WEST VANCOUVER HIGH-PERFORMANCE LANEWAY HOUSE

CASE STUDY

With a footprint of only 54 square meters, this laneway home was built in the rear lot of an existing single-family residence in Vancouver's Point Grey neighborhood. The house's energy performance is much higher than equivalents built to Vancouver's building bylaw requirements.

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PREPARED BY

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THE UNIVERSITY OF BRITISH COLUMBIA

GENERAL OVERVIEW

This building was designed with partial prefabrication technology, which is the signature construction technology of the design/build team. They built the framing on site and prefabricated Structural Insulated Panels (SIPs). This hybrid method reduced construction time and cost and simplifies airtightness process.

Project Overview

Building Type	Single-Family Laneway Residence
Climate Zone	5
Location	Point Grey, Vancouver
Gross/Treated Floor Area	74.1 m^2 / 53.6 m^2
Building Height	6.6 m
Number of Floors	2 stories
Project completion date	April 2017

Project Team

Project Owner	Private homeowners
Architect	Lanefab Design/Build
Structural Engineer	Deer Lake Engineering Inc.
Builder	Lanefab Design/Build
PH Consultant	Lanefab Design/Build

Project Context

At the time that this house was developed, the City of Vancouver had prescriptive requirements for single family houses' energy performance. This house was exceeded those requirements.

In respond to global climate change concerns, the City of Vancouver released the Zero Emissions Building Plan, which sets a roadmap for making all new buildings zero emissions by 2030. In 2017, the Province of British Columbia enacted the Energy Step Code to incrementally move toward net-zero energy ready buildings by 2032.

This study explores the possible solutions and challenges for small houses, like this laneway house, to meet these new requirements. To do so in a theoretical exercise was conducted to improve the energy performance of this building to Passive House standard requirements. The Passive House standard requirements are comparable with step 5 of BC Energy Step Code.

ENERGY PERFORMANCE

This building was designed to reduce energy use through increased insulation, use of a Heat Recovery Ventilator (HRV), high-performance windows, energy efficient lighting and appliances, and metering of energy usage. These solutions are similar, but not as strenuous as Passive House solutions.

Envelope

The SIP panel used for the envelope provided high thermal resistance with less thickness and higher air tightness compared to traditional wood framing. For an improved airtightness, the connection between interior OSB sheathings were taped. Placing the airtight layer on the interior side and adding an interior service cavity, reduced the risk of puncture on the exteriors or interior during construction and use of the building.

The building's wood-frame windows and doors have significantly higher thermal performance compared to those used in a code-level equivalent house. The windows are triple-glazed with high performance Passive House-rated frames. The skylight used is quadruple-glazed.

Heating & Cooling

The building has a central heating system with electric hydronic baseboard heaters and a Plenum duct, an air-distribution box attached directly to the supply outlet of the HRV. An Rheem Eco-Hybrid WH50GM air-source air-source heat pump provided both space heating and domestic hot water in a conventional tank.

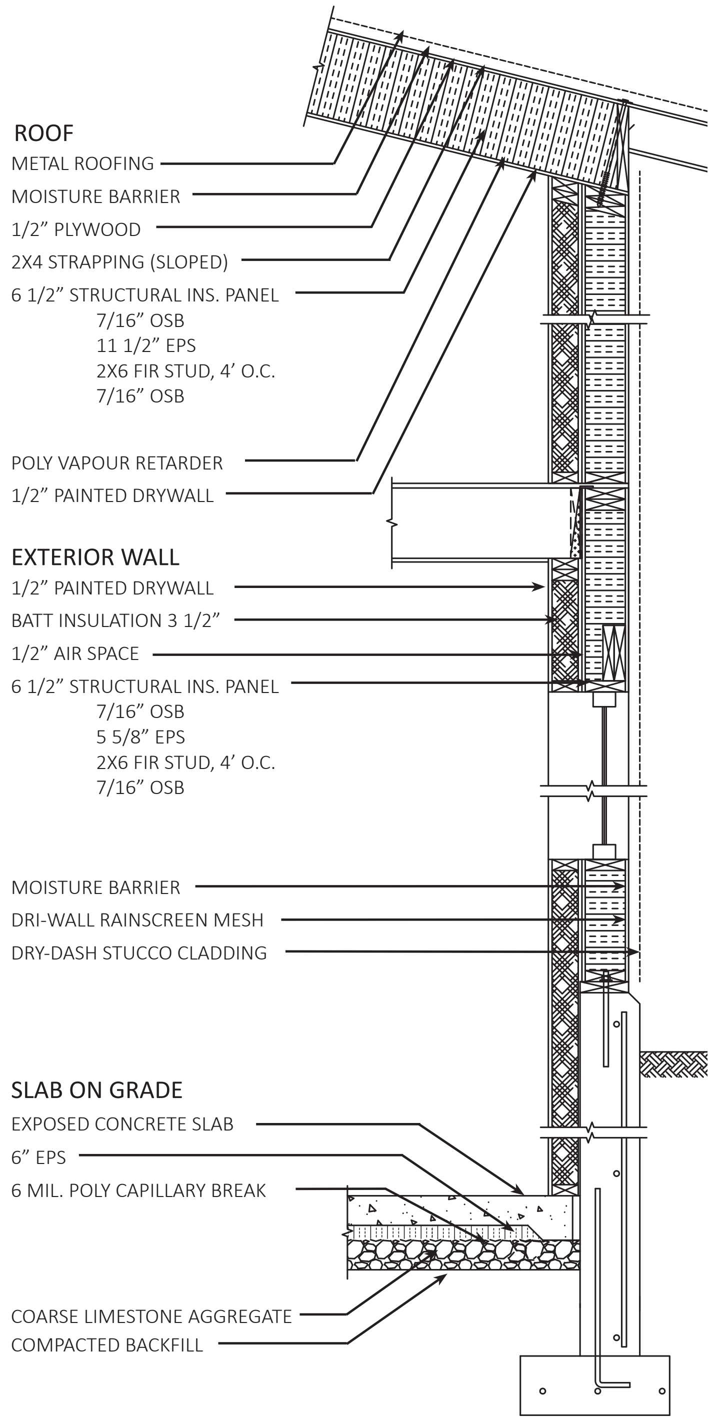
The house uses passive cooling strategies through shading and cross ventilation and stack effect through windows and the skylight.

Heat Recovery Ventilation

This house uses Venmar Kubix Heating Recovery Ventilation (HRV) system that allows for a comfortable and healthy indoor environment, and has an efficiency of 71%. It is supplemented by secondary fans on the electric kitchen range and exterior dryer exhaust system.

Renewable Energy

Appropriate infrastructure for future inclusion of sustainable energy technologies was considered, including wiring and piping, for future use of solar panels and a charging station for electric vehicles.



Wall Section: Common assemblies and details found in this structure. Note the use of SIPs to allow for thinner walls with adequate insulation. The water barrier system reduces risk of deredation through rainscreen cladding. A lack of insulation in the concrete slab on grade and direct connection to the wall results in some thermal bridging.

PASSIVE HOUSE UPGRADE

A theoretical study was conducted to assess the feasibility of achieving a Passive House Classic level performance for this laneway home. However, due to its small size and insufficient solar heat gain, achieving Passive House performance proved to be challenging.

As-built baseline compared to theoretical upgrades and passive house criteria.

Parameter	Characteristic	Unit	Passive House Criteria	Passive House Alternative	As-built	Theoretical Upgrade
Air tightness		ACH @ 50Pa	≤ 0.6	-	1.99	0.6
Space Heating	Annual demand	kWh /m²a	≤ 15	-	59	15.3
	Heating load	W/m²		≤ 10	30	13
Space cooling	Annual demand	kWh /m²a	≤ 15	-	3	5
	Cooling load	W/m²	-	≤ 10	0	0
	Frequency of overheating > 25˚ C	%	≤ 10	-	1.4	11
Primary energy requirements	Non-renewable (PE)	kWh/m²a	-	≤ 60	144	61.7
	Renewable (PER)	kWh/m²a	≤ 120	-	280	135

Upgrades

Without changing the overall design of the home or the wall dimensions, the following improvements were modeled in a Passive House Planning Package (PHPP):

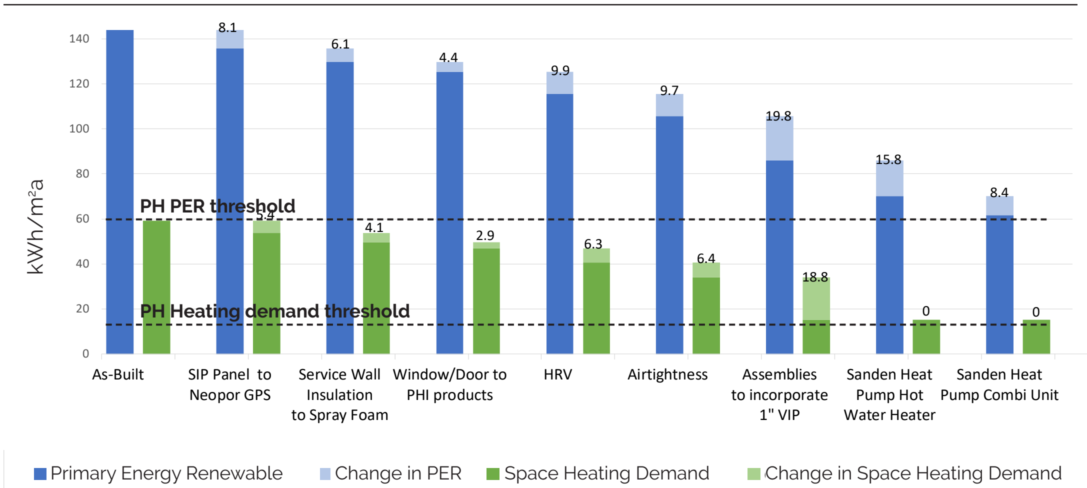
1. Use of Neopor instead of EPS foam in SIP panels
2. Replacing batt insulation and air space with 2 lb spray foam
3. Fenestration upgrades to PH certified products
4. HRV upgrades to PH certified products
5. Using Vacuum Insulation Panels (VIP) in all assemblies
6. Improving airtightness to 0.6 ACH
7. Using a heat pump for hot water
8. Using a split-system heat pump for hot water

Results

The most significant improvements in performance were due to additional insulation, combining spray foam and VIPs. Although the final results did not quite meet passive House standard performance, the theoretical changes were confined to the original design's wall thickness, which is thinner than average passive house walls.

In the original design, window and door performance, mechanical systems, and airtightness prevent the house from achieving Passive House level performance. Additionally it is more difficult to achieve Passive House certification in smaller houses. This is because of:

- Heat loss due to high envelope surface area relative to heated floor area (known as the form factor)
- Higher air change rate due to a smaller volume of air.



Changes in energy performance due to theoretical upgrade steps. Each step is cumulative.

Due to the building's relatively small size, its form factor is 4.83, whereas that of a typical Passive House single-family house is around 3.

GLOSSARY

Key terms, definitions, and abbreviations used in this case study.

BC Energy Step Code A voluntary provincial standard that provides an incremental and consistent approach to achieving more energy-efficient buildings that go beyond the requirements of the base BC Building Code.

Heat Recovery Ventilator (HRV) A mechanical energy recovery system which works between two streams of different temperatures. Residual heat from exhaust gas is recovered and effectively transferred to a fresh air stream. Building exhaust air is used as a heat source or heat sink depending on climate conditions, time of year and requirements of the building.

Plenum duct An air-distribution box attached directly to the supply outlet of the HVAC equipment. The ductwork that distributes the heated or cooled air to individual rooms of the house connects to the plenum.

Heat Pump a mechanical device that transfers thermal energy in the opposite direction of spontaneous heat transfer by absorbing heat from a cold space and releasing it to a warmer reservoir.

Passive House an internationally recognized certification program, developed by an independent research institute based in Germany. The program is intended to result in buildings with extremely low space heating and cooling needs and consequently lower environmental impacts, as well as a comfortable indoor temperature and air quality.

Passive House Planning Package (PHPP) PHPP is specifically developed to design Passive House buildings and is based on a combination of several existing, proven and verified calculation methods that are compliant to the European standard for the thermal performance of buildings (EN 832).

Vacuum Insulation Panels (VIP) Commonly used as a retrofit for wood-frame walls.

Form Factor The form factor is the ratio of external surface area by internal treated floor area.

Structural Insulated Panels (SIPs) A sandwich structured composite, consisting of an insulating layer of rigid core sandwiched between two layers of structural board.

Non-renewable Primary Energy (PE) Demand The total energy demand for operation of a building, including heating, cooling, hot water, lighting, and plug loads. To account for energy losses along the generation and supply chain, Passive House Institute (PHI) multiplies the building energy requirement by a PE factor.

Primary Energy Renewable (PER) Demand To account for renewability of different energy sources, PHI developed new factors (PER) to replace PE factors.

Vancouver Building Bylaw Among BC municipalities, the City of Vancouver is uniquely able to adopt its own Building Bylaw. VBBL regulates the design and construction of buildings in the City.

Form Factor The form factor is the ratio of external surface area by internal treated floor area.

U-value A measure of thermal performance or heat transfer through a surface due to conduction and radiation. The lower the U-Value, the more energy efficient the surface is.