MIZU PASSIVE HOUSE CONSULTING

Project Documentation

Clark Road Passive House

1. Abstract

Single Family Residence in Squamish, British Columbia, Canada

1.1 Data

Year of construction	2019	**Space heating**	**13 kWh/(m²a)**
U-value external wall	0.083 W/(m²K)		
U-value basement ceiling	0.060 W/(m²K)	**Primary Energy Renewable (PER)**	38 kWh/(m²a)
U-value roof	0.063 W/(m²K)	**Generation of renewable energy**	N/A
U-value window	0.79 W/(m²K)	**Non-renewable Primary Energy (PE)**	82 kWh/(m²a)
Heat recovery	84 %	Pressure test n_{50}	0.19 h-1
Special features	Electric car charging station		

1.2 Brief Description

Located on the shores of the Squamish River, British Columbia, this single-family Passive House opens its main living area to the foothills of Mount Lapworth to the West, the iconic Stawamus Chief to the South and the imposing silhouette of Mt. Garibaldi to the East.

The beautiful coastal-alpine style of the building is the result of its future resident's desire for a light ecological footprint home and the builder's philosophy of sustainable design that respects the land, its people, and the environment.

This light ecological footprint was made possible by the adoption, early in the design process, of all fundamental Passive House principles, including optimizing floor layout for optimum natural lighting and taking advantage of predominant winds conditions for efficient natural cross-ventilation.

The mountainous terrain around the town of Squamish had significant horizon shading impact on the project. The lot, located inside the Squamish River flood plain, imposed certain design constraints for the ground floor of the building.

Built using traditional materials and construction techniques, the building was certified to Passive House Classic in 2020

1.3 Responsible Project Participants

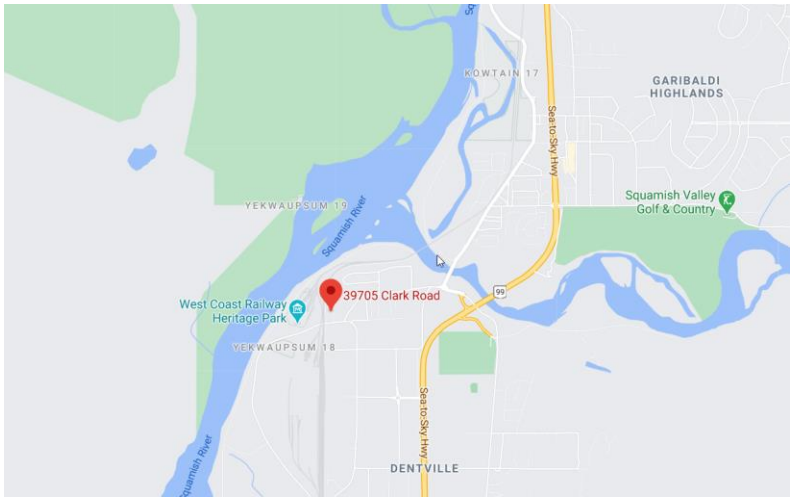
Architect:	Ms. Kayla Hildebrand bluewaterconcepts.ca
Implementation planning:	Mr. Mike Vancapelle bluewaterconcepts.ca
Building systems:	Mr. Pierre-Andre Santin, CPHC mizupassivehouse.com
Structural engineering:	Mr. Dan Wicke, PEng whmengineers.com
Building physics:	Mr. Pierre-Andre Santin, CPHC mizupassivehouse.com
Passive House project planning:	Mr. Pierre-Andre Santin, CPHC mizupassivehouse.com
Construction management:	Mr. Mike Vancapelle bluewaterconcepts.ca
Certifying body:	Mr. Stephen Quinn, Certifier peelpassivehouse.ca
Certification ID:	28507_APC_PH_20201117_SQ
Project ID:	6036
Author of project documentation:	Mr. Pierre-Andre Santin, CPHC mizupassivehouse.com
Date, Signature:	 Pierre-Andre Santin, CPHC November 17th 2020

2. Location

Geolocation overview

The Clark Road Passive House is located on the North End of Howe Sound, on the Sea to Sky highway linking Vancouver to Whistler, British Columbia, Canada.

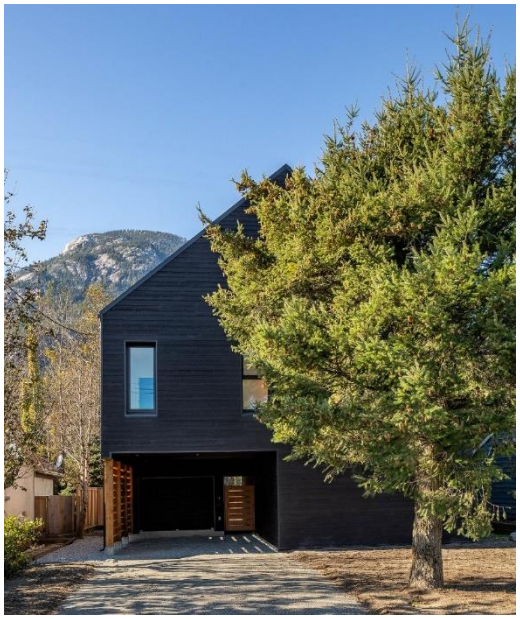
Street Map

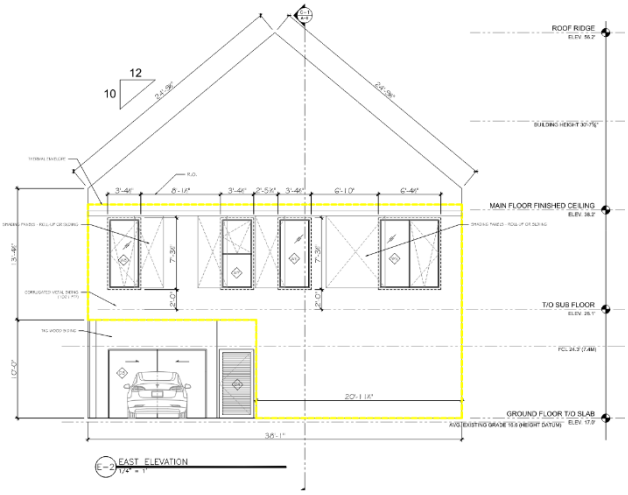


The Clark Road Passive House is the first Certified single family Passive House built in the District of Squamish. Throughout its development, the project has generated tremendous interest at all levels of government and in the local community.

3. Elevations

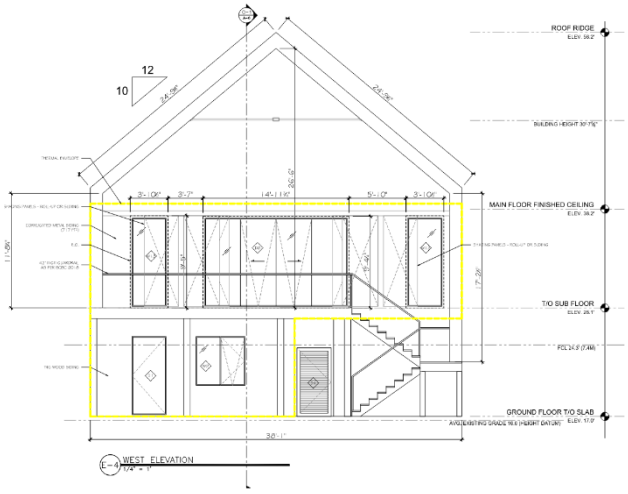
East Elevation





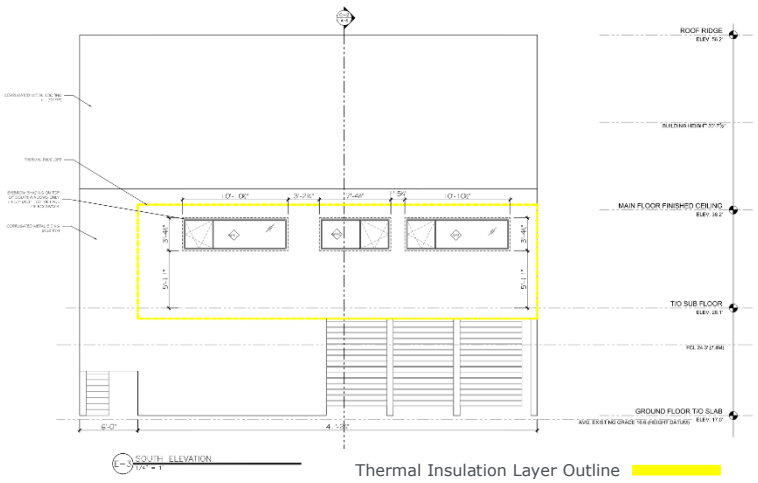
Thermal Insulation Layer Outline

West Elevation



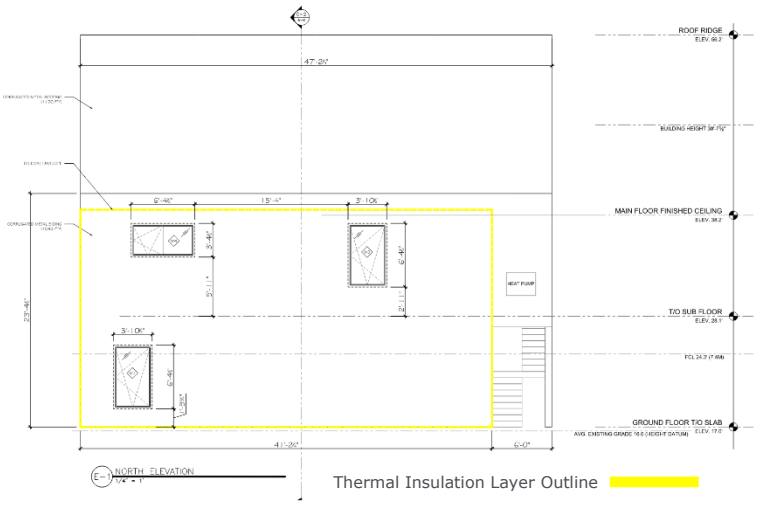
Thermal Insulation Layer Outline

South Elevation



Thermal Insulation Layer Outline

North Elevation

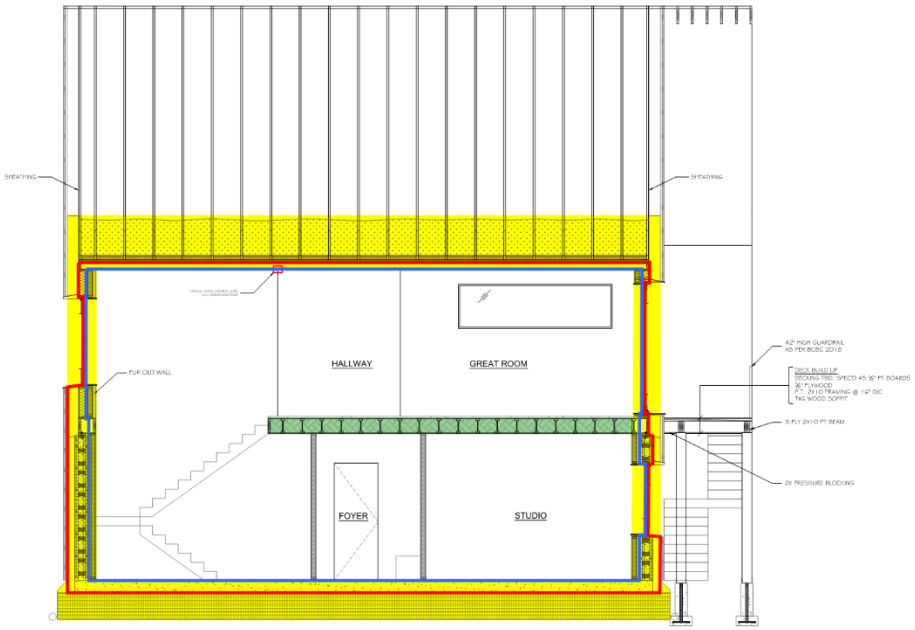


Thermal Insulation Layer Outline

4. Building Sections

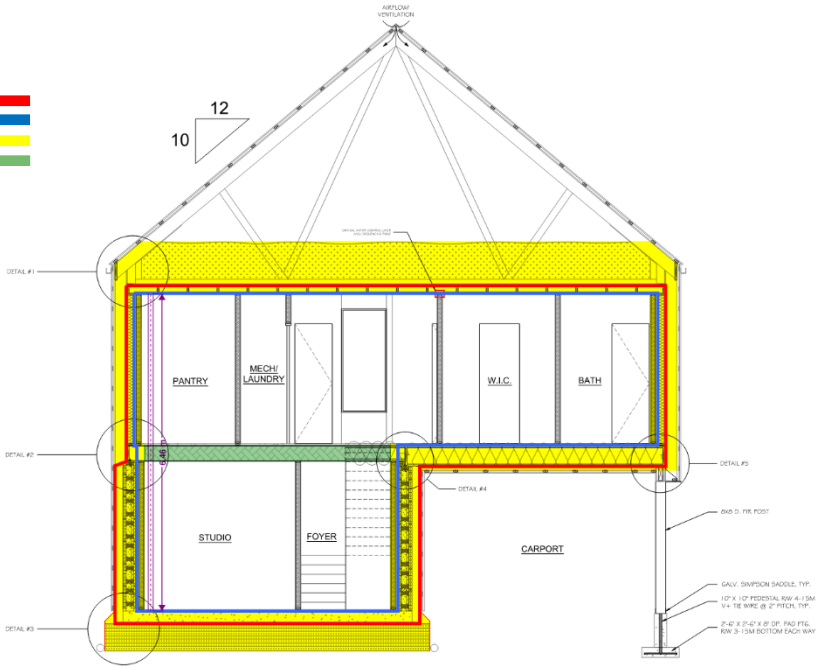
East-West Section

Air Barrier
Vapour Control Layer
Thermal Insulation Layer
Sound Control



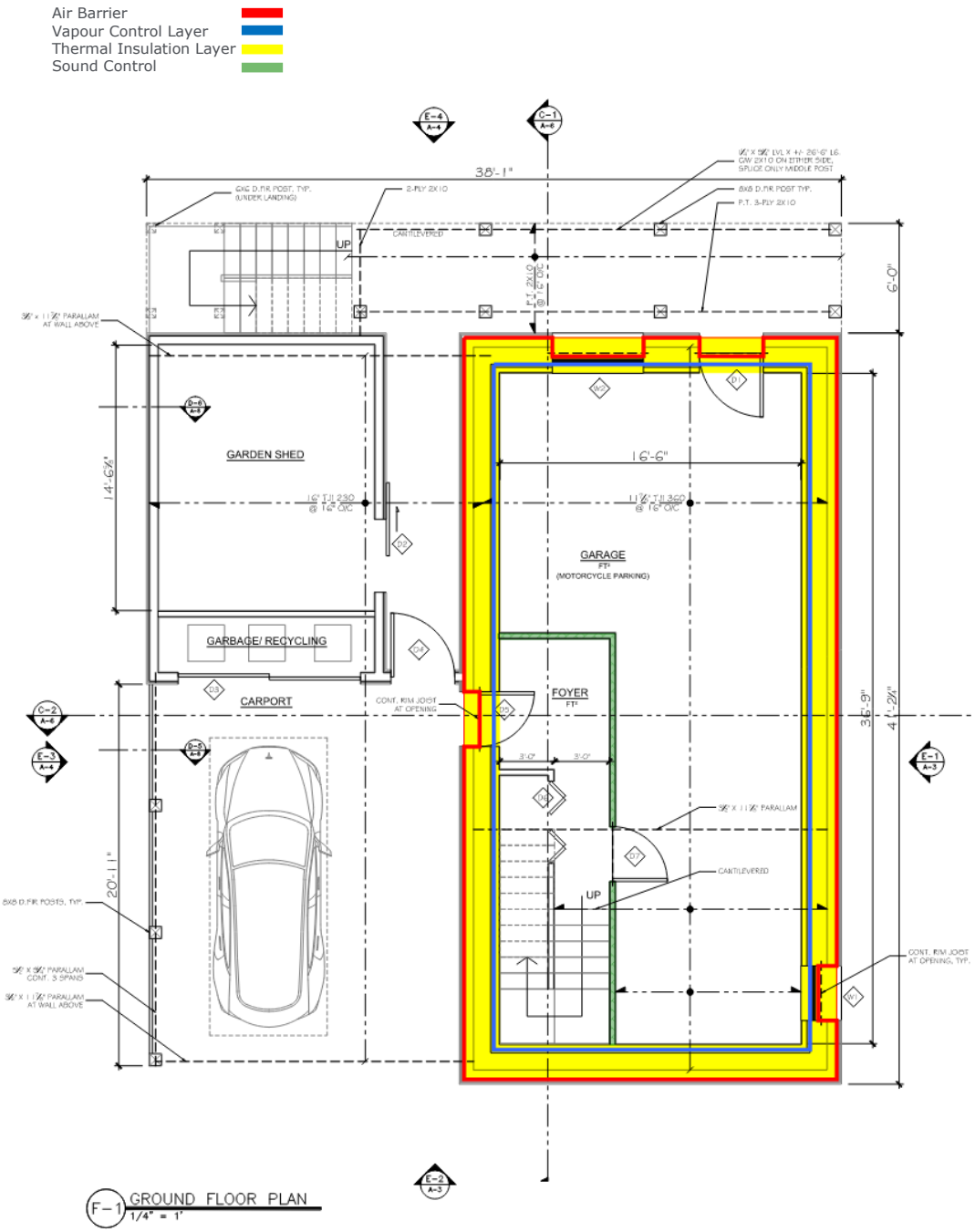
North-South Section

Air Barrier
Vapour Control Layer
Thermal Insulation Layer
Sound Control

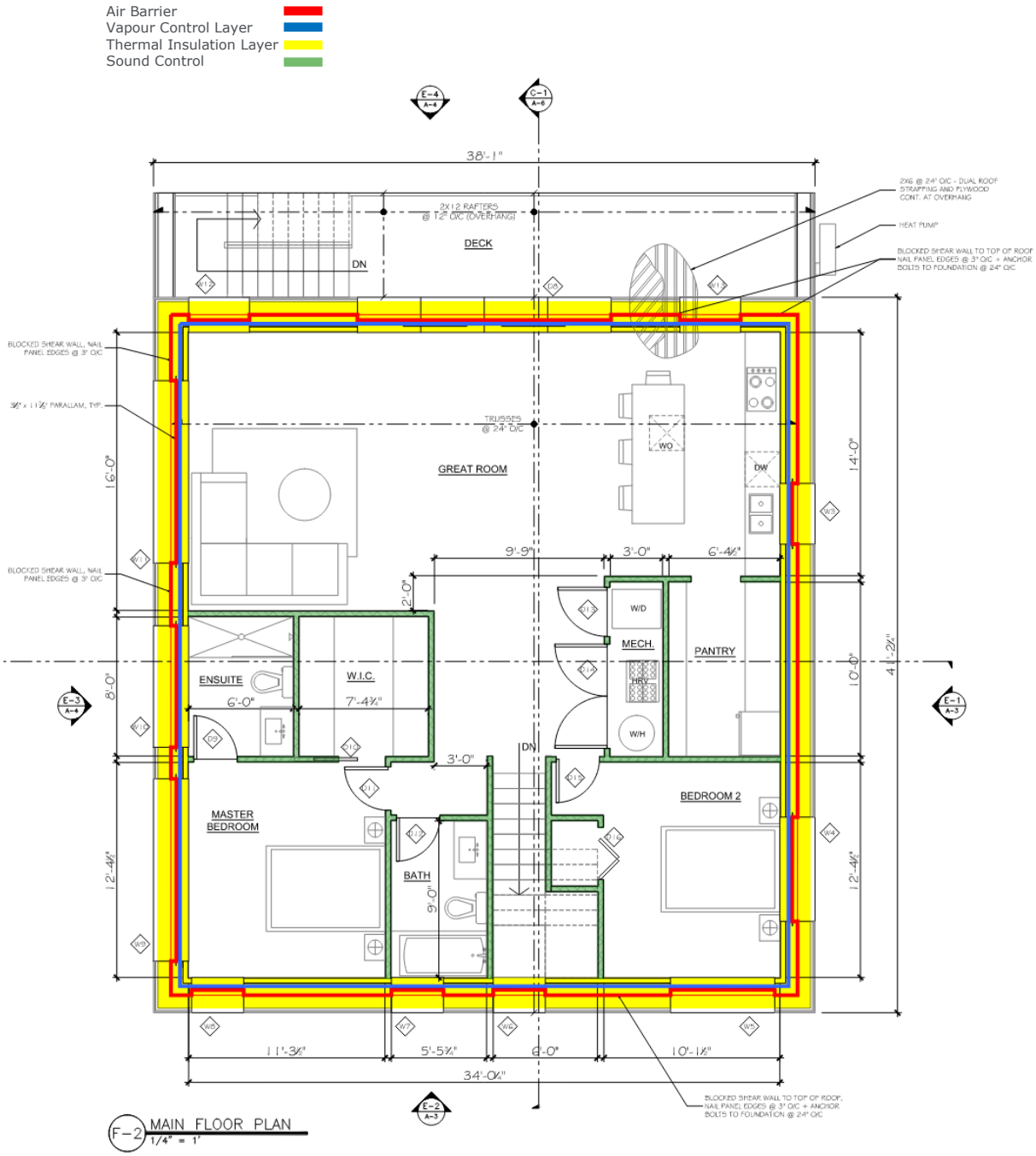


5. Floor Plans

Ground Floor



Main Floor



6. Interior Photos

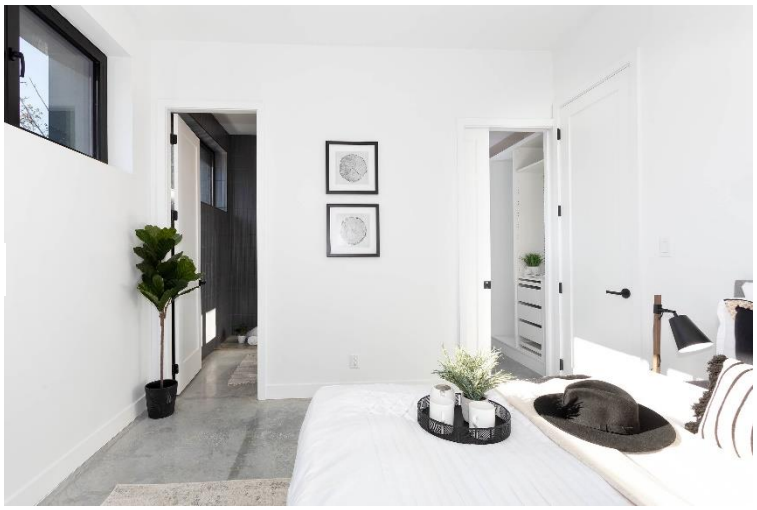
Main Floor Kitchen

Main Dining Area

Main Floor Living Area

Main Floor Guest Bedroom

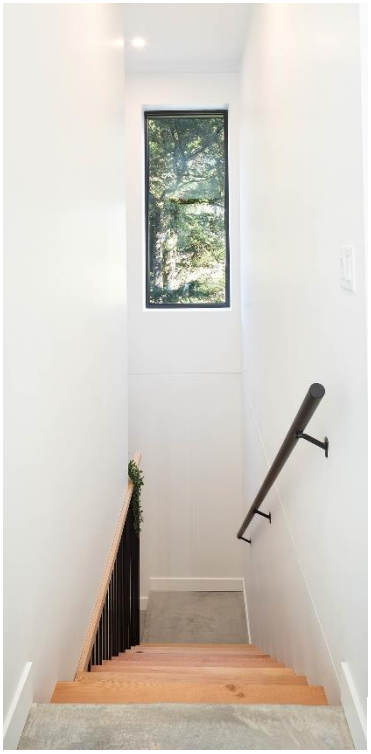
Main Floor Master Bedroom



Main Floor Master Bathroom

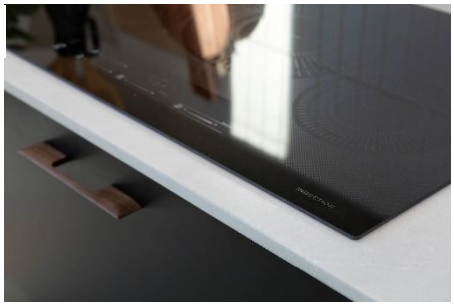
Ground Floor Main Entrance

Ground Floor Studio



Staircase

Induction Cooktop

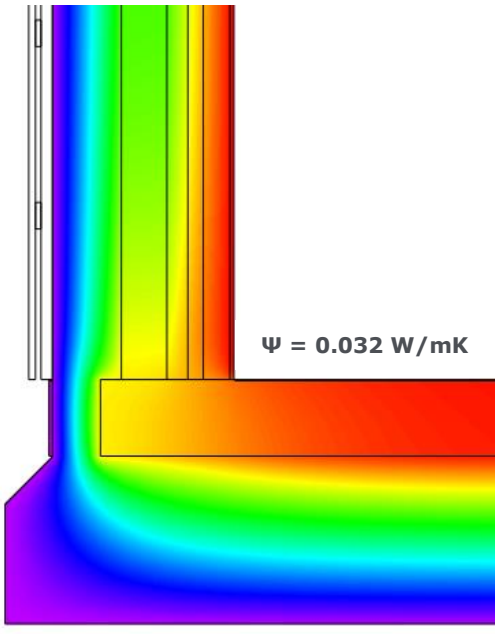


7. Thermal Envelope

Foundation details

22” EPS Type 2, Air Barrier
12” CIP concrete slab
U = 0.06 W/m²K

Slab rebar and building services penetrations



Slab edge insulation

Ground Floor Walls

The building is located within the boundaries of the Squamish River flood and debris plain: the ground floor wall assembly structural components use non-organic materials (Insulated Concrete Form).

U = 0.085 W/m²K

Assembly no.								Interior insulation?	
02ud	Wall AGL: ICF								
		Heat transmission resistance [m²K/W]							
Orientation of building element	2-Wall	interior R_{si}	0.13						
Adjacent to	3-Ventilated	exterior R_{se}	0.13						
Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]		R	Thickness [mm]	[in.]
Gypsum	0.250						0.29	12.7	0.50
Knauf EcoBatt	0.036	2x4/24 Wood Studs	0.130				12.05	88.9	3.50
Rockwool CB110 (Wall ICF)	0.036						8.01	50.8	2.00
ICF: Nudura EPS Type 2	0.036						11.02	69.9	2.75
ICF: Concrete (2% Steel)	2.500						0.35	152.4	6.00
ICF: Nudura EPS Type 2	0.036						11.02	69.9	2.75
EPS 2-16 Board	0.038						23.85	158.8	6.25
Rainscreen and Cladding								79.4	3.13
Percentage of sec. 1		Percentage of sec. 2		Percentage of sec. 3				Total [cm]	(in.)
94%		6.25%						68.3	26.88
								RSI	R
U-value supplement	0.0027 W/(m²K)			U-value:	0.085 W/(m²K)			11.71	66.51
								Btu/(h.ft².F)	(h.ft².F)/Btu

Main Floor Walls

The wood frames wall assembly of the main floor was carefully designed to have a U-value similar to the ICF walls on the ground floor, providing a uniform heat loss through all vertical areas of the thermal envelope.

U = 0.082 W/m²K

Assembly no.							Interior insulation?	
03ud	Wall AGL: Wood Framed							

Heat transmission resistance [m²K/W]

Orientation of building element: 2-Wall — interior R_{si}: 0.13

Adjacent to: 3-Ventilated — exterior R_{se}: 0.13

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	R	Thickness [mm]	[in.]
Gypsum	0.250					0.29	12.7	0.50
Knauff EcoBatt	0.036	2x4/24 Wood Studs	0.130			12.05	88.9	3.50
Knauff EcoBatt	0.036			2x6/24 Wood Studs	0.130	18.94	139.7	5.50
Plywood Sheathing	0.130					0.83	19.1	0.75
Rockwool CB-110	0.036					36.06	228.6	9.00
Rainscreen and Cladding							79.4	3.13

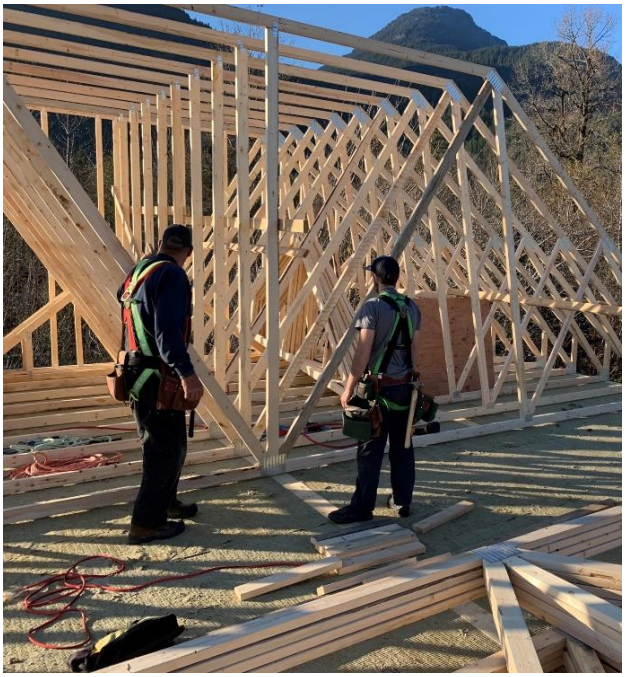
Percentage of sec. 1	Percentage of sec. 2	Percentage of sec. 3	Total [cm]	(in.)
88%	6.25%	6.25%	56.8	22.38

U-value supplement: 0.0021 W/(m²K)

U-value: 0.082 W/(m²K)

RSI	R
12.22	69.38
Btu/(h.ft².F)	(h.ft².F)/Btu

Roof



The thermal envelope follows the main floor horizontal ceiling. The engineered trusses keep the roof's structural design simple, easy to erect, and cost efficient, while providing the high pitch alpine esthetics desired by the client.

U = 0.063 W/m²K

Assembly no.								Interior insulation?	
04ud	Roof: Engineered Wood Trusses								
		Heat transmission resistance [m²K/W]							
Orientation of building element	1-Roof	interior R_{si}	0.10						
Adjacent to	0.24	exterior R_{se}	0.24						
Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	R		Thickness [mm]	[in.]
Gypsum	0.250					0.29		12.7	0.50
Knauf EcoBatt	0.036	2x6/24 Wood Rafters	0.130			18.94		139.7	5.50
Plywood Sheathing	0.130					0.69		15.9	0.63
Rockwool CB110	0.036					6.01		38.1	1.50
Rockwool Batt	0.036			2x4/24 Wood Trusses	0.130	12.05		88.9	3.50
Blow-in Cellulose (Roof)	0.054					48.08		457.2	18.00
Percentage of sec. 1		Percentage of sec. 2		Percentage of sec. 3				Total [cm]	(in.)
88%		6.25%		6.25%				75.2	29.63
							RSI	*R*	
U-value supplement	W/(m²K)			U-value: 0.063	W/(m²K)		15.78	89.59	
							Btu/(h.ft².F)	(h.ft².F)/Btu	

Exposed Floor

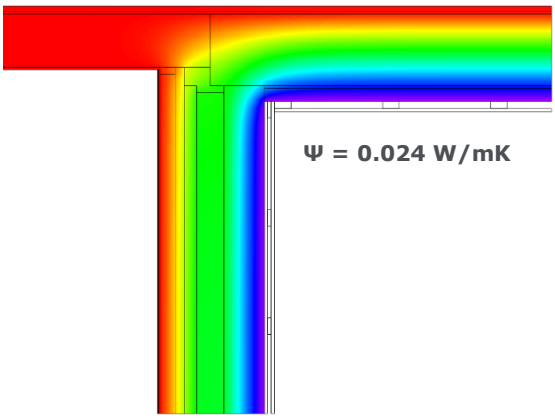
The XPS rigid foam glued on both sides of the TJIs' web reduces thermal bridging and facilitates the friction-fit installation of the rockwool batts in the exposed floor.

U = 0.075 W/m²K

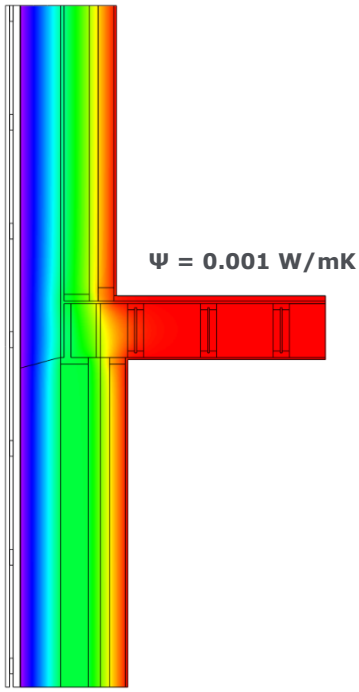
Assembly no.								Interior insulation?	
05ud	Exposed Floor: Insulated TJI-560								
		Heat transmission resistance [m²K/W]							
Orientation of building element	3-Floor	interior R_{si}	0.17						
Adjacent to	3-Ventilated	exterior R_{se}	0.17						
Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	R	Thickness [mm]	[in.]	
Polished Concrete	2.000					0.09	31.8	1.25	
Sub-floor	0.130					0.69	15.9	0.63	
Rockwool Batt	0.036	Wood Flange	0.130	Wood Flange	0.130	3.51	34.9	1.38	
Rockwool Batt	0.036	XPS	0.029	OSB Web	0.130	51.33	336.6	13.25	
Rockwool Batt	0.036	Wood Flange	0.130	Wood Flange	0.130	3.51	34.9	1.38	
Plywood Sheathing	0.130					0.55	12.7	0.50	
Rockwool CB110 (Exposed Floor)	0.036					12.02	76.2	3.00	
Rainscreen and Cladding							57.2	2.25	
	Percentage of sec. 1		Percentage of sec. 2		Percentage of sec. 3		Total [cm]	(in.)	
	78%		19.1%		2.7%		60.0	23.63	
U-value supplement		W/(m²K)	U-value:	0.075	W/(m²K)		RSI	R	
							13.29	75.45	
							Btu/(h.ft².F)	(h.ft².F)/Btu	

8. Junction Details

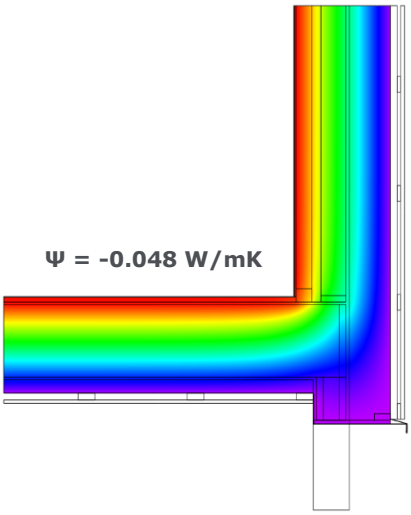
ICF wall to exposed floor transition



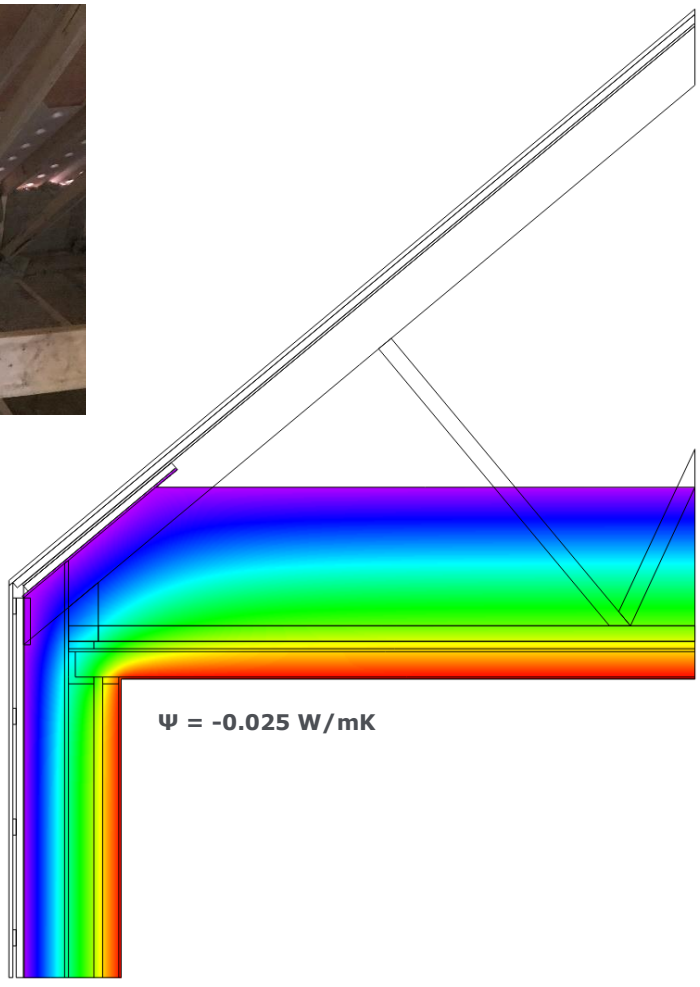
ICF to wood frames walls transition



Exposed Floor to Wall



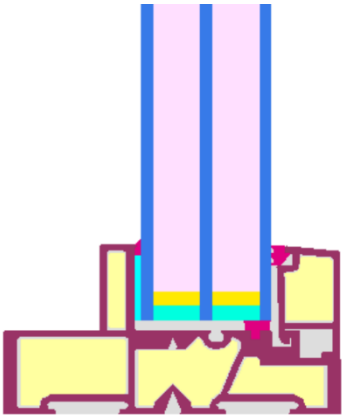
Wall to Roof



9. Windows

Certified window frame

Category: **Fixed window**
Manufacturer: **Cascadia Windows & Doors, Langley, BC, Canada**
Product name: **Cascadia Fixed Window PH**



This certificate was awarded based on the following criteria for the cool, temperate climate zone

Comfort	U_W = 0.77	≤	0.80 W/(m² K)
	$U_{W,installed}$	≤	0.85 W/(m² K)
	with U_g	=	0.70 W/(m² K)
Hygiene	$f_{Rsi=0.25}$	≥	0.70

www.passivehouse.com

Frame Data

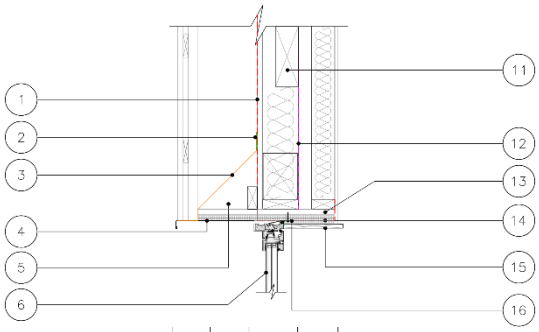
Frame values			Frame width b_f mm
Top fixed	(tof)		58
Side fixed	(sf)		58
Bottom fixed	(bof)		58
Mullion fixed	(m)		99

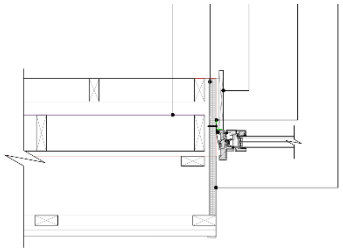
Super Spacer Premium: ***0.020 W/mK***

Triple Pane Insulated Glazing Unit

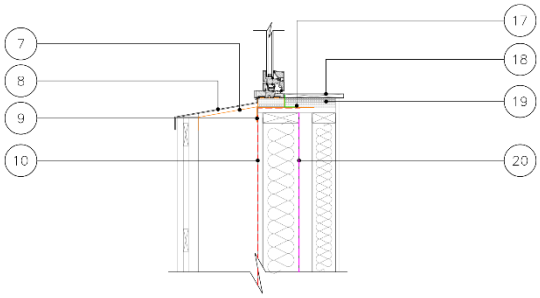
Low-E options	Center-of-Glass Data per EN 673		
	U_g	SHGC	VT
Calibration Panel	0.700		
180/180	0.646	0.555	0.690
272/180	0.618	0.392	0.626
270/180	0.612	0.352	0.607
366/180	0.594	0.270	0.563
340/180	0.602	0.166	0.337
180/180/i89	0.604	0.531	0.675
272/180/i89	0.597	0.378	0.611
270/180/i89	0.574	0.340	0.593
366/180/i89	0.558	0.262	0.550
340/180/i89	0.565	0.165	0.331

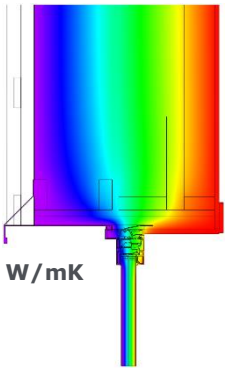
Window details



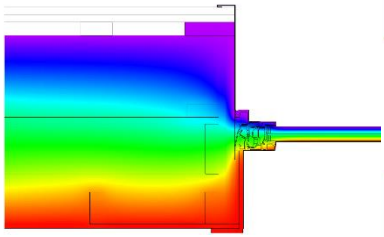


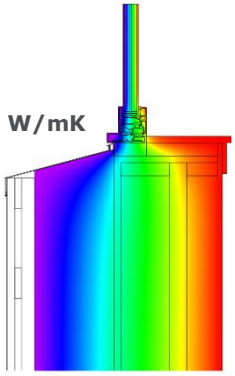
Ψ = 0.028 W/mK





Ψ = 0.027 W/mK





Ψ = 0.024 W/mK

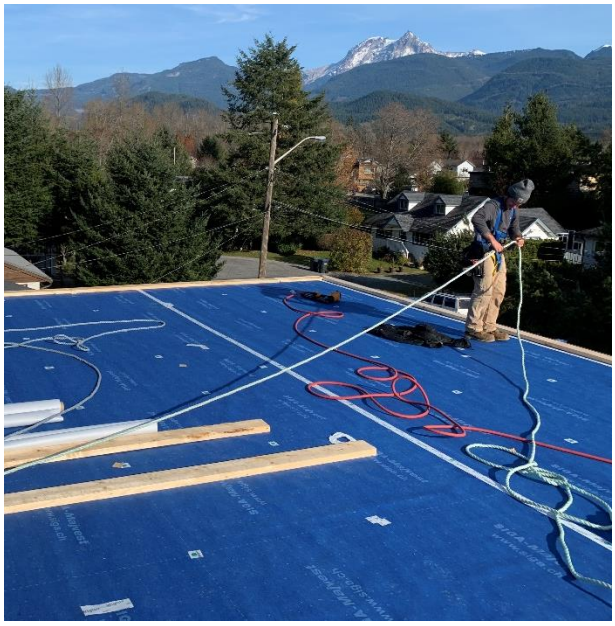
9. Airtight Envelope

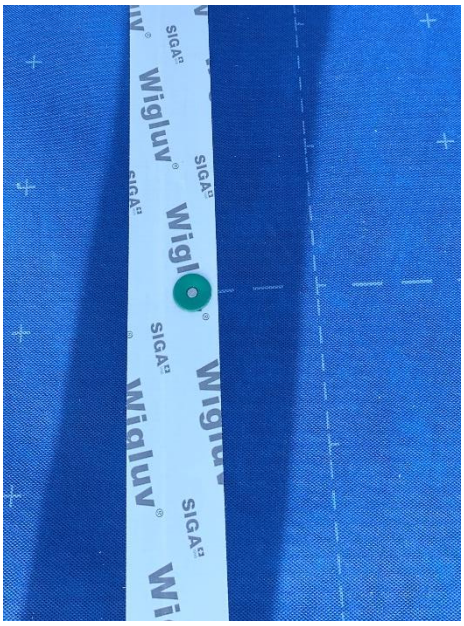
An “exterior” air barrier strategy provides airtightness for the building.

The air barrier layer under the building’s concrete slab-on-grade is a 10-mil polyolefin membrane (WR Meadows Perminator®) taped (Using WR Meadows Perminator® Tape) to the base of the Nudura Insulated Concrete Form (ICF) ground floor foundation walls.

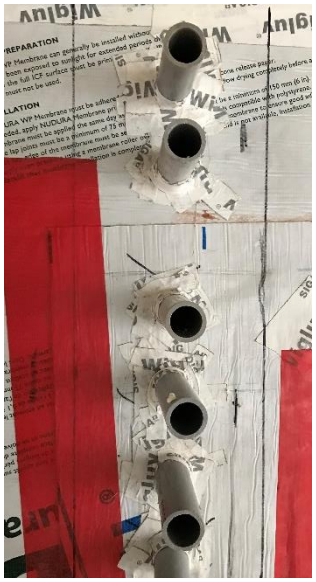
An airtight peel and stick membrane (Nudura Waterproofing Membrane®) applied to the exterior side of the ICF foundation walls overlaps the Perminator® membrane at its perimeter.

A Weather Resistant Barrier (WRB) and Air Barrier (AB) membrane (Siga Majvest®) is mechanically fastened to the main floor wood-framed walls sheathing, to the roof deck (Horizontal plywood layer between the horizontal ceiling and the roof trusses) and over the rough openings of all windows and doors.





High-performance airtight tape (Siga Fentrim®) is used to complete the connection between the Siga Majvest®, the Nudura Waterproofing® Membrane, and the inside face of the window and door frames. All mechanical, electrical, and ventilation penetrations are fitted with airtight EPDM gaskets (ProClima Kaflex®) and taped to the Siga Majvest® with Siga Wigluv®). Air sealing of penetrations through the Nudura Waterproofing Membrane® and the WR Meadows Perminator® is made using the manufacturers' recommended tapes.



Final Passive House Air Leakage Test Report

In Compliance with EN13829 – European Union

Summary

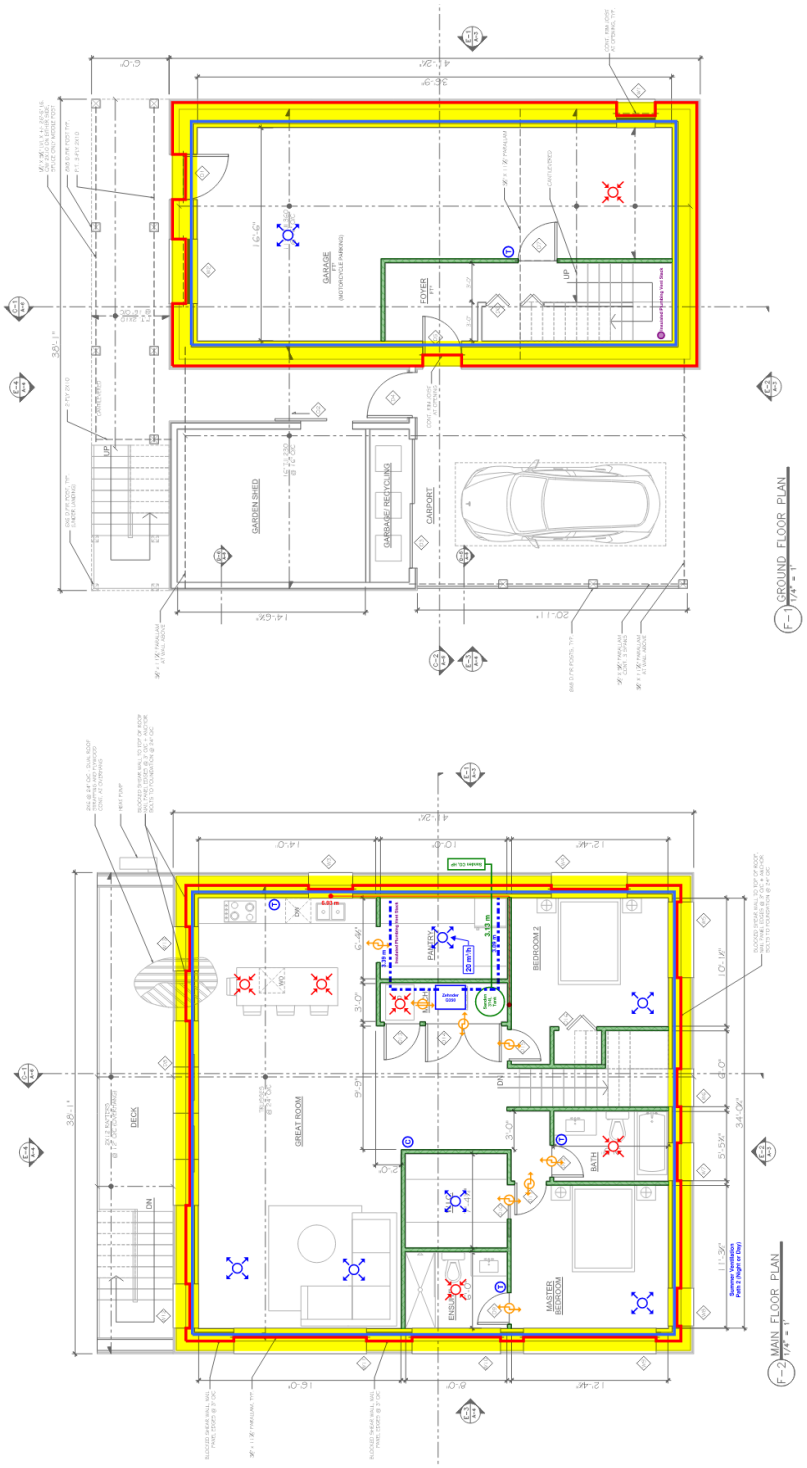
retrotec **FanTestic**	version: **5.11.79**	licensed to: **Domus Home Energy**
Test date: **2020-09-14**	By: **Barbara Meihuizen**	
Customer:		
Building Lot Number:		
Building address:	**39705 Clark Road** **Squamish, BC** **Canada**	

Building and Test Information	
Test file name:	**EN13829-EU 2020-09-14 1109**
Building volume [m^3]:	**508**
Envelope Area [m^2]:	**640.4**
Floor Area [m^2]:	**161.5**
Building Height (from ground to top) [m]:	**6.5**
Building Exposure to wind:	**Partially protected building**
Accuracy of measurements:	**0%**

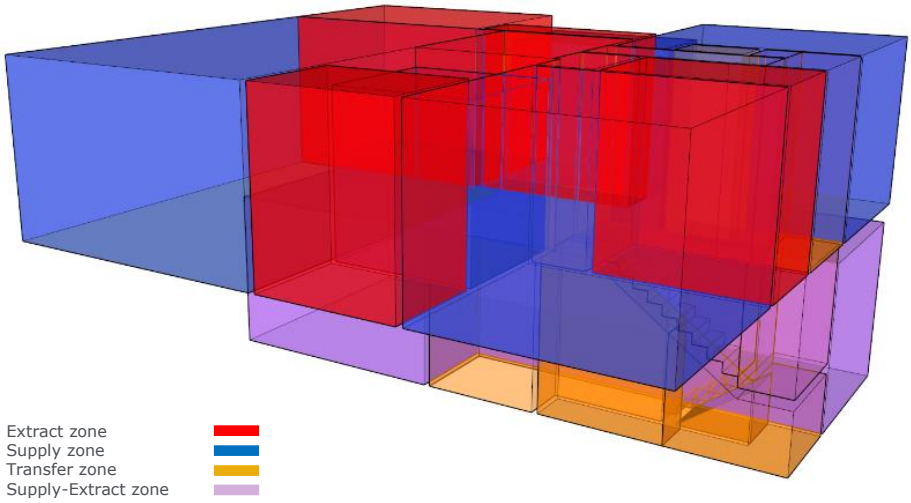
Results	
Air flow at 50 Pa, [m^3/h]	**96.330**
Air changes at 50 Pa, n_{50} [/h]	**0.19**
Flow per Envelope Area at 50 Pa, [$m^3/h/m^2$]	**0.150**
Flow per Floor Area at 50 Pa, [$m^3/h/m^2$]	**0.597**
Effective leakage area at 50 Pa, [cm^2]	**29.35**
Equivalent leakage area at 50 Pa, [cm^2]	**48.15**
Leakage per Envelope Area at 50 Pa, [cm^2/m^2]	**0.045850**
Leakage per Floor Area at 50 Pa, [cm^2/m^2]	**0.182**

10. Heating and Ventilation System

Diffusers and passive transfer grilles locations



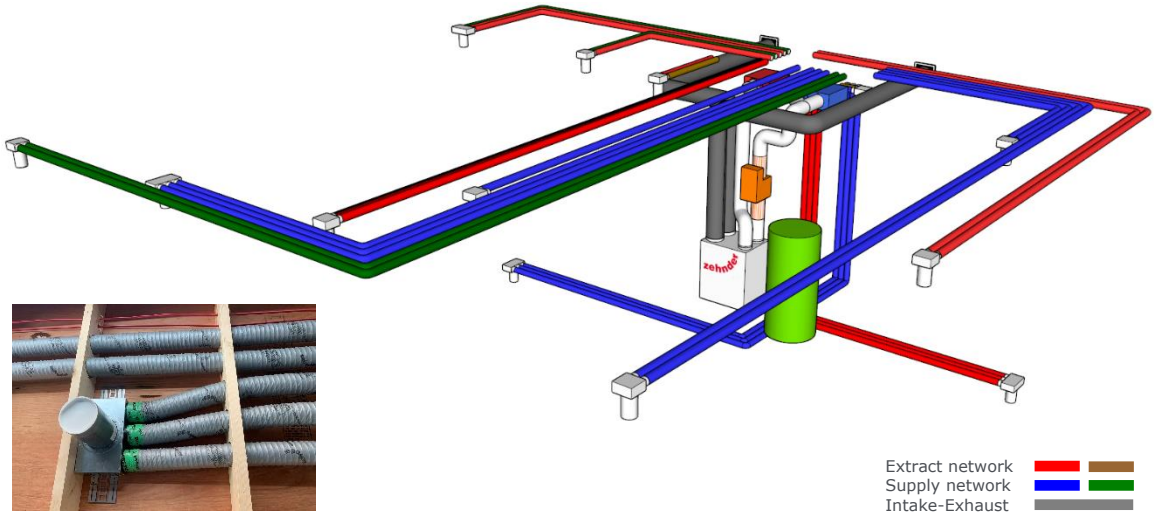
V_{n50} supply, extract, and transfer volumes



Getting a clear understanding of the ventilation system early in the design process was key to optimize the floor plan layout for year-round thermal comfort.

Ventilation System 3D Layout

This 3-dimensional model of the ventilation system helped the design team avoid structural and other building services conflicts, balance duct lengths for system efficiency and easy provisioning, and ensure that the mechanical room was adequately dimensioned and laid out.



Zehnder ComfoAir Certified HRV and Supply Air Heater

The Clark Road Passive House is solely heated via Supply Air. A 3.5kW electric Post-Heater tempers the supply air, whilst localized heat sources (electric in-floor mats) provide additional comfort in temperature sensitive (extract) rooms like bathrooms.

Category:	**Air handling unit with heat recovery**
Manufacturer:	**Zehnder Group Zwolle B.V. Netherlands**
Product name:	**ComfoAir Q350 HRV, Comfort Vent Q350 HRV**
Specification:	Airflow rate < 600 m^3/h
Heat exchanger:	Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate	η_{HR}	≥	75 %
Specific electric power	$P_{el,spec}$	≤	0.45 Wh/m^3
Leakage		<	3 %
Comfort	Supply air temperature ≥ 16.5 °C at outdoor air temperature of –10 °C		

Airflow range
70–270 m^3/h
Heat recovery rate
η_{HR} = 90 % [1]
Specific electric power
$P_{el,spec}$ = 0.24 Wh/m^3

[1] At an airflow of 138 m^3/h, a heat recovery of η_{HR} = 91 % is reached. Due to the frost protection strategy at outdoor temperatures of -15 °C the air flow rate is reduced to about 200 m^3/h.

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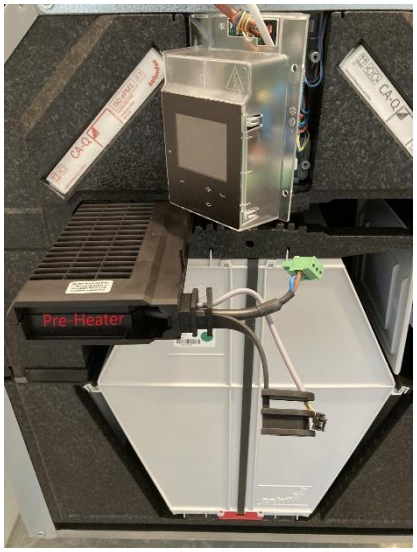
cool, temperate climate

CERTIFIED COMPONENT
Passive House Institute



HRV built-in pre-heater unit

Ceiling access doors to ComfoWell and activated carbon housing

Localized heat sources (bathroom in-floor heat)

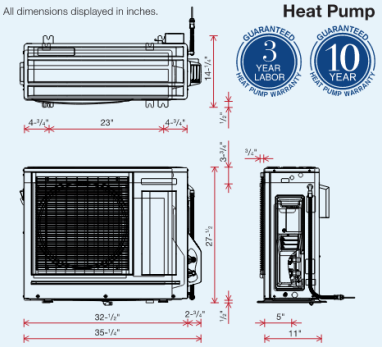
11. Domestic Hot Water

The domestic hot water is generated by a Sanden CO2 Split Heat Pump. All water lines are insulated and heat-traced when exposed to outdoor air.

SANCO2 GEN3 Specifications

All dimensions displayed in inches.

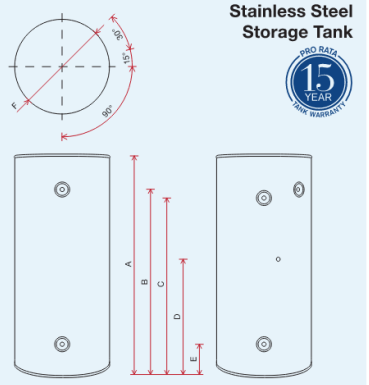
Heat Pump



Outdoor Unit (Heat Pump) Model No. GS3-45HPA-US

Performance	43-gal. system	83-gal. system
Energy Factor	3.09	3.84
First Hour Rating	71 gallons	101 gallons
Specifications		
Water Temperature Setting	130°F to 175°F	
Ambient Air Operating Temperature	-20°F to +110°F	
Heat Pump Capacity	15,400 Btu/h	
Heat Pump Capacity	4.5 kW	
Heat Pump COP	5.0	
Refrigerant Type	R744 (CO_2)	
Compressor Type	Inverter	
Power Voltage	208/230v ~1Ph ~ 60Hz	
Breaker Size	15 Amps	
MCA	13 Amps	
Outdoor Operating Noise Level	37 dB	
Weight	106 lbs	
Pipe Size (Tank to Heat Pump)	½" (Hot & Cold)	
Max Length Inc Vertical	50 ft	
Max Vertical Separation	16 ft	
Max Water Pressure	95 Psig	

Stainless Steel Storage Tank



Tank Model No:	GAUS-160QTA	GAUS-315EQTD	SAN-43SSAQA	SAN-83SSAQA
A Height	47-1/4"	58-1/8"	38-1/8"	68-1/8"
B Hot Water Outlet & PR Valve	37-1/8"	49-1/8"	29-1/2"	60-1/4"
C Heat Pump Return	37-1/8"	49-1/8"	29-1/2"	60-1/4"
D Sensor Port	17-1/8"	37"	9-3/4"	40 3/8"
E Cold Water Inlet / Cold Water to HP	8-1/4"	7-7/8"	8-3/4"	8-3/4"
F Diameter	22-1/2"	26-3/4"	24-1/2"	24-1/2"
Weight (lbs)	88 lbs	154 lbs	88 lbs	115 lbs
Tank Capacity (gallons)	43 gallons	83 gallons	43 gallons	83 gallons

Connection Sizes	
Cold Water Inlet	3/4" NPT
Hot Water Outlet	3/4" NPT
Cold Water to Heat Pump	3/4" NPT
Hot Water Return from Heat Pump	3/4" NPT
Pressure Relief Valve Setting (Psig)	125 Psig

Note: Materials and specifications are subject to change without notice.

REV 1216

Outdoor Heat-Pump Unit

Interior Insulated Tank

12. Passive House Planning Package

Passive House Verification

MIZU PASSIVE HOUSE CONSULTING

Building:	Clark Road Passive House		
Street:	39705 Clark Road		
Postcode/City:	V8B 0E7	Squamish	
Province/Country:	British Columbia	CA-Canada	
Building type:	Single Family House		
Climate data set:	ud---00-CA-0072a-Squamish		
Climate zone:	3: Cool-temperate	Altitude of location:	5 m
Home owner / Client:			
Street:			
Postcode/City:		Vancouver	
Province/Country:	British Columbia	CA-Canada	

Architecture:	Blue Water Concepts Ltd.		
Street:	PO Box 302		
Postcode/City:	V0N 1T0	Garibaldi Highlands	
Province/Country:	British Columbia	CA-Canada	
Energy consultancy:	MIZU Passive House Consulting Inc.		
Street:			
Postcode/City:	V3M 3A7	New Westminster	
Province/Country:	British Columbia	CA-Canada	

Mechanical engineer:			
Street:			
Postcode/City:		Vancouver	
Province/Country:	British Columbia	CA-Canada	
Certification:	Peel Passive House Consulting Ltd.		
Street:	118 Craigleith Road		
Postcode/City:	L9Y 0S3	Blue Mountains	
Province/Country:	Ontario	CA-Canada	

Year of construction:	2019	Interior temperature winter [°C]:	20.0
No. of dwelling units:	1	Internal heat gains (IHG) heating case [W/m²]:	2.4
No. of occupants:	3.0	Specific capacity [Wh/K per m² TFA]:	100
		Interior temp. summer [°C]:	25.0
		IHG cooling case [W/m²]:	2.4
		Mechanical cooling:	

Specific building characteristics with reference to the treated floor area

				Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area m²	161.5				
Space heating	Heating demand kWh/(m²a)	12.75	≤	15	-	yes
	Heating load W/m²	10.38	≤	-	10	
Space cooling	Cooling & dehum. demand kWh/(m²a)	-	≤	-	-	-
	Cooling load W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C) %	1.2	≤	10		yes
	Frequency of excessively high humidity (> 12 g/kg) %	0	≤	20		yes
Airtightness	Pressurization test result n_{50} 1/h	0.19	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	82	≤	-		-
Primary Energy Renewable (PER)	PER demand kWh/(m²a)	38	≤	60	60	yes
	Generation of renewable energy (in relation to projected building footprint area) kWh/(m²a)	0	≥	-	-	

[2] Empty field: Data missing; '-': No requirement

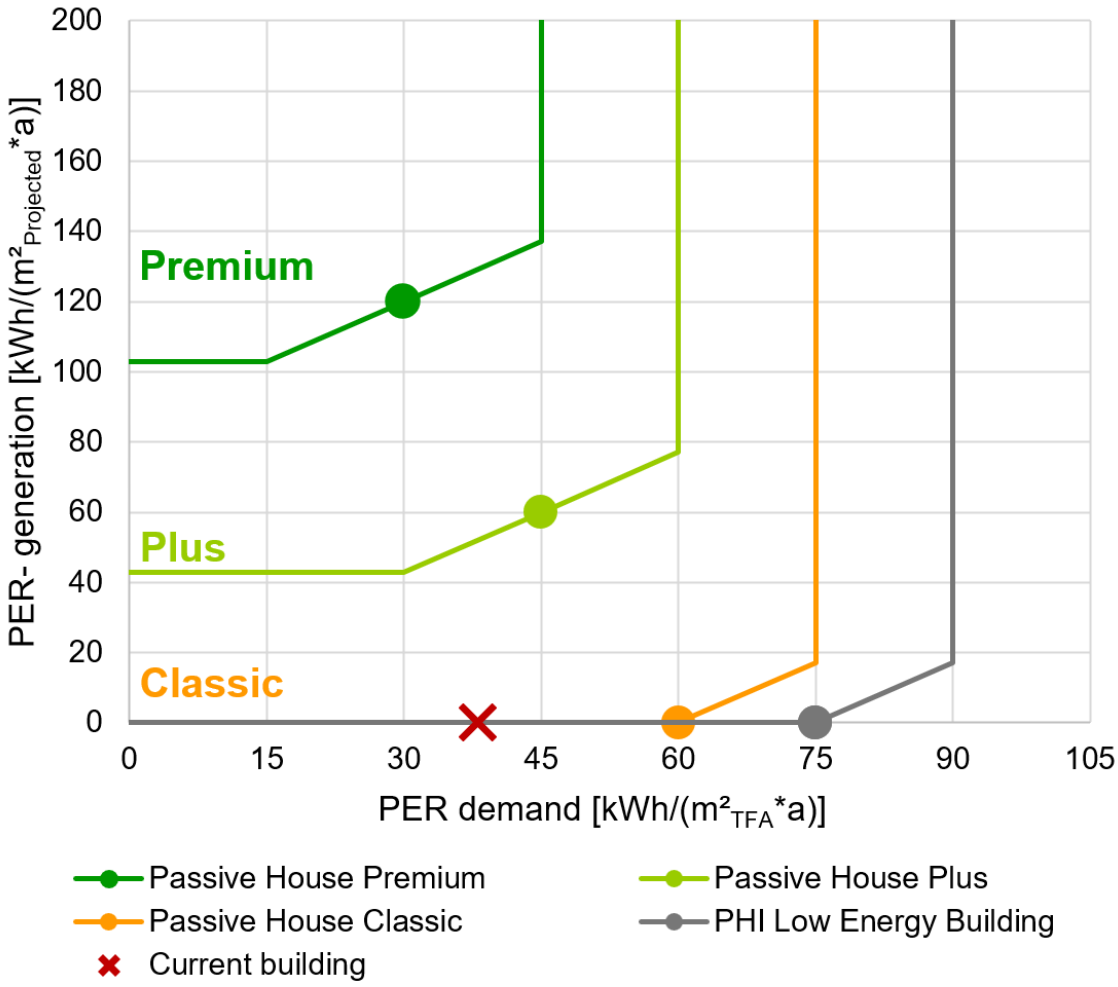
I confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this verification.

Passive House Classic? yes

Task:	First name:	Surname:	Signature:
1-Designer	Pierre-Andre	Santin	

Issued on:		City:
MIZU Passive House Consulting Inc.		New Westminster

13. Primary Energy Renewable



14. Construction Cost

Data not available.

15. Acknowledgments

Photographs by Kristen McGaughey, Blue Water Concepts, and MIZU Passive House Consulting.