACH <sub>50</sub>

*Photos courtesy of Grande Pacific Homes*



# Soo Valley

## Prefabricated Housing

### SOO VALLEY, BRITISH COLUMBIA

The Soo Valley Prefabricated Housing project began with a vision to accelerate the availability of low-carbon housing. Intended for a remote site within the traditional territories of the Lil'wat and Squamish Nations, yet not far from the ski resort of Whistler, the project's brief was to create an off-grid custom prefabricated house that could then be spun off as a prototype for a smaller townhouse design for use as workforce and ski resort housing.

For this location's high mountain climate, where temperatures can drop to  $-25^{\circ}\text{C}$ , pursuing Passive House helps to achieve the goal of energy self-sufficiency for this house. The project will offer exceptional comfort, resilience, and integration within the local ecological systems—all highly desirable attributes of a prototype for a much larger community.

The site for the prototype house proved challenging due to its prime views to the northeast, setting up a battle between views and warmth. Overhangs are being used to block the sun on the south side, while deep reveals or fins are used to block solar gain through the east- and west-facing glazing.

Opting for constructing with prefabricated components offers obvious benefits for a house in this snowy climate, allowing manufacturing during winter. In addition, prefabrication dramatically reduces construction waste and site disturbance.

For this project, there were a few challenges that affected the specifications. This house is being designed for intermittent occupancy, so there will be fewer internal loads than would be the case in a fully occupied residence, necessitating a thicker building envelope. An added challenge was meeting the project's desired aesthetic of exposed glulam beams and wood structure. Optimal collaboration was required between all teams to properly conceal the electrical wiring within the wood structure.



#### TEAM

##### Architect

[Perkins+Will](#)

##### Mechanical and Electrical Engineers

[Integral Group](#)

##### Passive House Consulting

[RDH Building Science](#)

##### Builder

[Durfeld Constructors](#)

[BC Passive House](#)

##### Client

[Delta Land](#)

[Development Ltd.](#)



Renderings courtesy of Perkins+Will

The prototype was designed with a suspended floor over a crawl space to minimize disturbance of the ground. While yielding aesthetic and environmental benefits, this approach can also result in colder floors, which here are mitigated by a low-mass radiant floor that is geothermally fed. The low-mass radiant floor is faster to react than concrete, and thus suited to houses with intermittent occupancy.

Geo-exchange heat pumps will be supplying the hot water, thus avoiding the overproduction of hot water in the summer. By taking advantage of moderate ambient ground temperatures of  $10^{\circ}\text{C}$ , the geo-exchange loop also provides preheating and precooling of the high-efficiency ERVs.

The PV panels are inclined at a steep angle to shed snow. Additional renewable energy is provided by a wind turbine. Backup is provided through battery storage and hydrogen fuel cells. The fuel cells were chosen to meet responsiveness needs when large groups arrive for a visit. With the completion of this pilot project, Integral Group will be instrumental in pushing for increased scale in the production of Passive House residential construction.

#### PASSIVE HOUSE METRICS

<b>Heating demand</b>	18.4 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy</b>	50 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	22 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)





## WestBay Passive House

**WEST VANCOUVER,  
BRITISH COLUMBIA**

This revolutionary Passive House home by BattersbyHowat Architects combines contemporary West Coast architecture with an innovative mechanical system and a PV array to achieve a beautiful, passive, net zero energy home. Completed in March 2019, the home is occupied by James Dean, his wife Janet Allan, and their family.

Dean's design principles for the home were comfort, beauty, health, efficiency, and fun. He was

### TEAM

**Architect**  
[BattersbyHowat Architects](#)

**Builder**  
[Naikoon Contracting Ltd](#)

**Passive House Consulting**  
[Econ Group](#)

**Mechanical Engineer**  
[Integral Group](#)

**ERV Supply, Balancing,  
and Commissioning**  
[Small Planet Supply](#)

convinced that the Passive House standard could fulfill all these requirements; Allan was not so enamoured with the beauty of many Passive House homes they had viewed. Undeterred, Dean found examples they liked and assembled a team to realize their vision. Dean also wanted the home to be a test bed of technologies and an educational tool for the community. The home's construction is featured in a video series produced in collaboration with the British Columbia Institute of Technology (BCIT) for use in tradesperson training courses ([commons.bcit.ca/zeroenergybuildings/videos](https://commons.bcit.ca/zeroenergybuildings/videos)).

The building incorporates CLT construction, allowing for rapid assembly of the above-grade floors, minimal waste and robust materials. The south-facing home has floor-to-ceiling glass for uncompromised ocean views, deep overhangs to protect against solar radiation, and thermally isolated slabs on the balconies. These design elements are combined with a mechanical system utilizing a next-generation ERV, an air source heat pump, and hydronic heating and cooling in the ventilation air.

Stuart Hood of Integral Group explains that there is increasing anecdotal evidence that some Passive House homes are overheating. There can be several reasons for this, such as increasing temperatures due to climate change and reluctance to open windows due to external noise, air pollution, forest fires, and security issues. However, there are also concerns that a house that complies with the Passive House requirement of less than 10% of the hours above 25°C, as shown in the PHPP, can be unacceptable for some people.

Integral Group undertook an alternate thermal modelling analysis to ensure that this home's summertime and shoulder season design strategy could prevent overheating.

After moving in, the homeowners commented that they loved how the home felt inside. In a previous home on the same site, Dean used to be woken up by the heavy goods trains passing along the tracks 100 feet away; now he doesn't hear them at all. As to the fun in the home's design, the Passive House cat door and earth-coupled passive wine cellar built into the site's natural slope are features that raise a smile at every party.

### PRODUCTS

**Structural Thermal Breaks**  
[Schöck](#)



Photos by (opposite page) Eva Rooks and (left) James Dean



### PASSIVE HOUSE METRICS

<b>Heating demand</b>	9 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy demand</b>	43 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.33 ACH <sub>50</sub>

# Multigenerational Passive House

LANGLEY, BRITISH COLUMBIA

At first glance, the 485-m<sup>2</sup> house on a quiet countryside road in Langley appears to be like any other. The charming modern farmhouse is a simple two-storey rectangle with a welcoming wraparound porch. But upon closer inspection, it is obvious that the house is very different: It is a multigenerational home built to the Passive House standard.

The functional floor plan has been carefully designed to provide comfortable living quarters for several generations of the same family. The home features a master bedroom with ensuite on each floor, four additional bedrooms, a large family room with access to an outdoor living space, and spacious kitchen and dining areas. The intent is for an older couple to live on the ground floor, while a younger couple and their children live on the upper floor. The flexible layout also offers the possibility of separating the lower level to create two autonomous units.

Other differences are hidden inside the building envelope and in the mechanical room. Owner-builder Mike Cairns and his parents always intended to design and build a highly energy-efficient home. However, during the design process, the term *energy-efficient* evolved. Having spent his career in the home construction industry, Cairns added to his credentials and became a Certified Passive House Tradesperson. And it was then that he and his parents decided to make their new home a Passive House.

The shift from high-efficiency to Passive House required a few easy upgrades to the building envelope. The house has a 0.9-metre-tall below-grade crawl space fabricated from R-28 integrated concrete forms wrapped in an additional 7.6 cm of EPS insulation. The 2 x 6 wall assembly features 17.2 cm of exterior EPS insulation, R-20 batt insulation in the interior wall cavity, high-performance doors with vacuum-insulated glass, and PHI-certified windows for a total nominal R-45. The roof assembly will include blown cellulose at R-85 with graphite-infused EPS insulation around the reduced-height edges for a net average of R-76.

Cairns's experience in water damage-related construction retrofits influenced the design criteria of the air barrier. To avoid the recurrent West Coast issue of vapour trapped inside the wall cavity, there is no interior air or vapour barrier. Plywood sheathing was chosen for its natural "smart" vapour permeability to allow moisture egress and cavity drying. A high-vapour-permeable air-



## TEAM

**Builder/CPHT**

[Mike Cairns](#)

**CPHD**

[Tannaz D. Tehrani](#)

**Designer/CBDO**

[Nicholas Petrie](#)

**Certifier**

[RDH Building Science](#)



(left) Photo courtesy of 360hometours.ca; (above) rendering by Draft On Site Services

and-water-barrier membrane is layered on top of the sheathing. Special care was paid to the installation of the windows to ensure a continuous air barrier for optimal performance of both the fenestration and the overall wall assembly.

The design and orientation of the home were also considered. The long axis of the building is oriented westward from north to south to coincide with the natural contours of the land. Generous overhangs on the west façade protect the windows from pervasive afternoon solar exposure. For additional protection, the multipoint locking patio doors will include vacuum-insulated glass for a nominal R-14. Every space also features large tilt-and-turn windows to provide effective natural ventilation. Both interior and exterior shading systems will be used on windows to further control solar heat gain.

In addition to passive heating during the shoulder seasons, the home will be heated in winter, when necessary, with an electric fireplace in the family room. An HRV will provide efficient ventilation. Domestic hot water will be provided by a heat pump hot water tank. In southern British Columbia, 100% of electricity is hydro and is available for as little as \$0.08/kWh. This carbon-free power supply will be the main source of power for this multigenerational Passive House. However, to future-proof the home, rooftop solar PV will be prewired.

Once completed, this modern farmhouse will provide very comfortable, healthy, and durable living for three generations of forward-thinking Canadians.

## PRODUCTS

**Windows & Doors**

[Innotech](#)



## PASSIVE HOUSE METRICS

<b>Heating demand</b>	15 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	48 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)



Rendering courtesy of Urban West Architecture and Marken Design + Consult

# Capilano Passive House

**NORTH VANCOUVER,  
BRITISH COLUMBIA**

This West Coast modern Passive House surrounds and frames a south-facing courtyard garden by way of large sliding patio doors and carefully located windows that create an intimate relationship between the interior and exterior spaces.

The south courtyard features generous seating areas, a low-energy saltwater pool, and extensive landscaping featuring plant species that are low maintenance, drought tolerant, and native to the Pacific Northwest. The north courtyard features a play area, terraced plantings with a vegetable garden, and fruit trees adjacent to the kitchen.

Solar shading is provided through strategically placed trees and large south-facing roof overhangs that permit the winter sun to penetrate deep into the interior space in colder months, with reduced direct sunlight in the summer months.

## TEAM

**Construction Manager**  
[Naikoon Contracting Ltd.](#)

**Architecture**  
[Urban West Architecture](#)  
[Marken Design & Consult](#)

**Passive House Consultant**  
[Marken Design & Consult](#)

**Structural Engineers**  
[Aspect Structural Engineers](#)

A locally sourced cross-laminated timber (CLT) structural system is featured throughout the house's interior. This renewable resource provides structural simplicity, enhanced thermal performance, and a beautiful exposed-wood interior finish. The CLT structural system will also provide a more efficient and timely construction process compared to conventional light wood framing.

The high-performance building envelope is finished with a combination of western red cedar and high-density fibre cement panels. The thermal-bridge-free design aims to optimize the envelope's thermal performance and the home's solar gains during winter months.

Natural resources are utilized throughout the building in various ways. Solar panels located on the upper roof will harvest solar energy for use throughout the year with any excess energy stored in a battery and fed back to the electric grid. Almost as much energy will be produced through PV energy production as the building uses in a year, helping this home to achieve its planned Certified Passive House Plus designation.

Expansive plantings on the green roof enhance its thermal performance and utilize rainwater before it finds its way to underground rainwater collection tanks used for site irrigation and cleaning.

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	14.5 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	3 kWh/m <sup>2</sup> a
<b>Primary energy</b>	65.7 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.6 ACH <sub>50</sub> (design)



**THE PASSIVE HOUSE STANDARD IS THE PATH FORWARD. BE READY.**



Alta Lake Passive House

# Temperance Street Passive House

**SASKATOON, SASKATCHEWAN**

Temperance Street Passive House enjoys the merit of being the first building in Saskatchewan that was certified as a Passive House Plus by the PHI. The three-storey duplex was designed and built in 2016 by Robin Adair of the green builder inc. for homeowners Jim Spinney and Holly-Ann Knott. Attention to detail during construction was crucial in obtaining the outstanding final airtightness test result of 0.17 ACH<sub>50</sub>. A 6.8-kW PV system was installed on this all-electric building.

Photo by Sarah Adair

## TEAM

**Homeowners**  
Holly Ann Knott and Jim Spinney

**Designer/Builder**  
[the green builder, inc.](#)

**Mechanical Engineering**  
[Bright Buildings](#)

**Structural Engineering**  
[Rempel Engineering](#)

## PASSIVE HOUSE METRICS

<b>Heating demand</b>	15 kWh/m <sup>2</sup> a
<b>Cooling and dehumidification demand</b>	0 kWh/m <sup>2</sup> a
<b>Primary energy renewable (PER)</b>	58 kWh/m <sup>2</sup> a
<b>Air leakage</b>	0.17 ACH <sub>50</sub>



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# One Homeowner's Experience

Passive House Canada's Sacha Sauvé talks with Carolyn Gisborne, who lives in a Passive House building on Vancouver Island.

**SS: HOW DID YOU FIRST HEAR ABOUT PASSIVE HOUSE?**

**CG:** I first heard of Passive House when I was working as housing policy analyst in Victoria on British Columbia's building code. I understood Passive House as a high level of building certification that BC was trying to attain, and that it was a gold standard in building.

While working on building-code policy I was invited with other government officials to tour a building site for a Passive House condo that was under development, which at the time was the first multi-unit residential building in Canada being built to the Passive House standard.

**SS: HOW DID YOU DECIDE TO LIVE IN A PASSIVE HOUSE?**

**CG:** During the tour I had the opportunity to see and hear about the materials used, the process of building, and how the challenges of building to the Passive House standard differed from building to the current code. I came away from that tour wanting to live in a Passive House. I was awestruck by what I had learned, and the exterior walls of the building hadn't even been framed yet!

My husband and I purchased one of the condos of the project I toured. We hadn't thought seriously of buying a home until we came across Passive

House. This was more than buying a home, it was buying into a philosophy and practicality.

**SS: WHAT WAS IT ABOUT PASSIVE HOUSE THAT CAUGHT YOUR ATTENTION?**

**CG:** What stood out the most was the simplicity of the building—that Passive House uses a combination of ancient ideas, like orientation, simple design, roof pitch, and solar heat gains in winter. I loved that the standard married fundamental principles with new technology. I look at life from a perspective of efficiency, and this building maximizes efficiency. Passive House is everything it needs to be and nothing more. As a minimalist, that really spoke to me.

**SS: WHAT ARE THE SOME OF THE BENEFITS TO LIVING IN A PASSIVE HOUSE? WHEN YOU MOVED IN, DID YOU IMMEDIATELY NOTICE ANY DIFFERENCE FROM LIVING IN A HOUSE BUILT TO CODE?**

**CG:** Once moved in, we immediately noticed how quiet it was. It was like living in a sound studio. The air felt clean, and there were no weird smells. If you cooked a meal with strong smells or burnt the food, the smell was quickly gone. The air changed over so quickly that our clothes dried on a rack in a couple of hours (which is difficult

in a humid climate like Vancouver Island). During the summer wildfires, the condo was free of smoke smell; we never got sick in the winter; and we felt so good about raising our daughter in our home knowing the air was as clean as it could be.

benefit, because energy generated was resold to BC hydro and kept strata fees [fees covering ongoing maintenance, insurance, and energy use] low—\$186 a month for a new build (six-plex).

But the biggest benefit of living in a Passive House was that we never had

*This was more than buying a home, it was buying into a philosophy and practicality.*

Our energy bills dropped in the orders of magnitude. Our average energy bill for a two-bedroom condo with high ceilings is \$30 a month. Solar panels on the roof were a huge

to think of the indoor temperature. If we wanted to heat our home, we would bake a loaf of bread and have a shower and the place would be warm for the night. The coldest our place

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ever got was 16°C after being away four days in the month of December. We turned a little space heater on, and within a couple of hours the condo was warm again. (Other than heated bathroom floor tiles, our home needs no heating system, thanks to its Passive House envelope.)

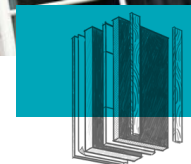
In the last three years of living in our Passive House condo, the only maintenance we had to do was change roughly \$20 of air filters. We never had to worry about a furnace or air conditioner breaking, and we knew that in the event of something catastrophic (like an earthquake) we could live in the condo comfortably.

**SS: IF YOU COULD SHARE ANY LAST THOUGHTS ABOUT PASSIVE HOUSE AND THE FUTURE OF**

**PASSIVE HOUSE BUILDINGS WITH OUR READERS, WHAT WOULD THEY BE?**

**CG:** I have never lived in a place I love so much. Living in a Passive House building has provided so many benefits for our family. Our home is ultra quiet, the air never feels stuffy or drafty, and our heating bills are incredibly low. As a homeowner, living here also provides peace of mind with no furnace or air conditioner to worry about or maintain. Our strata fees are also low, thanks to the solar panels that generate income for the strata. I feel that this is the future of building in Canada, and that everyone should be able to enjoy the benefits of a Passive House home.

**Matt Risinger**  
Builder and building science expert



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