



Certified
Passive House
Passive House Institute

classic | plus | premium

Project Documentation: Cheakamus Crossing Passive House Plus



Single Family Dwelling with Suite in Whistler, BC, Canada

1.1 Data

General information

altitude:	606 m
climate:	Cool temperate
year:	2017
TFA:	266 m ²

Assemblies and Components

slab:	500mm EPS, 100mm Concrete U-Value: 0.066 W/m ² K
wall:	140mm Wood Frame w/ Rock Wool 240mm TJI Cavity w/ Cellulose U-Value: 0.097 W/m ² K
roof:	400mm TJI w/ Cellulose 140mm Cavity w/ Rock Wool U-Value: 0.079 W/m ² K
windows:	Euroline UPVC Frame U-Value: 0.78 W/m ² K
HRV:	Paul Novus 92.4 % Heat Recovery Efficiency

PHPP

A/V ratio:	1.1
air leakage:	0.25 n50, 1/h
heating demand:	14.5 KWh/m ² a
heating load:	12 W/m ²
PER demand:	32 KWh/m ² a
PER generation:	37 KWh/m ² a (footprint: 158 m ²)
PE:	74 KWh/m ² a

1.2 Description

Situated in Cheakamus Crossing, the 2010 Whistler Olympic Athlete's Village area, this building is home to a young and active family, accommodating their outdoor orientated lifestyle. A 140m² PV array located on the roof allows this project to be certified under the 'Passive House Plus' standard. The site-built wall assembly consists of a 2x6 frame with an exterior 9" TJI cavity filled with dens-pack cellulose, Euroline's PH window system covers the glazed areas and a Novus HRV will ventilate the main dwelling as well as the 1 Bedroom suite.

The main challenge in the planning phase has been to achieve the 'Passive House Plus' classification, not a simple feat for a project this size.

1.3 Project Consultants

Design: Econ Group Ltd, Marcel Studer dipl.arch.eth, www.econgroup.ca
Structural: KSM, Eric Man p.eng
PHPP: Econ Group Ltd, Marcel Studer dipl.arch.eth, www.econgroup.ca
Construction: Econ Group Ltd, Marcel Studer dipl.arch.eth, www.econgroup.ca
Certification: Earth Cycle Technologies, Robert Ryan, www.earthcycle.co
Cert. ID: Project ID 5561

Author of project documentation:

A handwritten signature in black ink, appearing to read 'M. Studer', written in a cursive style.

Marcel Studer dipl.arch.eth
Econ Group Ltd, , www.econgroup.ca

Date: March 14, 2018

2 Site Context & Facades



Location Overview

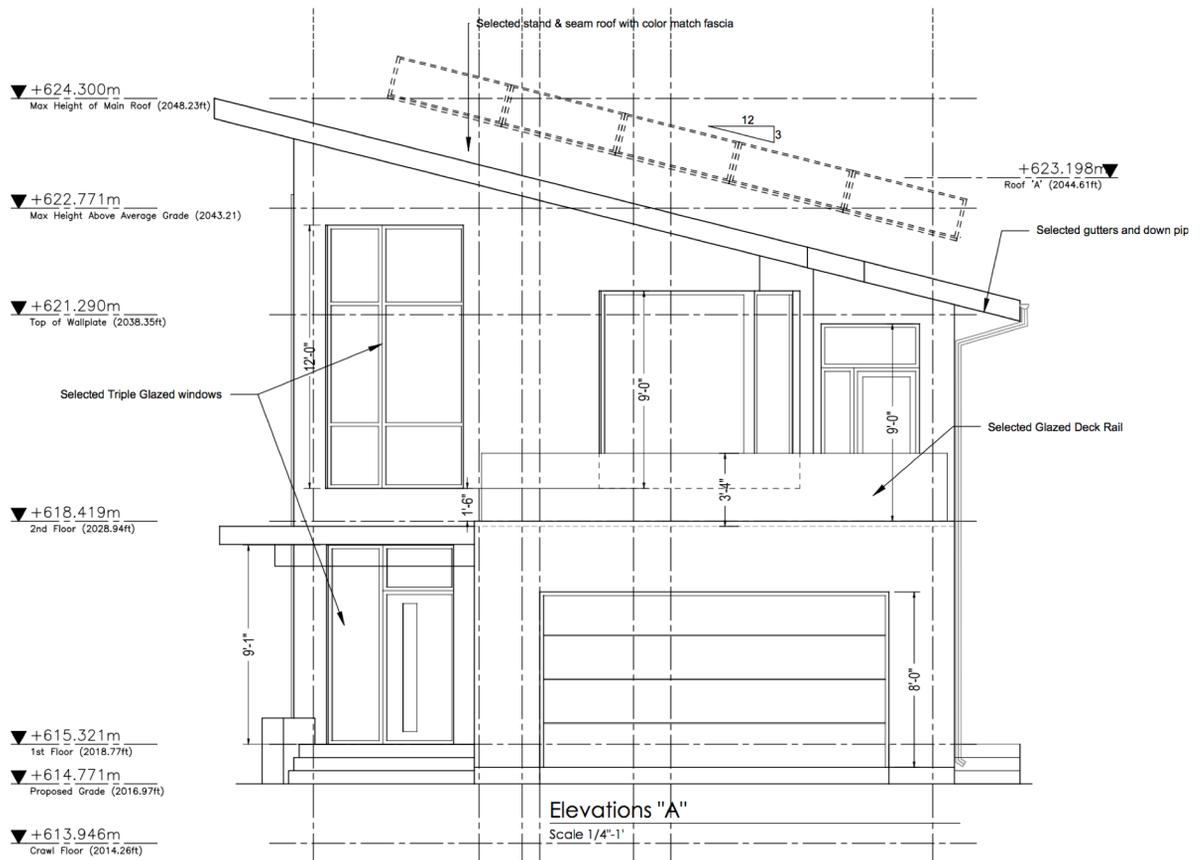


Area Map

The project is located in a new sub-division development just outside Whistler, BC Canada. The site only allowed access from the south side, where the attached garage had to be located, taking away a good portion of our Southern solar gain potential. The nearby mountain ranges further limited the solar exposure of the site.

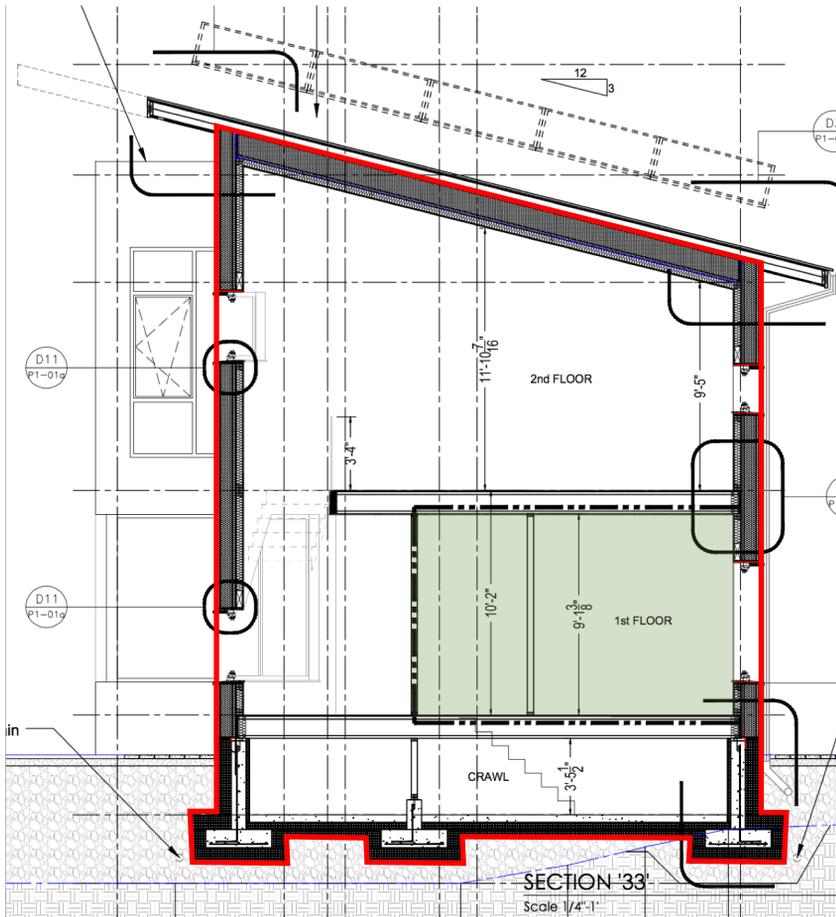
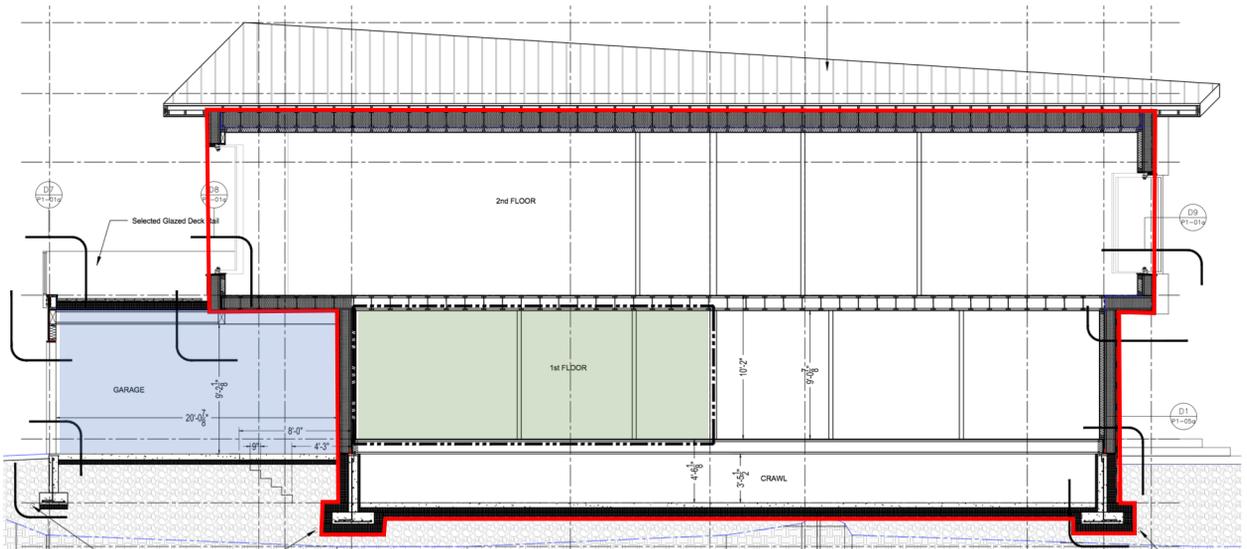


South Facade



3 Cross Section

The soil conditions of the site didn't allow for a full basement. A 1m "mini-basement" allows for storage and helps to improve the TFA. The access to the basement is from the un-conditioned garage through a floor pit with a PH window as a door.

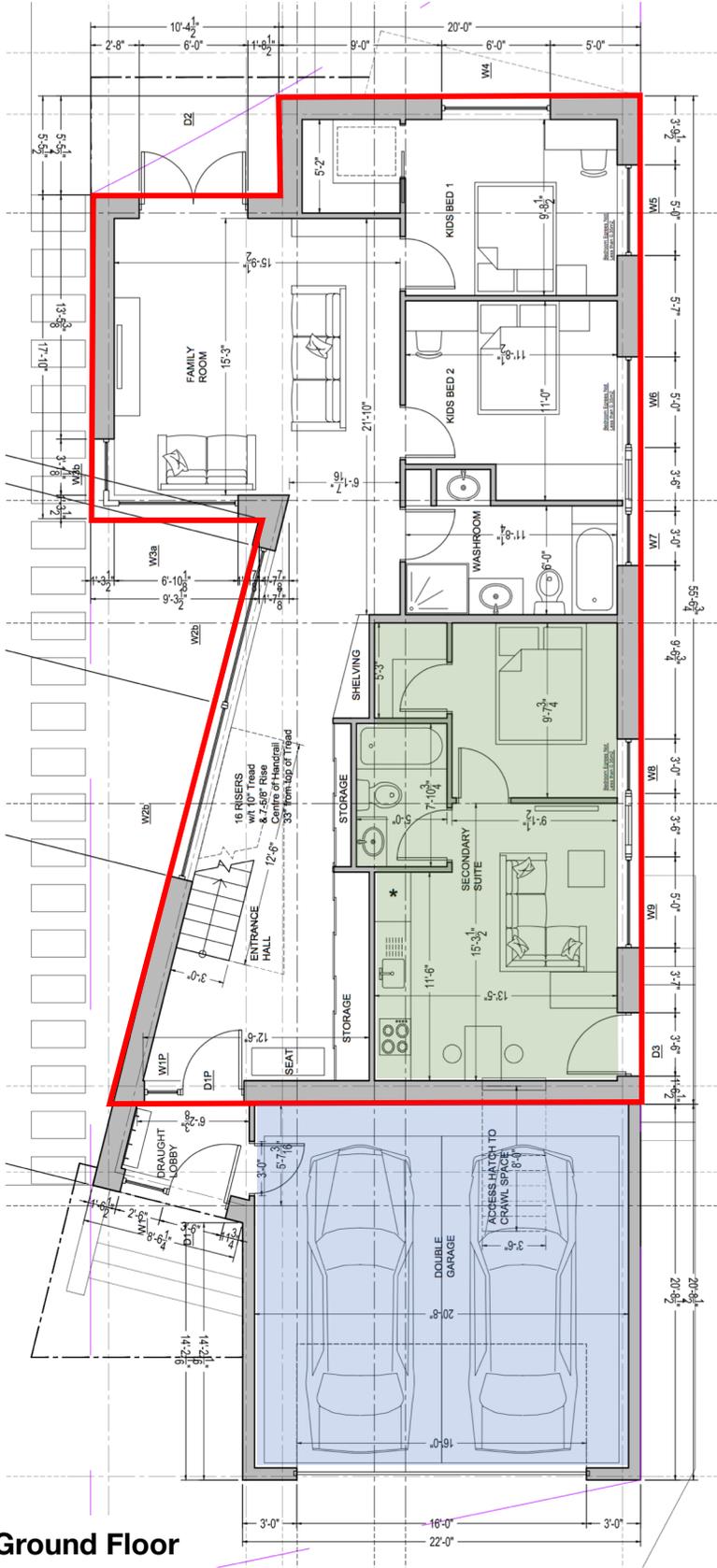
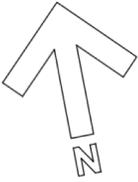


Thermal Envelope

Secondary Suite

Attached Garage

4 Floor Plans & Interior Photos

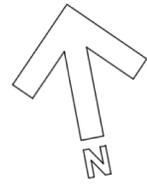
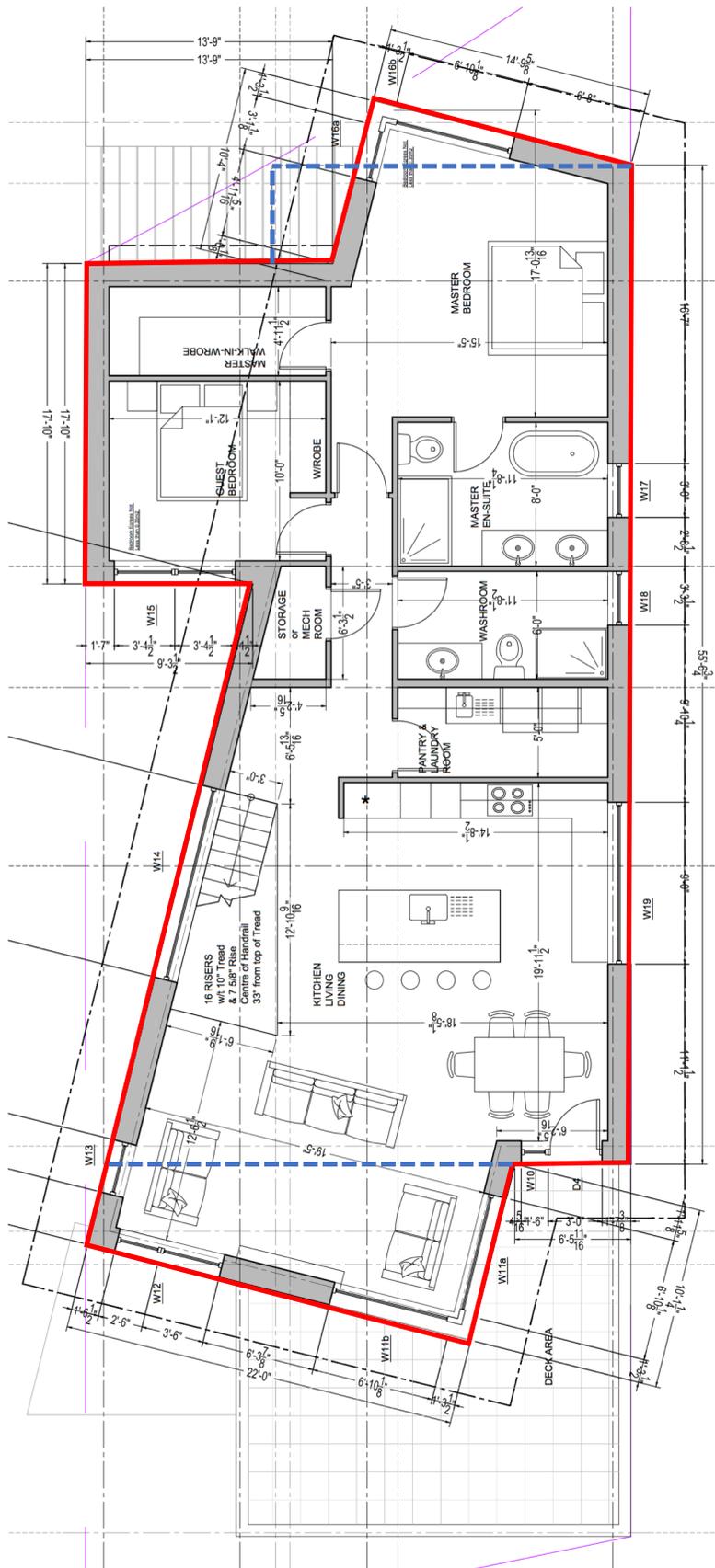


Ground Floor

Thermal Envelope

Secondary Suite

Attached Garage

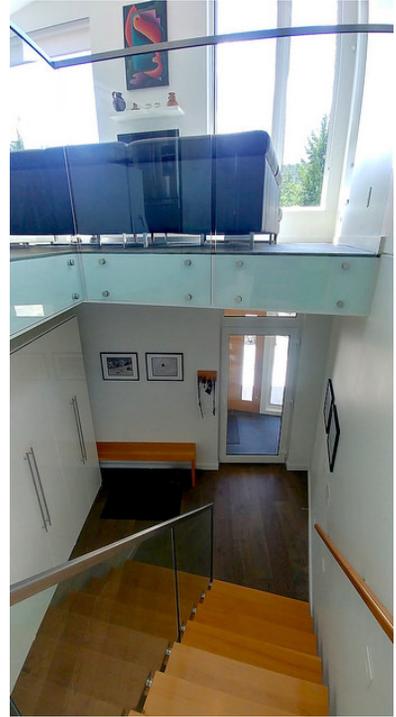


Thermal Envelope

Envelope Below

Upper Floor

The programming of this project had to include enough living space for a family of four people plus a one bedroom suite. The attached garage was kept out side the PH envelope connected to the dwelling via a vestibule. Parts of the West side of the building were designed on a off-angle to allow for some extra windows to the South. Locating the main living areas on the upper floor was a necessity to permit more natural light and some views of the surrounding mountains. The interior finishes were chosen to be durable and cost effective, matching the overall modern design of the building.



Entry Area & Stairs



Family Room (lower level)



Main Kitchen



Living Room



Master Bedroom

5.1 Foundation Details



8" (203mm) of EPS under footings



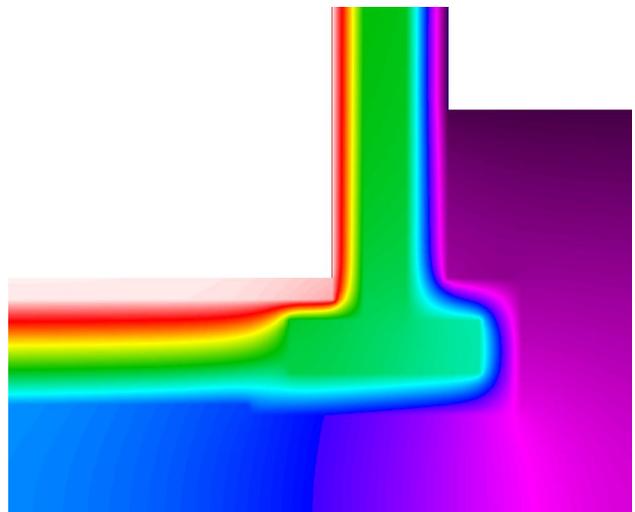
8" (203mm) of EPS wrapped on exterior of footing and foundation wall



6" (152mm) of EPS on interior of foundation wall
U-Value: 0.094 W/m²K



20" (508mm) of EPS under foundation slab
U-Value: 0.066 W/m²K



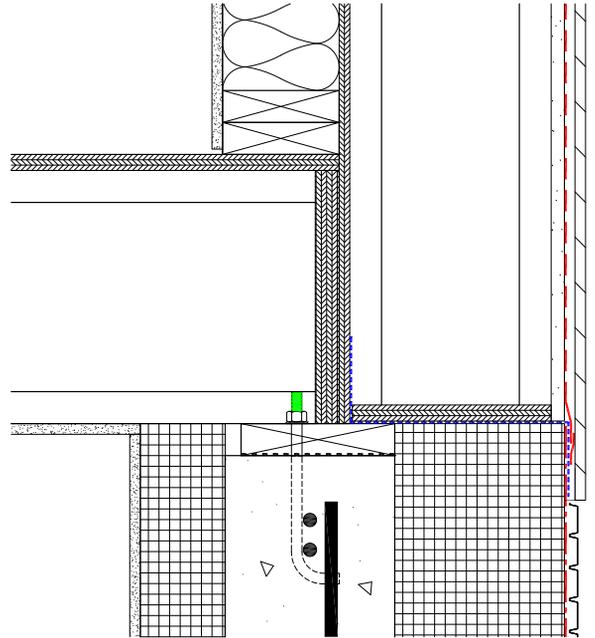
Thermal Bridge Model (THERM) of Footing Detail: Ψ -0.146 W/(m·K)

5.2 Wall Details



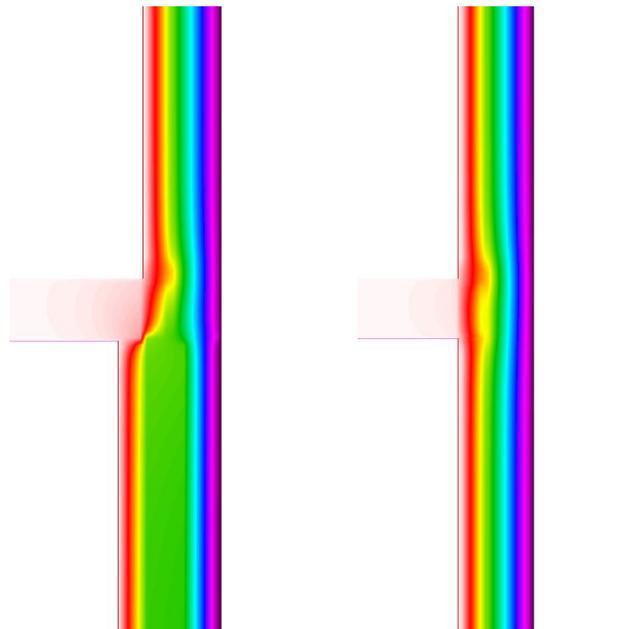
5.5" (140mm) light wood frame insulated with rock-wool

Assembly U-Value: **0.097 W/m²K**



9.5" (240mm) TJI cavity insulated with dense-pack cellulose, 15mm wood-fibre board

Thermal Bridge Models (THERM) of Floor to Wall Connections:



Lower Floor:
 Ψ 0.01 W/(m·K)

Upper Floor:
 Ψ 0.009 W/(m·K)

5.3 Roof Details

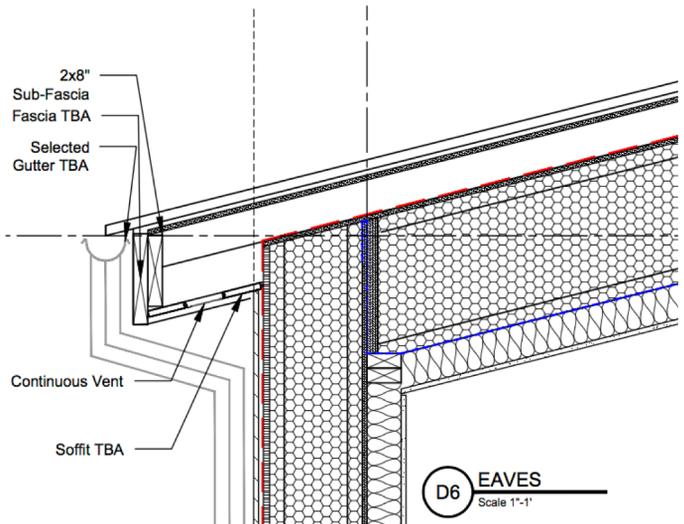


16" (400mm) TJI structure insulated with dense-pack cellulose

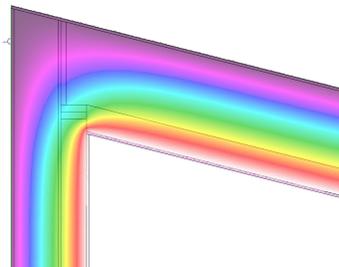
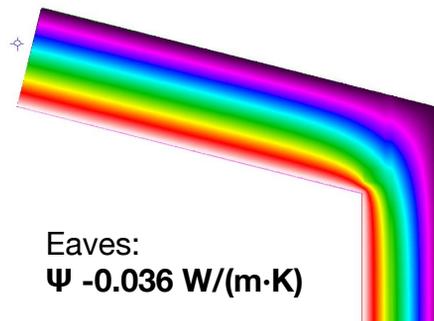


5.5" (140mm) installation cavity insulated with rock-wool

Assembly U-Value: **0.079 W/m²K**



Thermal Bridge Models (THERM) of Roof Connections:



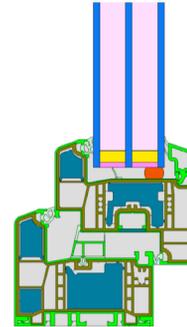
5.4 Window Details

Category: **Window frame**
 Manufacturer: **EuroLine Windows Inc.,
 Delta, BC,
 Canada**
 Product name: **Series 4700, ThermoPlus PHC**

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

Comfort $U_W = 0.79 \leq 0.80 \text{ W}/(\text{m}^2 \text{ K})$
 $U_{W, \text{installed}} \leq 0.85 \text{ W}/(\text{m}^2 \text{ K})$
 with $U_g = 0.70 \text{ W}/(\text{m}^2 \text{ K})$

Hygiene $f_{Rsi=0.25} \geq 0.70$



Passive House efficiency class

phE	phD	phC	phB	phA
-----	-----	-----	------------	-----

www.passivehouse.com

CERTIFIED COMPONENT
Passive House Institute

PH Certified UPVC Window Frame

Frame values			Frame width	U-value frame
			b_f mm	U_f W/(m ² K)
Top	(to)		115	0.78
Side	(s)		115	0.78
Bottom	(bo)		115	0.78

Window Frame Data



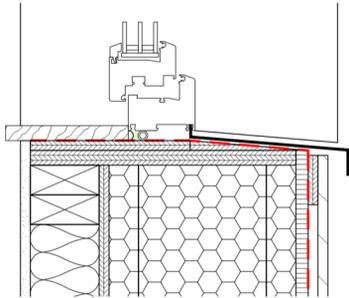
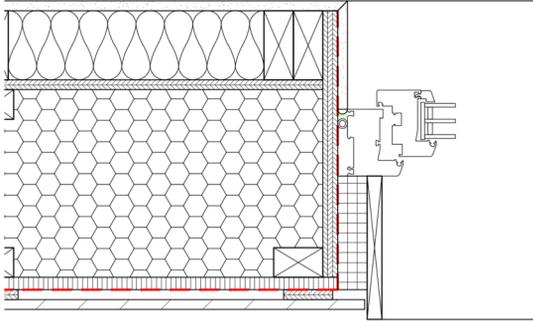
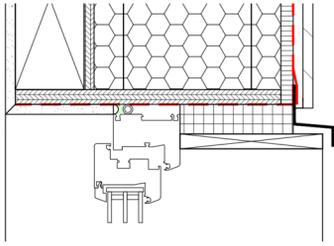
10/3/2013

4mm - Exterior Lite: LoE 180 #2 Clear
 16mm - Airspace and Gas 90% argon
 4mm - Middle Lite: Clear LoE 180 #3
 16mm - Airspace and Gas 90% argon
 4mm - Inboard Lite: LoE 180 #5 LoE 180 #5

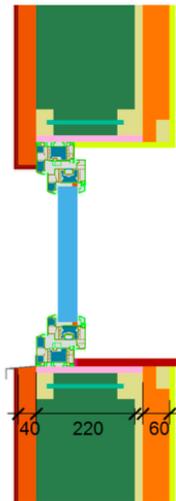
		Visible	
		Transmission:	Refl. Exterior:
Solar	Transmission:	69%	69%
	Refl. Exterior:	20%	19%
	Refl. Interior:	20%	21%
Fading	UV Transmission:	9%	9%
	Uvalue	0.63	0.63

Note
 • Values are center of glass calculated using WIS under EN410 & EN673
 • Lite should be heat treated due to location of coating

Glass specification
 Spacer: $\Psi 0.033 \text{ W}/(\text{m}\cdot\text{K})$



Window installation detail drawing



Ψ_{install}	W/(m K)
Top	0.017
Side	0.017
Bottom	0.022

Ψ Values for Installation



6 Airtight Envelope



Interior Airtight Layer (Vapour Control): foundation concrete, taped plywood (SIGA Rissan), continuous membrane on ceiling (PROCLIMA Intello taped with Tescon Vana)



Exterior Airtight Layer (Water Resistive Barrier): foundation water proofing (SOPREMA Colphene peel & stick), continuous membrane on walls and sub-roof (PROCLIMA Mento 1000 taped with Tescon Vana), Window sills (GRACE Vicor), Window airtight connection (PROCLIMA Tescon Vana).

AIR LEAKAGE TEST REPORT

In compliance with EN13829

Prepared: 2017-08-28

Performed by: Troy Glasner

Test Date: 2017-04-05

Test File: EN13829-SE 2017-08-24 1157

Prepared for: Econ Group Construction and Development Ltd.



E3 ECO GROUP INC.

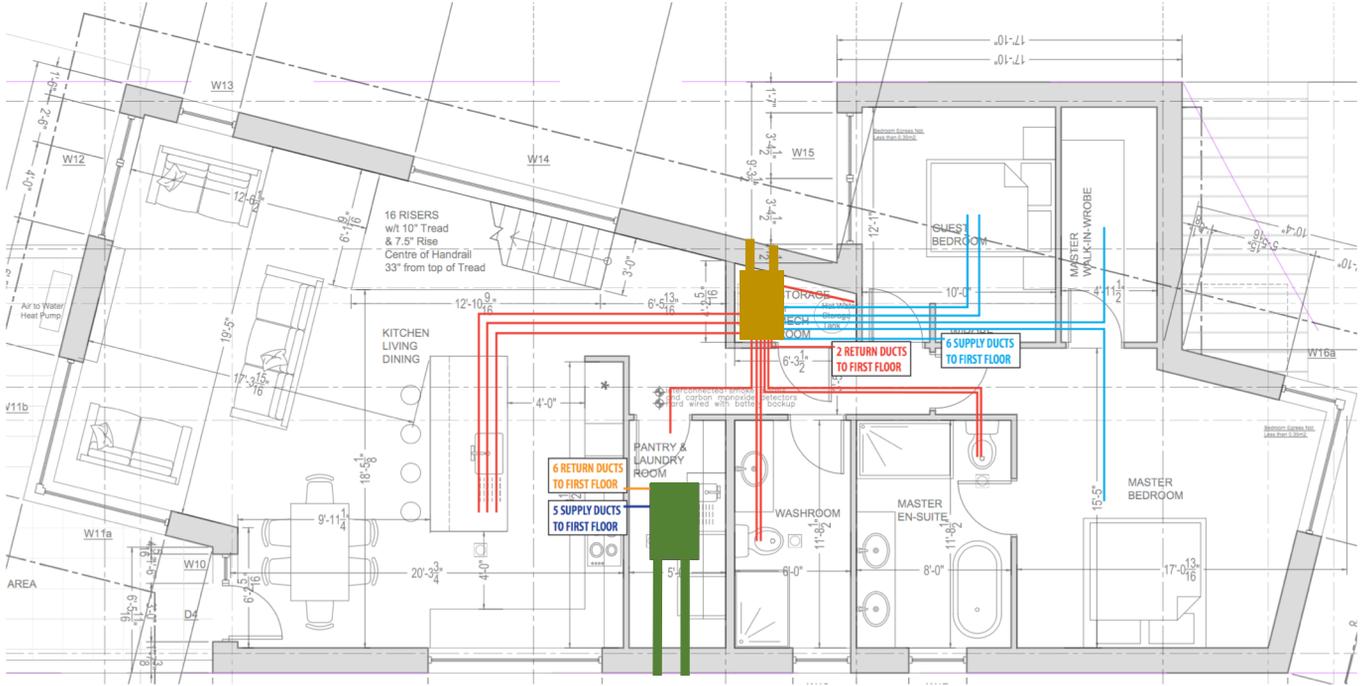
BUILDING BLOCKS OF
SUSTAINABILITY

1067 Madeley Way
Whistler, BC
Canada
V0N 1B1

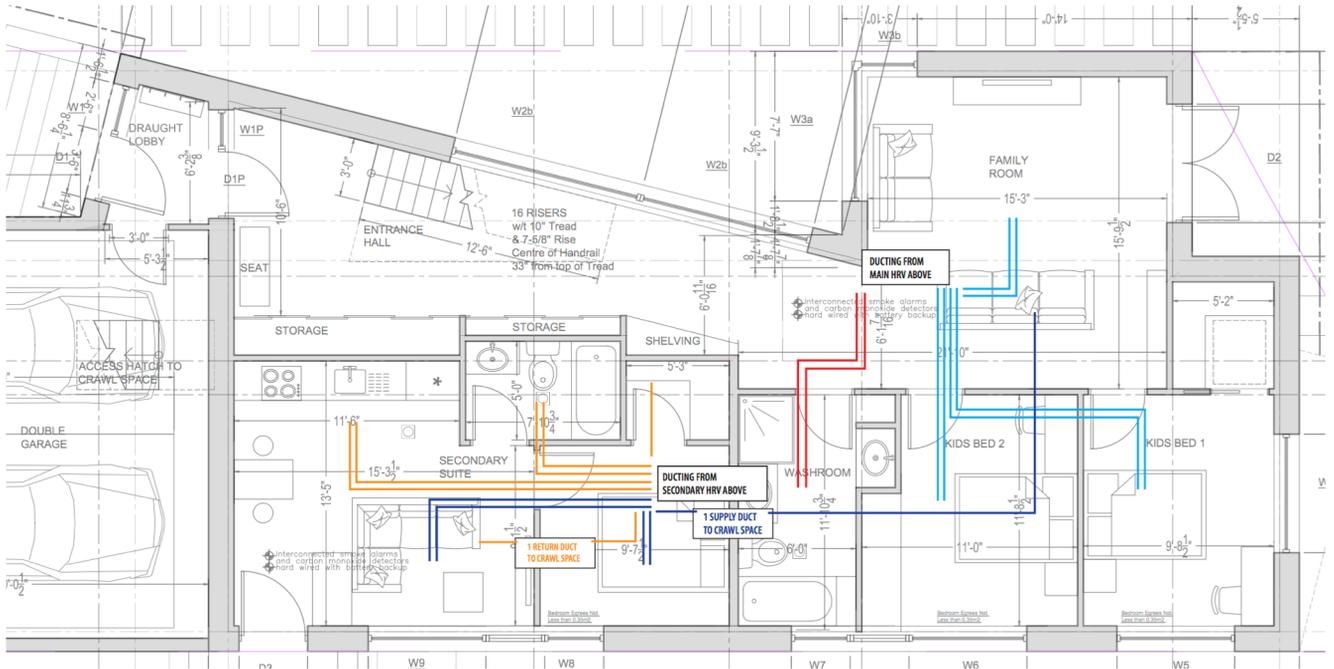
Building and Test Information	
Test file name:	EN13829-SE 2017-08-24 1157
Building volume [m ³]:	885
Envelope Area [m ²]:	831
Floor Area [m ²]:	265.5
Building Height (from ground to top) [m]:	8.5

Results	
Air flow at 50 Pa, V ₅₀ [L/s]	61.25
Air changes at 50 Pa, n ₅₀ [/h]	0.25
Permeability at 50 Pa, Q ₅₀ [L/s/m ²]	0.074
Specific leakage at 50 Pa, w ₅₀ [L/s/m ²]	0.231

7 Ventilation System



Upper Floor Ventilation Layout



Lower Floor Ventilation Layout



Main HRV:
PAUL NOVUS 300



Secondary HRV:
ZEHNDER ComfoAir 200

— Main HVR - Supply 3" Flex Duct

— Main HVR - Return 3" Flex Duct

— Secondary HVR - Supply 3" Flex Duct

— Secondary HVR - Return 3" Flex Duct



Category: **Air handling unit with heat recovery**
 Manufacturer: **PAUL Wärmerückgewinnung GmbH**
Germany
 Product name: **novus 300**

Specification: Airflow rate < 600 m³/h
 Heat exchanger: Recuperative

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

Heat recovery rate $\eta_{HR} \geq 75\%$
 Specific electric power $P_{el,spec} \leq 0.45 \text{ Wh/m}^3$
 Leakage < 3%

Comfort Supply air temperature $\geq 16.5^\circ\text{C}$
 at outdoor air temperature -10°C

Airflow range
121–231 m ³ /h
Heat recovery rate
$\eta_{HR} = 93\%$
Specific electric power
$P_{el,spec} = 0.24 \text{ Wh/m}^3$

■ At an airflow of 144 m³/h, a heat recovery of $\eta_{HR} = 94\%$ is reached.

www.passivehouse.com



Main HRV: PAUL novus 300



Category: **Air handling unit with heat recovery**
 Manufacturer: **Zehnder Group Nederland B.V.**
Netherlands
 Product name: **ComfoAir200, ComfoD250, WHR920**

Specification: Airflow rate < 600 m³/h
 Heat exchanger: Recuperative

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

Heat recovery rate $\eta_{HR} \geq 75\%$
 Specific electric power $P_{el,spec} \leq 0.45 \text{ Wh/m}^3$
 Leakage < 3%

Comfort Supply air temperature $\geq 16.5^\circ\text{C}$
 at outdoor air temperature -10°C

Airflow range
60–150 m ³ /h
Heat recovery rate
$\eta_{HR} = 92\%$
Specific electric power
$P_{el,spec} = 0.42 \text{ Wh/m}^3$

www.passivehouse.com



Secondary HRV: ZEHNDER ComfoAir 200

8 Heating & DHW

SanCO₂ Specifications

Heat Pump

GUARANTEED 10 YEAR HEAT PUMP WARRANTY

Top view: 4.8" (left), 22.9" (center), 4.8" (right)

Front view: 14.3" (height), 0.5" (width), 29.7" (height), 32.5" (width), 2.8" (width), 35.4" (total width)

Side view: 1.6" (height), 0.8" (width), 2.8" (width), 11.1" (total width)

Heat Pump

GUARANTEED 10 YEAR HEAT PUMP WARRANTY

All dimensions displayed in inches.

Dimensions	
Weight	123 lbs

Technical	
Power Input	1.0kW
COP	4.5 ^
Energy Factor	3.35
Refrigerant	R744 (CO ₂)
Water Temperature Setting	149°F
Compressor Type	Inverter
Power Supply	220-240V / 60Hz / 1Ph
Breaker Size	15 Amps
Operating Noise Level	38 dB
Ambient Air Operating Temperature	-15°F to +110°F

Water Connections & Settings	
Inlet	½" BSP
Outlet	½" BSP

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

Stainless Steel Storage Tank

GUARANTEED 10 YEAR TANK WARRANTY

Top view: 26" (diameter), 151" (circumference), 90° (angle)

Side view: A (height), B (Hot Water Outlet & PTR Valve), C (Heat Pump Return), D (Sensor Port), E (Cold Water Inlet / Heat Pump Flow)

Stainless Steel Storage Tank

GUARANTEED 10 YEAR TANK WARRANTY

Model No:	GAUS-250EQTA/B	GAUS-315EQTD/G
A Height	70.9"	58.7"
B Hot Water Outlet & PTR Valve	61"	49.6"
C Heat Pump Return	61"	49.6"
D Sensor Port	32.5"	37.0"
E Cold Water Inlet / Heat Pump Flow	8.25"	7.9"
F Diameter	22.5"	26.6"
Weight	132 lbs	154 lbs.
Storage Capacity	66 gallons	83 gallons

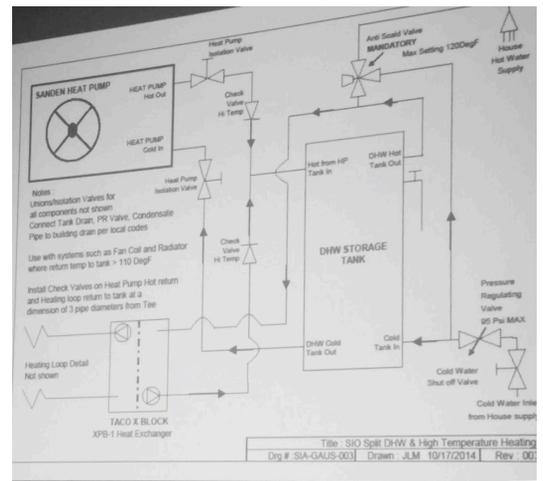
Water Connections & Settings		
Tank Relief Valve Setting	101.5 PSI	101.5 PSI

Maximum Mains Pressure Settings		
With or Without PRV	72.5 PSI	72.5 PSI
Max Inlet Water Pressure	72.5 PSI	72.5 PSI

Heat Pump & Tank Specification, for DHW and Heating via Fan Coil in HRVs



Installation of Outdoor Unit



Installation Diagram

9 PHPP

Passive House Verification



Architecture: Econ Group Ltd
 Street: 402-510 Chesterfield Ave
 Postcode/City: V7M 2L9 North Vancouver
 Province/Country: British Columbia
Energy consultancy: Econ Group Ltd
 Street: 402-510 Chesterfield Ave
 Postcode/City: V7M 2L9 North Vancouver
 Province/Country: British Columbia
 Year of construction: 2016_17
 No. of dwelling units: 2
 No. of occupants: 5.6

Building: Cheakamus Crossing Passivehouse
 Street: 1067 Madeley Place
 Postcode/City: V0N 1B1 Whistler
 Province/Country: British Columbia CA-Canada
 Building type: Single Family with Suite
 Climate data set: CA0022a-Whistler
 Climate zone: 3: Cool-temperate Altitude of location: 606 m
Home owner / Client: Dale Mikkelsen
 Street: 1067 Madeley Place
 Postcode/City: V0N 1B1 Whistler
 Province/Country: British Columbia
Mechanical engineer:
 Street:
 Postcode/City:
 Province/Country:
Certification: Robert Ryan
 Street: 10 Springfield
 Postcode/City:
 Province/Country: Wicklow
 Interior temperature winter [°C]: 20.0 Interior temp. summer [°C]: 25.0
 Internal heat gains (IHG) heating case [W/m²]: 2.5 IHG cooling case [W/m²]: 2.5
 Specific capacity [Wh/K per m² TFA]: 132 Mechanical cooling:

Specific building characteristics with reference to the treated floor area

		Treated floor area m ²		Criteria	Alternative criteria	Fulfilled? ²
Space heating	Heating demand kWh/(m ² a)	265.4	≤	15	-	yes
	Heating load W/m ²	12	≤	-	10	
Space cooling	Cooling & dehum. demand kWh/(m ² a)	-	≤	-	-	-
	Cooling load W/m ²	-	≤	-	-	-
	Frequency of overheating (> 25 °C) %	0.2	≤	10	-	yes
	Frequency of excessively high humidity (> 12 g/kg) %	0.0	≤	20	-	yes
Airtightness	Pressurization test result n ₅₀ 1/h	0.25	≤	0.6	-	yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m ² a)	74	≤	-	-	-
Primary Energy Renewable (PER)	PER demand kWh/(m ² a)	32	≤	45	32	yes
	Generation of renewable energy (in relation to pro-jected building footprint area) kWh/(m ² a)	37	≥	60	37	

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 Plus? **yes**
Signature:

Task: 2-Certifier First name: Robert Surname: Ryan
 Certificate ID: 2018 01 24 Issued on: Wicklow Ireland City:

10 Economics

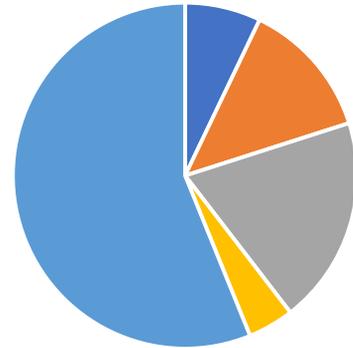
Overall Construction Cost:

CAD 1,156,000
EUR 740,500

Cost per m2 of TFA:

EUR 2,790

Construction cost percentages:	
Design fee	3
Windows	6
Insulation, tapes & membranes	9
HVAC (no cooling)	2
Interior & Exterior finishes	26
Upgrade to PH+	4



Construction Cost Percentages of Key Elements

Increased cost to move from PH Classic to PH Plus:

	CAD	EUROS
PV array:	22,000	14,000
Additional insulation:	4,500	2,900
HRV upgrade:	5,000	3,200
Heating upgrade:	2,500	1,600
Drain water recovery:	1,000	640
Appliance upgrade:	1,500	960

Total additional cost to achieve PH Plus: **36,500 CAD** / **23,300 EUROS**

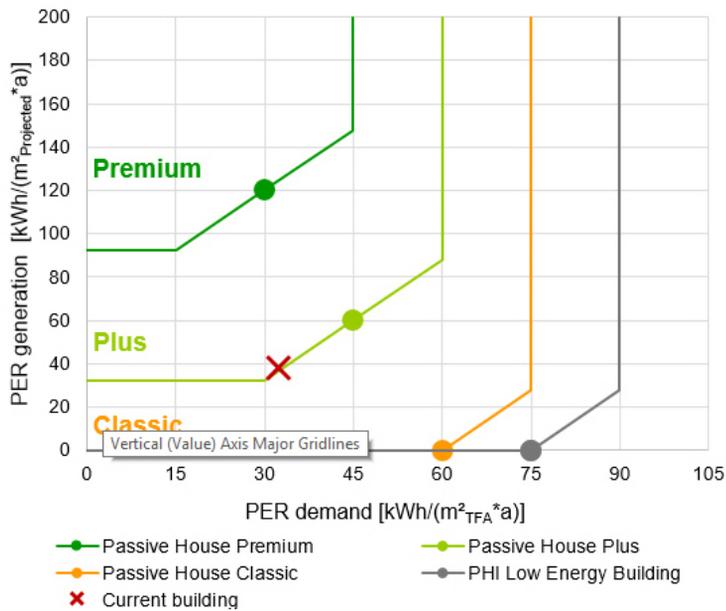
This equals an increase of the overall cost by **~3.5%**

or an additional of **\$12** per square foot or **\$129 per m²** of building
(a small amount, easy to off-set with smart finishing choices)

	Total Energy Consumption kWh/a	Energy Production kWh/a	Monthly Energy kWh/month	Energy Rates \$0.15 / \$0.18 \$/month	Savings over Baseline \$/month	Additional Mortgage \$/month (30y)	Net Monthly Cost of Ownership
Canadian Avg.* Code Baseline	39,150	n/a	3,263	587	Baseline	Baseline	Baseline
Cheakamus PH plus	7,581	5548	169	25	562	427	-135

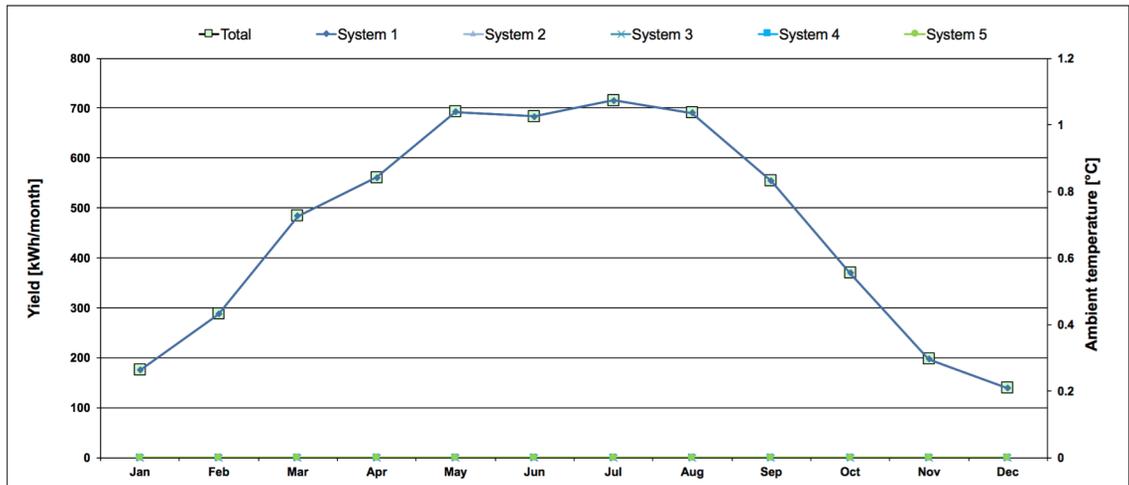
Monthly Cost of Ownership Calculation

11 PER Demand / Production



Annual electricity yield after the inverter, absolute
 Related to projected building footprint area
 CO2-equivalent emissions according to 1-CO2 factors GEMIS (Germany)
 PE-factor according to 1-PE factors (non-renewable) PHI Certification

5548					5548	kWh/a
37.0					37	kWh/m²A _{projected} *a
349.5					349.5	kg/a
0.00				0.0	0.00	kWh _{per} /kWh _{end}



Annual Production of the PV-System

12 References

This project was presented as part of the 22nd International Passive House Conference, March 9 2018 in Munich:

Session 3, Market Rate Passive Design – Vancouver, BC

Studer, Marcel; Picciano, Lucio

p.179 of the conference catalogue