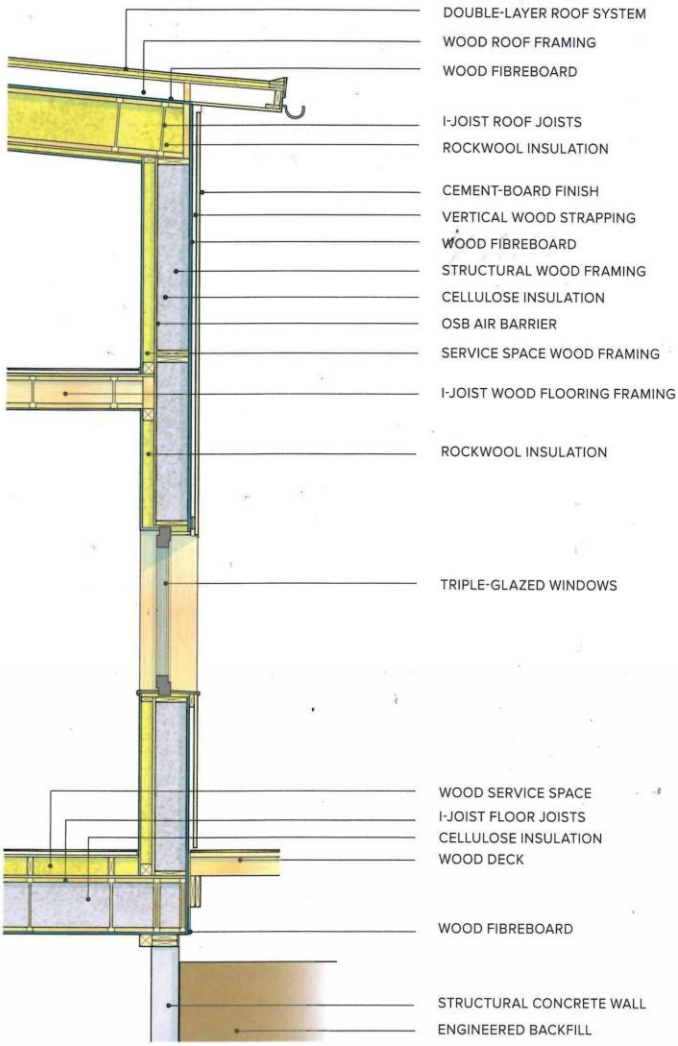
TOWARDS A PASSIVE ARCHITECTURE

TEXT Stephanie Calvet

RESIDENTIAL DESIGNERS ACROSS CANADA ARE STRETCHING TO REACH THE LOW-ENERGY METRICS OF THE RIGOROUS PASSIVHAUS STANDARD. NOW, THE STANDARD IS ALSO STRETCHING OUT TO REACH THEM.



TERRELL WONG

RAINBOW DUPLEX — WALL SECTION

The seeds of the modern passive-house industry were sown in Regina in 1977. Prompted by the oil crisis, a team of researchers constructed the visionary Saskatchewan Conservation House—a home three times more energy-efficient than the average contemporary home, with no furnace. Unfortunately, the burgeoning Canadian interest in advanced building was curtailed after an abrupt drop in energy prices.

A decade later in Germany, the rigorous voluntary Passivhaus standard was born. In 1990, a group of designers built a row of townhouses as a proof of concept. The row homes encapsulated the standard's core principles: super-insulation, extreme airtightness and use of passive solar techniques. Passivhaus mandates annual energy limits for heating and cooling (each 15 kWh per square metre of floor area), total energy consumption (120 kWh per square metre of floor area) and air leakage (0.6 air changes per hour). The resulting buildings use up to 90% less energy than conventional ones and require little or no additional heating, beyond that supplied by recycled air, occupants' body heat, lighting and appliances. How specifically a building meets these performance requirements is up to its designers.

There are now estimated to be some 30,000 certified Passivhaus buildings worldwide. North American designers are among those that have taken on the challenge. One such firm, Vancouver-based Marken Design, has over a dozen Passivhaus projects completed or on the go. The success of its Rainbow Passive House in Whistler helped educate local residents and policy makers on energy-efficient design. It was inspired by a prefabricated model shipped from Austria and assembled for the 2010 Winter Olympics, and was the first Canadian-built project to be certified by the Passivhaus Institute.

Rainbow Passive House boasts a super-insulated, virtually airtight shell constructed with prefabricated panels by manufacturer BC Passive House. The 16"-thick section comprises a 2" x 4" service wall nested inside a 2" x 10" structural and insulating wall. The exterior wall is filled with blown-in cellulose, and sheathed on the inside with oriented strand board that acts as both air barrier and vapour retarder. To minimize penetrations to the airtight barrier, plumbing and electrical are routed through the interior

BELOW, LEFT TO RIGHT The Rainbow Passive House by Marken Design; the firm's South Surrey Passive House, completed in 2013, has not yet needed to turn on its heat; South Surrey Passive House's heavy-duty windows.

MARKEN DESIGN + CONSULTING

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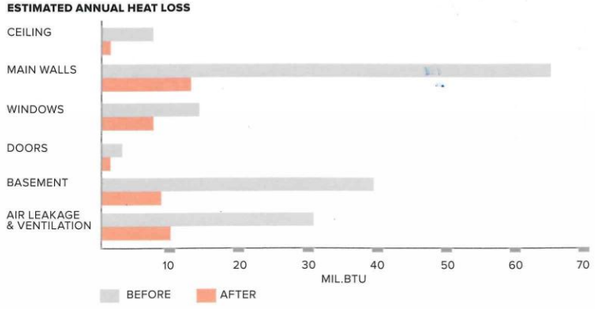

ABOVE, TOP TO BOTTOM Solares Architecture co-founders Christine Lolley and Tom Knezic gutted a Toronto home and renovated it with Passivhaus principles; an open plan maximizes usable space in the compact home.

wall, built on site by the contractor.

The Passivhaus-certified home also includes multi-lock triple-pane windows, a 95%-efficient HRV that provides a complete air change every 90 minutes, and a ductless mini-split heat pump. The owners enjoy smaller energy bills, decreased noise and reduced maintenance. They've commented on indoor comfort—the consistent temperature and fresh interior air. Principal Alex Maurer credits these gains to Passivhaus's proprietary design software, which uses thermodynamic modelling calculations to predict heat flow. This enables designers to fine-tune components to meet project design goals and energy objectives.

To keep costs reasonable, Maurer guides clients towards strategically investing in elements that cannot be easily updated in the future. His project budgets are weighted towards the building envelope. Flooring and countertop upgrades are deprioritized, and projects may include provisions for solar panels and greywater systems—to be added later on.

But it is not always easy to sell a stringent European energy standard to the Canadian market. In Maurer's experience, the average Canadian tends to be happy with a "good enough" home and to overlook future savings in ongoing operational costs, as well as the health and comfort benefits of a highly energy-efficient home.

In other parts of the country, clients and architects may be keen on low-energy homes, but find it challenging to achieve the rigorous Passivhaus standards. Nonetheless, practitioners across Canada are integrating similar design principles and are conceiving of buildings as complex systems that integrate both envelope and mechanical components.

For Toronto-based eco-residence specialists Solares Architecture, the significantly colder climate has made it difficult to reach certification. Still, each of their renovation and new-build projects presents an opportunity for the firm, led by principals Christine Lolley and Tom Knezic, to up its game. To achieve a more airtight building, far greater levels of insulation are needed, as are higher levels of workmanship, which challenges budgets. However, the rating isn't the whole story for energy-conscious clients who are looking for long-term solutions that do right by the environment while balancing efficiencies with cost.

Lolley and Knezic's own two-storey home exemplifies their commitment. After an extensive renovation, which they referred to as a "deep energy retrofit," the detached home now consumes 84% less energy than before.

To create a much tighter envelope, they gutted the 450-square-foot enclosure back to the brick, then packed it with insulation and replaced old windows with new ones. Underpinning to create a basement apartment had a secondary benefit: the house now stands on a concrete foundation poured atop four inches of expanded polystyrene foam. For wall framing, 2" x 4" studs were placed an inch away from the brick, at intervals of 24 inches rather than the usual 16 to reduce thermal bridging. Four inches of spray-foam insulation was then applied for a total R-value of 27. The roof assembly now has an R-value of over 50, with six inches of insulation added to the top and lower-density foam applied between the rafters.

At high-performance levels, minimal heating and cooling input is needed to keep a house comfortable. When the family returned from a trip during a January of epic cold, it found the house had lost only four degrees. And when you don't have space to waste, small systems are beneficial. A tiny combination boiler—no larger than a backpack—feeds the home's three levels with in-floor hydronic heating and domestic hot water. By tying a ductless mini-split into the energy-recovery ventilation ductwork, they created a unified, consistent and quiet air-delivery system for both heat and air conditioning.

"It's still challenging for people to make that conceptual leap; that their house should be airtight," says Lolley. "It's about controlling the airflow, not gaining air through cracks or up the sewer pipe. Without airtightness, insulation is useless. It's like buying the best Canada Goose parka but not zipping it up." After the envelope was in place, every leak was identified with an infrared camera and filled with acoustical sealant. The final air leakage rate of 2.08 air changes per hour is significantly better than the average Canadian home, which cycles through 4-6 air changes per hour.

Despite meeting LEED Platinum levels for airtightness, Lolley and Knezic's home doesn't attain the Passivhaus standard for that metric. However, those elusive Passivhaus targets may soon become easier to reach. Passive House Institute US, an affiliate and Passivhaus certifier, is advocating for a departure from the European methodology.

Stuart Fix, an Edmonton mechanical engineer and President of ReNü Building Science, sits on the PHIUS technical committee. In Fix's view, the vast majority of projects, particularly in cold Canadian climates, are discouraged by high-cost premiums associated with Passivhaus. Certifying every building, everywhere, to a set of European energy-performance standards is not optimal, he says. The German model was based on a more moderate climate, higher energy costs, and a base building construction of greater quality. PHIUS has proposed an adapted standard called PHIUS+ that takes into account specific North American climate zones and economic data to set more achievable targets. Their vision is for greater mainstream adoption in the industry, and for governments and municipalities to eventually integrate PHIUS+ into building codes.

Although single-family homes have been the stock and trade of the Passivhaus standard, the approach is increasingly being applied to multifamily, institutional and commercial project types. Fix drew on Passivhaus principles in consulting on a mixed-use commercial development in Edmonton: the recently completed Mosaic Centre for Conscious Community and Commerce by Manasc Isaac Architects. Here, passive design techniques are supplemented with active measures such as a geothermal heating system and a 180 kW photovoltaic system. The result is a net-zero-energy building, designed to produce as much energy over the course of a year as it uses. Manasc Isaac will be seeking Living Building Challenge and LEED Platinum certification for the project.

"Whether you hit the targets or not, there is real value in the Passivhaus Institute's methodology," says Fix. "Once informed by these techniques, no matter what your capital budget is, you can make the best use of that investment in energy efficiency. It's just a question of how far you take it."

Government, industry, environmental and consumer interests clearly intersect with the Passivhaus approach. However, there is more to be done in building up both the supply and demand side. Key to expanding a Passivhaus ethos in the North American market is educating prospective owners and occupants in the cost-benefit rationale. A developer might consider a Passivhaus agenda if homebuyers valued it. Commercial projects could benefit if the standard was adjusted in scope and benchmarks to set high—but attainable—goals for the Canadian climate.

Meanwhile, practitioners continue to push forward in integrating leading technology and design elements to create increasingly sustainable buildings. The 1977 Saskatchewan Conservation House was ahead of its time. Now, Canadian architects are determined to build on its legacy.


SONNY SHEM


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ABOVE Three views of the Mosaic Centre for Conscious Community and Commerce in Edmonton, designed by Manasc Isaac Architects to Passivhaus targets, and supplemented with active solar components.

Stephanie Calvet is a Toronto-based architect and writer.