Passive House Verification

Building:	MUNSELL RESIDENCE
Street:	526 Maple Mnt Rd
Postcode/City:	V9L 5X7 — Maple Bay
Province/Country:	BC — CA-Canada
Building type:	SINGLE FAMILY DWELLING
Climate data set:	ud---01-CA0065a-Nanaimo
Climate zone:	3: Cool-temperate — Altitude of location: 102 m
Home owner / Client:	Don & Jane Munsell
Street:	6703 Elkington Ave.
Postcode/City:	V9L 5X2 — Maple Bay
Province/Country:	BC — CA-Canada

Architecture:	Ecocentric Design
Street:	2600 Nimmo Rd
Postcode/City:	V0R 3C0 — Westholme
Province/Country:	BC Canada — CA-Canada
Energy consultancy:	Ecocentric Design
Street:	2600 Nimmo Rd
Postcode/City:	V0R 3C0 — Westholme
Province/Country:	BC Canada — CA-Canada

Mechanical engineer:	
Street:	
Postcode/City:	
Province/Country:	
Certification:	RDH Building Science
Street:	740 Hillside Ave, Victoria
Postcode/City:	V8T 1Z4 — Victoria
Province/Country:	BC — CA-Canada

Year of construction:	2018	Interior temperature winter [°C]:	20.0
No. of dwelling units:	2	Internal heat gains (IHG) heating case [W/m²]:	2.4
No. of occupants:	5.9	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

The PHPP has not been filled completely; it is not valid as verification

				Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	312.0			
Space heating	Heating demand	kWh/(m²a)	12.6	≤ 15	-	yes
	Heating load	W/m²	8.0	≤ -	10	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤ -	-	-
	Cooling load	W/m²	-	≤ -	-	
	Frequency of overheating (> 25 °C)	%	0.5	≤ 10		yes
	Frequency of excessively high humidity (> 12 g/kg)	%	0.3	≤ 20		yes
Airtightness	Pressurization test result n_{50}	1/h	0.3	≤ 0.6		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	70.2	≤ -		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	32.0	≤ 60	60	yes
	Generation of renewable energy (in relation to projected building footprint area)	kWh/(m²a)	0.0	≥ -	-	

[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:
2-Certifier	Eric	Catania	

Certificate ID	Issued on:	City:
34404-34405_RDH_PH_20220531_EC	31-05-22	Vancouver, BC

Climate data

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Selection of climate data

Country:	ud-User Data
Region:	All
	1-Sortierung: Alphabetisch
Climate data set:	ud---01-CA0065a-Nanaimo
Climate zone:	3: Cool-temperate

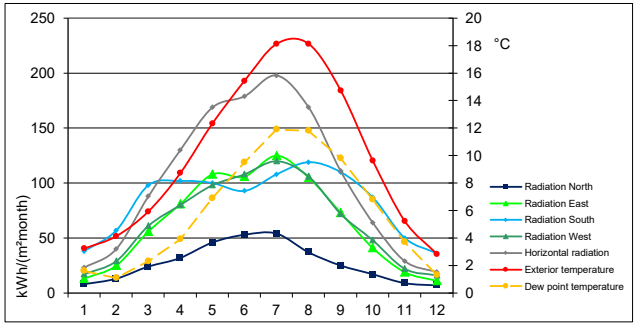
Altitude

Weather station:	25.0	m
Building location:	102	m

Result overview

Annual heating demand	12.6	kWh/(m²a)
Heating load	8.0	W/m²
Frequency of overheating	0.5	%
Sensible cooling	0.3	kWh/(m²a)
Latent cooling	0.0	kWh/(m²a)
Cooling load	-	W/m²
PER demand	32.0	kWh/(m²a)

	Data for heating Annual method	Data from monthly balance Heating	Cooling	
Heating / cooling period	220	243	48	d/a
Heating / cooling degree hours	75	80	-7	kKh/a
Radiation North	118	156	68	kWh/(m²a)
Radiation East	263	361	183	kWh/(m²a)
Radiation South	478	568	188	kWh/(m²a)
Radiation West	287	364	180	kWh/(m²a)
Horizontal radiation	419	562	293	kWh/(m²a)



Month	1	2	3	4	5	6	7	8	9	10	11	12	Heating load		Cooling load		PER	
Days	31	28	31	30	31	30	31	31	30	31	30	31	Weather 1	Weather 2	Weather 1	Weather 2	factors	
ud---01-CA0065a-Nanaimo	Latitude °	49.2	Longitude °	-123.9	Altitude [m]	25	Daily temperature swing Summer [K]			9.5			Radiation: [W/m²]		Radiation: [W/m²]			
° C Exterior temperature	3.2	4.1	5.9	8.7	12.3	15.4	18.1	18.1	14.7	9.6	5.2	2.8	-5.7	1.2	27.5	22.1	1.20	Household electri
kWh/(m²month) Radiation North	8	13	24	32	46	53	54	37	25	17	9	7	13	6	85	55	1.15	Domestic hot wat
kWh/(m²month) Radiation East	13	25	56	81	108	106	125	105	73	41	19	11	23	7	225	180	1.45	Heating
kWh/(m²month) Radiation South	38	57	98	102	100	93	108	119	110	87	50	36	68	8	210	245	1.00	Cooling
kWh/(m²month) Radiation West	17	29	61	80	98	108	120	106	72	48	22	16	23	6	230	175	1.00	Dehumidification
kWh/(m²month) Horizontal radiation	23	40	88	130	169	179	198	169	111	64	29	19	39	13	370	255		
° C Dew point temperature	1.6	1.1	2.3	3.9	6.9	9.5	11.9	11.8	9.8	6.8	3.7	1.3			17.8	16.0		
° C Sky temperature	-5.0	-5.9	-5.0	-3.0	0.5	4.0	6.0	6.5	4.1	0.5	-2.8	-5.6			15.5	16.0		
° C Ground temperature	10.7	10.0	10.0	10.6	11.6	12.9	14.8	15.4	14.7	14.1	13.0	11.8	10.0	10.0	15.5	15.5		
Comment:	Temperature = interpol PHI; Other = derived from Meteonorm																	

2 Error(s)

U-value of building assemblies

Passive House with PHPP Version 9.6a

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Secondary calculation: Equivalent thermal conductivity of still air spaces -> (on the right)
Wedge-shaped assembly layer -> (on the right)
Unheated / uncooled attic -> (on the right)

Assembly no.	Building assembly description	Interior insulation?
01ud	**Wood frame wall - ambient**	

Heat transmission resistance [m²K/W]

Orientation of building element: **2-Wall**
Adjacent to: **3-Ventilated**
interior R_{si}: 0.13
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)]	Thickness [mm]
drywall	**0.250**					**13**
2x4 stud service fibreglass	**0.037**	**2x4s stud @ 400 o/c**	**0.130**			**89**
plywood sheathing	**0.130**					**19**
TJI 110 w/ dense pack cellulose	**0.039**	**TJI Flange @ 16" o/c**	**0.130**			**35**
TJI 110 w/ dense pack cellulose	**0.039**			**TJI Web @ 16" o/c**	**0.130**	**171**
TJI 110 w/ dense pack cellulose	**0.039**	**TJI Flange @ 16" o/c**	**0.130**			**35**
Rockwool comfort board	**0.036**					**76**

Percentage of sec. 1	Percentage of sec. 2	Percentage of sec. 3	Total
88%	**9.4%**	**2.3%**	**43.9** cm

U-value supplement: W/(m²K)

U-value: 0.095 W/(m²K)

Assembly no.	Building assembly description	Interior insulation?
02ud	**Conc wall - ground**	

Heat transmission resistance [m²K/W]

Orientation of building element: **2-Wall**
Adjacent to: **2-Ground**
interior R_{si}: 0.13
exterior R_{se}: 0.00

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
GWB	**0.250**					**13**
2x4 stud cavity AIR	**0.483**	**2x4 @ 600mm o/c**	**0.130**			**89**
ICF	**0.031**					**70**
Concrete wall	**2.300**					**203**
ICF	**0.031**					**70**
Terrafoam platinum GPS Type 2	**0.029**		**0.893**			**102**

Percentage of sec. 1	Percentage of sec. 2	Percentage of sec. 3	Total
94%	**6.3%**		**54.7** cm

U-value supplement: W/(m²K)

U-value: 0.145 W/(m²K)

Assembly no. 03ud — Conc wall - ambient — Interior insulation?

Heat transmission resistance [m²K/W]

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

Adjacent to: 1-Outdoor air — exterior R_{se}: 0.04

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
GWB	0.250					13
2x4 stud cavity AIR	0.483	2x4 @ 600mm o/c	0.130			89
ICF	0.031					70
Concrete wall	2.300					203
ICF	0.031					70
Terrafoam platinum GPS Type 2	0.029					102
concrete board for first 12"	2.300					13
metal cladding above 12"						

Percentage of sec. 1: 94% — Percentage of sec. 2: 6.3% — Percentage of sec. 3: — — Total: 55.9 cm

U-value supplement: — W/(m²K) — **U-value: 0.116** W/(m²K)

Assembly no. 04ud — Conc wall - ground - stairs — Interior insulation?

Heat transmission resistance [m²K/W]

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

Adjacent to: 2-Ground — exterior R_{se}: 0.00

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
GWB	0.250					13
no service cavity!						
ICF	0.031					70
Concrete wall	2.300					203
ICF	0.031					70
Terrafoam platinum GPS Type 2	0.029					102

Percentage of sec. 1: 100% — Percentage of sec. 2: — — Percentage of sec. 3: — — Total: 45.8 cm

U-value supplement: — W/(m²K) — **U-value: 0.119** W/(m²K)

Assembly no. 05ud — Basement floor — Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: 3-Floor — interior R_{si}: 0.17

Adjacent to: 2-Ground — exterior R_{se}: 0.00

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Concrete slab	2.300					102
Heat-sheet EPS tube locks	0.036	concrete	2.300			22
Heat-sheet EPS	0.036					51
Terrafoam platinum GPS Type 2	0.029					203

Percentage of sec. 1: 50% — Percentage of sec. 2: 50.0% — Percentage of sec. 3: — — Total: 37.8 cm

U-value supplement: — W/(m²K) — **U-value: 0.113** W/(m²K)

Assembly no. 06ud — Roof — Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: 1-Roof — interior R_{si}: 0.10

Adjacent to: 3-Ventilated — exterior R_{se}: 0.10

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
T&G	0.130					19
2x6 stud cavity AIR	0.545	2x6 @ 600mm o/c	0.130			140
Plywood sheathing	0.130					13
Parallel Cord Truss w/ Dense pack cellulose	0.040	Top cord	0.130			89
Parallel Cord Truss w/ Dense pack cellulose	0.040			Webbing	0.130	279
Parallel Cord Truss w/ Dense pack cellulose	0.040	Bottom cord	0.130			89

Percentage of sec. 1: 92% — Percentage of sec. 2: 6.3% — Percentage of sec. 3: 1.7% — Total: 62.9 cm

U-value supplement: W/(m²K)

U-value: 0.086 W/(m²K)

Assembly no. 07ud — Conc wall - ambient -stairs — Interior insulation?

Heat transmission resistance [m²K/W]

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

Adjacent to: 1-Outdoor air — exterior R_{se}: 0.04

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
GWB	0.250					13
no service cavity!						
ICF	0.031					70
Concrete wall	2.300					203
ICF	0.031					70
Terraloam platinum GPS Type 2	0.029					102
concrete board	2.300					22

Percentage of sec. 1: 94% — Percentage of sec. 2: 6.3% — Percentage of sec. 3: — Total: 48.0 cm

U-value supplement: W/(m²K)

U-value: 0.119 W/(m²K)

Assembly no. 08ud — Roof over attic — Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: 1-Roof — interior R_{si}: 0.10

Adjacent to: 3-Ventilated — exterior R_{se}: 0.10

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
2x6 stud cavity AIR	0.000	2x6 @ 600mm o/c	0.130			140
Plywood sheathing	0.130					13
Parallel Cord Truss w/ Dense pack cellulose	0.040	Top cord	0.130			89
Parallel Cord Truss w/ Dense pack cellulose	0.040			Webbing	0.130	279
Parallel Cord Truss w/ Dense pack cellulose	0.040	Bottom cord	0.130			89

Percentage of sec. 1: 92% — Percentage of sec. 2: 6.3% — Percentage of sec. 3: 1.7% — Total: 61.0 cm

U-value supplement: W/(m²K)

U-value: 0.089 W/(m²K)

Assembly no.		Interior insulation?
09ud	**LEGEND**	

Heat transmission resistance [m²K/W]

Orientation of building element
Adjacent to

interior R_{si}
exterior R_{se}:

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
changed in construction	**verified**	**june 2021**				**updated**
revised as per RDH certification feedback						

Percentage of sec. 1	Percentage of sec. 2	Percentage of sec. 3	Total
98%		**1.6%**	cm

U-value supplement W/(m²K)

U-value: W/(m²K)

Areas determination

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Summary

Temp.-zone	Area group	Group no.	Area / Length	Unit	Comment		Building assembly overview	Average U-value [W/(m²K)]	Radiation-gains heating season [kWh/a]	Radiation-load cooling period [kWh/a]
	Treated floor area	1	**311.95**	m²	*Treated floor area according to PHPP manual*				8 Months	2 Months
A	**North windows**	2	**13.93**	m²			**North windows**	**0.803**	**169**	**86**
A	**East windows**	3	**0.77**	m²	Results come from the 'Windows' worksheet.		**East windows**	**0.873**	**15**	**11**
A	**South windows**	4	**39.06**	m²	Window areas are subtracted from individual opaque areas.		**South windows**	**0.751**	**1535**	**527**
A	**West windows**	5	**4.97**	m²	which is displayed in the 'Windows' worksheet.		**West windows**	**0.824**	**129**	**80**
A	**Horizontal windows**	6	**0.00**	m²			**Horizontal windows**			
A	**Exterior door**	7	**0.00**	m²	*Please subtract area of door from respective building assembly*		**Exterior door**			
A	**External wall - Ambient**	8	**288.64**	m²	*Temperature zone "A" is ambient air*		**External wall - Ambient**	**0.097**	**142**	**84**
B	**External wall - Ground**	9	**112.94**	m²	*Temperature zone "B" is the ground*		**External wall - Ground**	**0.143**		
A	**Roof/Ceiling - Ambient**	10	**186.63**	m²			**Roof/Ceiling - Ambient**	**0.088**	**243**	**178**
B	**Floor slab / Basement ceiling**	11	**184.10**	m²			**Floor slab / Basement ceiling**	**0.113**		
		12	**0.00**	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"*					
		13	**0.00**	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"*	Factor for X				
X		14	**0.00**	m²	*Temperature zone "X": Please provide user-defined reduction factor (0 < ft < 1):*	**75%**				
							Thermal bridges - Overview	**Ψ [W/(mK)]**		
A	**Thermal bridges Ambient**	15	**140.18**	m	*Units in m*		**Thermal bridges Ambient**	**0.009**		
P	**Perimeter thermal bridges**	16	**61.51**	m	*Units in m; temperature zone "P" is perimeter (see 'Ground' worksheet)*		**Perimeter thermal bridges**	**0.021**		
B	**Thermal bridges FS/BC**	17	**0.00**	m	*Units in m*		**Thermal bridges FS/BC**			
I	**Building element towards neighb**	18	**0.00**	m²	*No heat losses, only considered for the heating load calculation*		**Building element towards neighbour**			
Total thermal envelope			**831.04**	**m²**			**Average therm. envelope**	**0.155**		

Go to building components list

Area input

2-Sorting: BY ID

Area no.	Building assembly description	To group No.	Assigned to group	Quantity	x (	a [m]	x	b [m]	+	User determined [m²]	-	User subtraction [m²]	-	Subtraction window areas [m²]	) =	Area [m²]	Selection building assembly / Building system	U-Value [W/(m²K)]	Deviation from North	Angle of inclination from the horizontal	Orientation	Reduction factor shading	Exterior absorptivity	Exterior emissivity
	Projected building footprint	**0**	Projected building footprint	**1**	x (		x		+	**184.10**	-		)		=	184.1								
	Treated floor area	**1**	Treated floor area	**1**	x (		x		+	**311.95**	-		)		=	312.0								
	Exterior door	**7**	Exterior door		x (		x		+		-		) -		=		Exterior door								
1	**Wall_Conc_Ambient_W**	**8**	External wall - Ambient	**1**	x (		x		+	**6.83**	-	**-0.73**	) -	**1.0**	=	6.5	**03ud-Conc wall - ambient**	**0.116**	**272**	**90**	**West**	**0.70**	**0.60**	**0.90**
2	**Wall_Conc_Ambient_S**	**8**	External wall - Ambient	**1**	x (		x		+	**1.25**	-		) -	**0.0**	=	1.3	**03ud-Conc wall - ambient**	**0.116**	**182**	**90**	**South**	**0.40**	**0.80**	**0.90**
3	**Wall_Frame_Ambient_W**	**8**	External wall - Ambient	**1**	x (		x		+	**71.00**	-	**0.73**	) -	**3.9**	=	66.3	**01ud-Wood frame wall - ambient**	**0.095**	**272**	**90**	**West**	**0.70**	**0.60**	**0.50**
4	**Wall_Frame_Ambient_S**	**8**	External wall - Ambient	**1**	x (		x		+	**115.16**	-		) -	**39.1**	=	76.1	**01ud-Wood frame wall - ambient**	**0.095**	**182**	**90**	**South**	**0.70**	**0.60**	**0.50**
5	**Wall_Conc_Ambient_N_2**	**8**	External wall - Ambient	**1**	x (		x		+	**6.39**	-	**-1.15**	) -	**0.0**	=	7.5	**03ud-Conc wall - ambient**	**0.116**	**2**	**90**	**North**	**0.40**	**0.80**	**0.90**
6	**Wall_Conc_Ambient_E**	**8**	External wall - Ambient	**1**	x (		x		+	**2.43**	-	**-2.80**	) -	**0.0**	=	5.2	**03ud-Conc wall - ambient**	**0.116**	**92**	**90**	**East**	**0.40**	**0.80**	**0.90**
7	**Wall_Frame_Ambient_N**	**8**	External wall - Ambient	**1**	x (		x		+	**95.06**	-	**1.15**	) -	**13.9**	=	80.0	**01ud-Wood frame wall - ambient**	**0.095**	**2**	**90**	**North**	**0.40**	**0.60**	**0.50**
8	**Wall_Frame_Ambient_E**	**8**	External wall - Ambient	**1**	x (		x		+	**48.91**	-	**2.80**	) -	**0.8**	=	45.3	**01ud-Wood frame wall - ambient**	**0.095**	**92**	**90**	**East**	**0.40**	**0.60**	**0.50**
9	**Wall_Conc_Ambient_N_strs**	**8**	External wall - Ambient	**1**	x (	**2.06**	x	**0.05**	+		-		) -	**0.0**	=	0.1	**07ud-Conc wall - ambient -stairs**	**0.119**	**2**	**90**	**North**	**0.40**	**0.80**	**0.90**
10	**Wall_Conc_Ambient_N_1**	**8**	External wall - Ambient	**1**	x (	**4.77**	x	**0.05**	+		-		) -	**0.0**	=	0.2	**03ud-Conc wall - ambient**	**0.116**	**2**	**90**	**North**	**0.40**	**0.80**	**0.90**
11	**Wall_Conc_Ground_W**	**9**	External wall - Ground	**1**	x (		x		+	**7.30**	-		) -	**0.0**	=	7.3	**02ud-Conc wall - ground**	**0.145**	**272**	**90**	**West**	**0.00**	**0.80**	**0.90**
12	**Wall_Conc_Ground_N_2**	**9**	External wall - Ground	**1**	x (		x		+	**33.31**	-		) -	**0.0**	=	33.3	**02ud-Conc wall - ground**	**0.145**	**2**	**90**	**North**	**0.00**	**0.80**	**0.90**
13	**Wall_Conc_Ground_N_strs**	**9**	External wall - Ground	**1**	x (	**3.70**	x	**2.06**	+		-		) -	**0.0**	=	7.6	**04ud-Conc wall - ground - stairs**	**0.119**	**2**	**90**	**North**	**0.00**	**0.80**	**0.90**
14	**Wall_Conc_Ground_N_1**	**9**	External wall - Ground	**1**	x (	**4.77**	x	**3.70**	+		-		) -	**0.0**	=	17.6	**02ud-Conc wall - ground**	**0.145**	**2**	**90**	**North**	**0.00**	**0.80**	**0.90**
15	**Wall_Conc_Ground_E**	**9**	External wall - Ground	**1**	x (		x		+	**33.79**	-		) -	**0.0**	=	33.8	**02ud-Conc wall - ground**	**0.145**	**92**	**90**	**East**	**0.00**	**0.80**	**0.90**
16	**Wall_Conc_Ground_S**	**9**	External wall - Ground	**1**	x (		x		+	**13.28**	-		) -	**0.0**	=	13.3	**02ud-Conc wall - ground**	**0.145**	**182**	**90**	**South**	**0.00**	**0.80**	**0.90**
17	**Roof_main_H**	**10**	Roof/Ceiling - Ambient	**1**	x (	**17.71**	x	**10.54**	+		-	**87.43**	) -	**0.0**	=	99.2	**06ud-Roof**	**0.086**	**182**	**10**	**Hor**	**0.90**	**0.60**	**0.35**
18	**Floor_bsmt_D**	**11**	Floor slab / Basement ceiling	**1**	x (	**17.71**	x	**10.39**	+		-		) -	**0.0**	=	184.1	**05ud-Basement floor**	**0.113**	**182**	**180**	**Hor**	**0.00**	**0.80**	**0.90**
19	**Roof_main_attic**	**10**	Roof/Ceiling - Ambient	**1**	x (		x		+	**87.43**	-		) -	**0.0**	=	87.4	**08ud-Roof no ceiling**	**0.089**	**182**	**10**	**Hor**	**0.90**	**0.60**	**0.35**
20					x (		x		+		-		) -	**0.0**	=									
21	-				x (		x		+		-		) -	**0.0**	=									
50	-				x (		x		+		-		) -	**0.0**	=									
Aend																								

Areas determination

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Summary

Temp.-zone	Area group	Group no.	Area / Length	Unit	Comment	Building assembly overview	Average U-value [W/(m²K)]	Radiation-gains heating season [kWh/a]
	Treated floor area	1	**311.95**	m²	*Treated floor area according to PHPP manual*			8 Months
A	**North windows**	2	**13.93**	m²	Results come from the 'Windows' worksheet.	**North windows**	**0.803**	**169**
A	**East windows**	3	**0.77**	m²	Window areas are subtracted from individual opaque areas.	**East windows**	**0.873**	**15**
A	**South windows**	4	**39.06**	m²	which is displayed in the 'Windows' worksheet.	**South windows**	**0.751**	**1535**
A	**West windows**	5	**4.97**	m²		**West windows**	**0.824**	**129**
A	**Horizontal windows**	6	**0.00**	m²		**Horizontal windows**		
A	**Exterior door**	7	**0.00**	m²	*Please subtract area of door from respective building assembly*	**Exterior door**		
A	**External wall - Ambient**	8	**288.64**	m²	*Temperature zone "A" is ambient air*	**External wall - Ambient**	**0.097**	**142**
B	**External wall - Ground**	9	**112.94**	m²	*Temperature zone "B" is the ground*	**External wall - Ground**	**0.143**	
A	**Roof/Ceiling - Ambient**	10	**186.63**	m²		**Roof/Ceiling - Ambient**	**0.088**	**243**
B	**Floor slab / Basement ceiling**	11	**184.10**	m²		**Floor slab / Basement ceiling**	**0.113**	
		12	**0.00**	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"*			
		13	**0.00**	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"* Factor for X			
X		14	**0.00**	m²	*Temperature zone "X": Please provide user-defined reduction factor (0 < ft < 1):* **75%**			

						Thermal bridges - Overview	Ψ [W/(mK)]
A	**Thermal bridges Ambient**	15	**140.18**	m	*Units in m*	**Thermal bridges Ambient**	**0.009**
P	**Perimeter thermal bridges**	16	**61.51**	m	*Units in m; temperature zone "P" is perimeter (see 'Ground' worksheet)*	**Perimeter thermal bridges**	**0.021**
B	**Thermal bridges FS/BC**	17	**0.00**	m	*Units in m*	**Thermal bridges FS/BC**	
I	**Building element towards neighb**	18	**0.00**	m²	*No heat losses, only considered for the heating load calculation*	**Building element towards neighbour**	
Total thermal envelope			**831.04**	**m²**		**Average therm. envelope**	**0.155**

Go to building components list

Thermal bridge inputs

Sortierung ändern

No.	Thermal bridge - denomination	Group No.	Assigned to group	Quantity	x (	Length [m]	-	Subtraction length [m]	) =	Length ℓ [m]	User determined psi value [W/(mK)]	User determined $f_{Rsi=0,25}$ (optional)	or	Selection building system	Ψ-Value [W/(mK)]	f_{Rsi}-Requirement met?
1	**TB-bsmt slab-conc wall**	**16**	Perimeter thermal bridges	**1**	x (	**31.84**	-		) =	31.84	**0.040**		or		**0.040**	
2	**TB-bsmt slab-frame wall**	**16**	Perimeter thermal bridges	**1**	x (	**21.02**	-		) =	21.02	**0.000**		or		**0.000**	
3	**TB-corner conc wall-grnd (vert)**	**16**	Perimeter thermal bridges	**1**	x (	**8.65**	-		) =	8.65	**0.000**		or		**0.000**	
4	**TB-frame wall-conc wall (vert)**	**15**	Thermal bridges Ambient	**1**	x (	**5.73**	-		) =	5.73	**0.020**		or		**0.020**	
5	**TB-floor-conc wall**	**15**	Thermal bridges Ambient	**1**	x (	**30.16**	-		) =	30.16	**0.020**		or		**0.020**	
6	**TB-floor-frame wall**	**15**	Thermal bridges Ambient	**1**	x (	**24.37**	-		) =	24.37	**0.020**		or		**0.020**	
7	**TB-corner conc wall-amb (vert)**	**15**	Thermal bridges Ambient	**1**	x (	**2.60**	-		) =	2.60	**0.000**		or		**0.000**	
8	**TB-corner frame wall (vert)**	**15**	Thermal bridges Ambient	**1**	x (	**19.82**	-		) =	19.82	**0.000**		or		**0.000**	
9	**TB-roof-frame wall**	**15**	Thermal bridges Ambient	**1**	x (	**56.50**	-		) =	56.50	**0.000**		or		**0.000**	
10	**Plumbing vent above loft/in floor**	**15**	Thermal bridges Ambient	**0**	x (	**19.09**	-		) =	0.00	**0.066**		or		**0.066**	
11	**Plumbing vent in 3.5" wall**	**15**	Thermal bridges Ambient	**0**	x (	**28.05**	-		) =	0.00	**0.115**		or		**0.115**	
12	**Plumbing vent above roof**	**15**	Thermal bridges Ambient	**1**	x (	**1.00**	-		) =	1.00	**0.046**		or		**0.046**	
13					x (		-		) =				or			
14					x (		-		) =				or			

TBend

Heat losses through the ground

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Building section 1

Ground characteristics			
Thermal conductivity	λ	2.0	W/(mK)
Heat capacity	ρc	2.0	MJ/(m³K)
Periodic penetration depth	δ	3.17	m

Climate data			
Avg indoor temp. winter	T_i	20.0	°C
Avg indoor temp. summer	T_i	25.0	°C
Avg ground surface temperature	$T_{g,ave}$	10.9	°C
Amplitude of $T_{g,ave}$	$T_{g,\wedge}$	7.7	°C
Phase shifting of $T_{e,m}$	τ	1.1	Months
Length of the heating period	n	7.2	Months
Heating degree hours - exterior	G_t	75.5	kKh/a

Building data							
Area of ground floor slab / basement	A	184.1	m²	U-value floor slab/basement ceiling	U_f	0.113	W/(m²K)
Perimeter length	P	56.2	m	TBs floor slab / basement ceiling	Ψ_B*l	0.00	W/K
Charact. dimension of floor slab	B'	6.55	m	U-value floor slab / basement ceiling i	U_f'	0.113	W/(m²K)
				Equivalent thickness floor	d_t	17.71	m

Floor slab type (select only one)

Slab on grade

Perimeter insulation width/depth	D		m	Orientation of perimeter insulation	horizontal		
Perimeter insulation thickness	d_n		m	(check only one field)	vertical	x	
Conductivity perimeter insulation	λ_n		W/(mK)				

x **Heated basement or floor slab completely / partially below ground level**

Basement wall height below ground le	z	1.94	m	U-Value wall below ground	U_{wB}	0.145	W/(m²K)

Unheated basement

Height aboveground wall	h		m	U-Value wall above ground	U_W		W/(m²K)
Basement wall height below ground le	z		m	U-Value wall below ground	U_{WB}		W/(m²K)
Air change unheated basement	n	0.20	h^{-1}	U-Value basement floor slab	U_{fB}		W/(m²K)
Air volume basement	V		m³				

Suspended floor above a ventilated crawl space (at max. 0.5 m below ground)

U-Value crawl space	U_{Crawl}		W/(m²K)	Area of ventilation openings	εP		m²
Height of crawl space wall	h		m	Wind velocity at 10 m height	v	4.0	m/s
U-Value crawl space wall	U_W		W/(m²K)	Wind shield factor	f_W	0.05	-

Additional thermal bridge heat losses at perimeter							
				Steady-state fraction	$\Psi_{P,stat}$*l		W/K
Phase shift	β		Months	Harmonic fraction	$\Psi_{P,harm}$*l	0.000	W/K

Groundwater correction							
Depth of the groundwater table	z_w	3.0	m	Groundwater correction factor	G_w	1.00792909	-
Groundwater flow rate	q_w	0.05	m/d				

Interim results

Phase shift	β	1.43	Months	Steady-state heat flow	Φ_{stat}	280.7	W
Steady-state transmittance	L_S	30.77	W/K	Periodic heat flow	Φ_{harm}	32.5	W
Exterior periodic transmittance	L_{pe}	11.59	W/K	Heat losses during heating period	Q_{tot}	1655	kWh
Transmittance building	L_0	36.60	W/K				

Monthly average temperatures in the ground for monthly method (building assembly 1)

Month	1	2	3	4	5	6	7	8	9	10	11	12	Avg. value
Winter	10.7	10.0	10.0	10.6	11.6	12.9	14.0	14.6	14.7	14.1	13.0	11.8	12.3
Summer	11.5	10.8	10.8	11.4	12.4	13.7	14.8	15.4	15.5	14.9	13.8	12.6	13.1

Design ground temperature for 'Heating load' worksheet 10.0 **For 'Cooling load' worksheet** 15.5

Reduction factor for 'Annual heating' worksheet 0.60

Total result (all building parts)

Phase shift	β	1.43	Months	Steady-state heat flow	Φ_{stat}	280.7	W
Steady-state transmittance	L_S	30.77	W/K	Periodic heat flow	Φ_{harm}	32.5	W
Exterior periodic transmittance	L_{pe}	11.59	W/K	Heat losses during heating period	Q_{tot}	1655	kWh
Transmittance building	L_0	36.60	W/K	Charact. dimension of floor slab	B'	6.55	m

Monthly Average temperatures in the ground for monthly method (all building assemblies)

Month	1	2	3	4	5	6	7	8	9	10	11	12	Avg. value
Winter	10.7	10.0	10.0	10.6	11.6	12.9	14.0	14.6	14.7	14.1	13.0	11.8	12.3
Summer	11.5	10.8	10.8	11.4	12.4	13.7	14.8	15.4	15.5	14.9	13.8	12.6	13.1

Design ground temperature for 'Heating load' worksheet 10.0 **For 'Cooling load' worksheet** 15.5

Reduction factor for 'Annual heating' worksheet 0.60

Passive House Components

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Go to: 'AREAS' www.passivehouse.com/component-database
Thermal bridges (Psi-values) Ventilation units
Glazing Compact units
Window frames Heat recovery DHW

Building assemblies (U-Values)

Recommended starting values for optimisation: U-values for walls and roofs | Floor slabs: 0.15 W/(m²K) | 0.26 W/(m²K)

		1			
ID	**Building system**	**Building assembly**	**Total thickness**	**U-Value**	**Interior insulation**
	Summary of the constructions calculated in 'U values' worksheet		m	W/(m²K)	-
01ud	**Wood frame wall - ambient**	**Wood frame wall - ambient**	**0.439**	**0.095**	**0**
02ud	**Conc wall - ground**	**Conc wall - ground**	**0.547**	**0.145**	**0**
03ud	**Conc wall - ambient**	**Conc wall - ambient**	**0.559**	**0.116**	**0**
04ud	**Conc wall - ground - stairs**	**Conc wall - ground - stairs**	**0.458**	**0.119**	**0**
05ud	**Basement floor**	**Basement floor**	**0.378**	**0.113**	**0**
06ud	**Roof**	**Roof**	**0.629**	**0.086**	**0**
07ud	**Conc wall - ambient -stairs**	**Conc wall - ambient -stairs**	**0.480**	**0.119**	**0**
08ud	**Roof over attic**	**Roof over attic**	**0.610**	**0.089**	**0**
09ud	**LEGEND**	**LEGEND**			**0**
10ud			**0.578**		**0**

Glazing

Glazing

	Recommended glazing type to start planning: Triple thermally insulated glazing (Please consider the comfort criterion!)		
ID	**Description**	**g-Value**	U_g-Value
			W/(m²K)
01ud			
02ud			
03ud	**Cardinal 270/180**	**0.33**	**0.62**
04ud			
05ud			
06ud			
07ud			
08ud			
09ud			
10ud			

Window frames

Window frames

		U_f-Value				Frame width				Glazing edge thermal bridge				Installation thermal bridge				Curtain wall facades:
ID	Description	left	right	bottom	above	left	right	bottom	above	$\Psi_{Glazing\ edge}$ left	$\Psi_{Glazing\ edge}$ right	$\Psi_{Glazing\ edge}$ bottom	$\Psi_{Glazing\ edge}$ top	$\Psi_{Installation}$ left	$\Psi_{Installation}$ right	$\Psi_{Installation}$ bottom	$\Psi_{Installation}$ top	χ_{GC} -value Glass carrier
		W/(m²K)	W/(m²K)	W/(m²K)	W/(m²K)	m	m	m	m	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/K
01ud	**Cascadia T&T**	**0.88**	**0.88**	**0.88**	**0.88**	**0.105**	**0.105**	**0.105**	**0.105**	**0.021**	**0.021**	**0.021**	**0.021**	**0.010**	**0.010**	**0.022**	**0.015**	**0.000**
02ud	**Cascadia T&T combi.left**	**0.88**	**0.90**	**0.88**	**0.88**	**0.105**	**0.095**	**0.105**	**0.105**	**0.021**	**0.021**	**0.021**	**0.021**	**0.010**	**0.000**	**0.022**	**0.015**	**0.000**
03ud	**Casdcadia Fixed**	**0.81**	**0.81**	**0.81**	**0.81**	**0.058**	**0.058**	**0.058**	**0.058**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.000**
04ud	**Casdcadia Fixed combi.right**	**0.88**	**0.81**	**0.81**	**0.81**	**0.048**	**0.058**	**0.058**	**0.058**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.000**
05ud	**Cascadia door**	**0.79**	**0.79**	**0.86**	**0.79**	**0.132**	**0.132**	**0.146**	**0.132**	**0.022**	**0.022**	**0.022**	**0.022**	**0.018**	**0.018**	**0.032**	**0.018**	**0.000**
06ud	**Cascadia FRONT door**	**0.79**	**0.79**	**0.86**	**0.79**	**0.132**	**0.132**	**0.146**	**0.132**	**0.022**	**0.022**	**0.022**	**0.022**	**0.018**	**0.018**	**0.100**	**0.018**	**0.000**
07ud	**Casdcadia Fixed combi.right FRONT**	**0.88**	**0.81**	**0.81**	**0.81**	**0.048**	**0.058**	**0.058**	**0.058**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.100**	**0.020**	**0.000**
08ud																		
09ud																		
10ud																		

Ventilation units with heat recovery

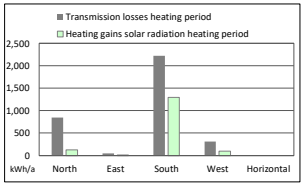
Ventilation units with heat recovery

	Recommended specifications to start planning: Frost protection: Yes; Humidity recovery: Yes	75 %		0.45	Additional Device Data								
ID	Description	Effective heat recovery efficiency	Humidity recovery efficiency	Electric efficiency	Application range		External pressure per section	Fittings Dp_{intern}	Frost protection necessary	Noise protection			Additional info
	User defined area	%	%	Wh/m³	m³/h	m³/h	Pa	Pa		35 dB(A)	Supply air dB(A)	Extract air dB(A)	
01ud	**Zehnder Q450**	**88%**	**0%**	**0.21**	**70**	**345**	**100**		**yes**		**59**	**46**	
02ud													
03ud													
04ud													
05ud													
06ud													
07ud													
08ud													
09ud													
10ud													

Windows

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Window area orientation	Global radiation (main orientations)	Shading	Dirt	Non-vertical radiation incidence	Glazing fraction	g-Value	Solar irradiation reduction factor	Window area	Window U-Value	Glazing area	Average global radiation		Transmission losses heating period	Heating gains solar radiation heating period
Standard values →	kWh/(m²a)	0.75	0.95	0.85				m²	W/(m²K)	m²	kWh/(m²a)		kWh/a	kWh/a
North	118	0.41	0.95	0.85	0.71	0.33	0.24	13.93	0.80	9.83	118	North	844	127
East	263	0.28	0.95	0.85	0.71	0.33	0.16	0.77	0.87	0.55	270	East	51	11
South	478	0.32	0.95	0.85	0.80	0.33	0.21	39.06	0.75	31.26	478	South	2215	1291
West	287	0.39	0.95	0.85	0.68	0.33	0.22	4.97	0.82	3.40	281	West	309	100
Horizontal	419	1.00	0.95	0.85	0.00	0.00	0.00	0.00	0.00	0.00	419	Horizontal	0	0
Total or average value for all windows.						0.33	0.22	58.74	0.77	45.05			3419	1529



Heating degree hours [kKh/a]: 75.5

Go to glazing list Go to window frames list

Recommendation for $U_{W,installed}$ [W/(m²K)]: 0.85 | 1.00 | 1.10 | 0.55

Qua n-tity	Description	Deviation from north	Angle of inclination from the horizontal	Orien- tation	Window rough openings: Width	Window rough openings: Height	Installed in: Selection from 'Areas' worksheet	Glazing: Selection from 'Components' worksheet	Frame: Selection from 'Components' worksheet	g-Value: Perpen-dicular radiation	U-Value: Glazing	U-Value: Frames (avg.)	Ψ Glazing edge: $\Psi_{Glazing\ edge}$ (Avg.)	Installation situation: left	right	bottom	top	$\Psi_{installation}$ (Avg.)	Results: Window Area	Glazing area	U_w installed	Glazed fraction per window
		°	°		m	m		1-Sorting: LIKE LIST	1-Sorting: LIKE LIST	-	W/(m²K)	W/(m²K)	W/(mK)	W/(mK) or 1/0				W/(mK)	m²	m²	W/(m²K)	%
1	Win_N1	2	90	North	2.134	0.559	7-Wall_Frame_Ambient_N	03ud-Cardinal 270/180	01ud Cascadia T&T	0.33	0.62	0.88	0.021	1	1	1	1	0.017	1.2	0.67	0.89	56%
1	Win_N2	2	90	North	1.118	2.032	7-Wall_Frame_Ambient_N	03ud-Cardinal 270/180	01ud Cascadia T&T	0.33	0.62	0.88	0.021	1	1	1	1	0.013	2.3	1.65	0.78	73%
1	Win_N3.1	2	90	North	1.118	2.591	7-Wall_Frame_Ambient_N	03ud-Cardinal 270/180	06ud-Cascadia FRONT door	0.33	0.62	0.80	0.022	1	0	1	1	0.037	2.9	1.97	0.79	68%
1	Win_N3.2	2	90	North	0.559	2.591	7-Wall_Frame_Ambient_N	03ud-Cardinal 270/180	07ud-Casdcadia Fixed combi.right FRONT door	0.33	0.62	0.84	0.020	0	1	1	1	0.032	1.4	1.12	0.83	77%
1	Win_N4	2	90	North	1.727	0.559	7-Wall_Frame_Ambient_N	03ud-Cardinal 270/180	01ud Cascadia T&T	0.33	0.62	0.88	0.021	1	1	1	1	0.016	1.0	0.53	0.90	55%
1	Win_N5	2	90	North	0.762	1.219	7-Wall_Frame_Ambient_N	03ud-Cardinal 270/180	01ud Cascadia T&T	0.33	0.62	0.88	0.021	1	1	1	1	0.013	0.9	0.56	0.85	60%
1	Win_N6.1	2	90	North	0.762	2.134	7-Wall_Frame_Ambient_N	03ud-Cardinal 270/180	02ud Cascadia T&T combi.left	0.33	0.62	0.89	0.021	1	0	1	1	0.014	1.6	1.08	0.80	66%
1	Win_N6.2	2	90	North	1.219	2.134	7-Wall_Frame_Ambient_N	03ud-Cardinal 270/180	04ud Casdcadia Fixed combi.right	0.33	0.62	0.83	0.020	0	1	1	1	0.020	2.6	2.25	0.73	86%
1	Win_E12	92	90	East	1.524	0.508	8-Wall_Frame_Ambient_E	03ud-Cardinal 270/180	03ud Casdcadia Fixed	0.33	0.62	0.81	0.020	1	1	1	1	0.020	0.8	0.55	0.87	71%
1	Win_S10.1	182	90	South	1.016	1.575	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	02ud Cascadia T&T combi.left	0.33	0.62	0.89	0.021	1	0	1	1	0.015	1.6	1.11	0.79	70%
1	Win_S10.2	182	90	South	1.270	1.575	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	04ud Casdcadia Fixed combi.right	0.33	0.62	0.83	0.020	0	1	1	1	0.020	2.0	1.70	0.74	85%
1	Win_S11.1	182	90	South	1.016	2.134	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	02ud Cascadia T&T combi.left	0.33	0.62	0.89	0.021	1	0	1	1	0.014	2.2	1.57	0.77	72%
1	Win_S11.2	182	90	South	1.270	2.134	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	04ud Casdcadia Fixed combi.right	0.33	0.62	0.83	0.020	0	1	1	1	0.020	2.7	2.35	0.73	87%
1	Win_S17.1	182	90	South	1.016	1.829	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	02ud Cascadia T&T combi.left	0.33	0.62	0.89	0.021	1	0	1	1	0.014	1.9	1.32	0.78	71%
1	Win_S17.2	182	90	South	2.032	1.829	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	04ud Casdcadia Fixed combi.right	0.33	0.62	0.82	0.020	0	1	1	1	0.020	3.7	3.30	0.71	89%
1	Win_S18.1	182	90	South	1.016	1.473	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	02ud Cascadia T&T combi.left	0.33	0.62	0.89	0.021	1	0	1	1	0.015	1.5	1.03	0.80	69%
1	Win_S18.2	182	90	South	1.422	1.473	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	04ud Casdcadia Fixed combi.right	0.33	0.62	0.82	0.020	0	1	1	1	0.020	2.1	1.79	0.74	85%
1	Win_S19.1	182	90	South	1.016	2.286	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	06ud-Cascadia FRONT door	0.33	0.62	0.80	0.022	1	0	1	1	0.037	2.3	1.51	0.81	65%
1	Win_S19.2	182	90	South	1.270	2.286	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	07ud-Casdcadia Fixed combi.right FRONT	0.33	0.62	0.83	0.020	0	1	1	1	0.041	2.9	2.53	0.76	87%
1	Win_S20.1	182	90	South	1.016	1.473	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	02ud Cascadia T&T combi.left	0.33	0.62	0.89	0.021	1	0	1	1	0.015	1.5	1.03	0.80	69%
1	Win_S20.2	182	90	South	1.270	1.473	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	04ud Casdcadia Fixed combi.right	0.33	0.62	0.83	0.020	0	1	1	1	0.020	1.9	1.58	0.75	84%
1	Win_S8.1	182	90	South	1.016	2.134	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	02ud Cascadia T&T combi.left	0.33	0.62	0.89	0.021	1	0	1	1	0.014	2.2	1.57	0.77	72%
1	Win_S8.2	182	90	South	2.032	2.134	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	04ud Casdcadia Fixed combi.right	0.33	0.62	0.83	0.020	0	1	1	1	0.020	4.3	3.89	0.71	90%
1	Win_S9.1	182	90	South	1.016	2.591	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	05ud Cascadia door	0.33	0.62	0.80	0.022	1	0	1	1	0.021	2.6	1.74	0.77	66%
1	Win_S9.2	182	90	South	1.422	2.591	4-Wall_Frame_Ambient_S	03ud-Cardinal 270/180	04ud Casdcadia Fixed combi.right	0.33	0.62	0.83	0.020	0	1	1	1	0.020	3.7	3.26	0.71	88%
1	Win_W13	272	90	West	0.762	1.372	1-Wall_Conc_Ambient_W	03ud-Cardinal 270/180	01ud Cascadia T&T	0.33	0.62	0.88	0.021	1	1	1	1	0.013	1.0	0.64	0.84	61%
1	Win_W14	272	90	West	1.067	2.286	3-Wall_Frame_Ambient_W	03ud-Cardinal 270/180	06ud-Cascadia FRONT door	0.33	0.62	0.80	0.022	1	1	1	1	0.031	2.4	1.61	0.82	66%
0																						
1	Win_W7	272	90	West	2.438	0.610	3-Wall_Frame_Ambient_W	03ud-Cardinal 270/180	03ud Casdcadia Fixed	0.33	0.62	0.81	0.020	1	1	1	1	0.020	1.5	1.15	0.82	77%
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Calculation of shading coefficients

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Latitude: 49.16 °

Orientation	Glazing area [m²]	Reduction factor winter r_v	Reduction factor cooling $r_{v,1}$	Reduction factor cooling load $r_{v,2}$	Solar load [kWh/(m²$_{Glazing}$a)]
North	9.83	41%	45%	45%	9
East	0.55	28%	37%	37%	19
South	31.26	32%	32%	31%	17
West	3.40	39%	46%	46%	23
Horizontal	0.00	100%	100%	100%	0

								Horizon		Lateral reveal		Reveal / Overhang						Reduction factors for shading in winter				Reduction factors for shading in summer				
Quantity	Description	Deviation from North	Angle of inclination from the horizontal	Orientation	Glazing width	Glazing height	Glazing area	Height of the shading object	Horizontal distance	Window reveal depth	Distance from glazing edge to reveal	Overhang depth	Distance from upper glazing edge to overhang	Additional reduction factor winter shading	Additional reduction factor summer shading	Reduction factor z for temporary sun protection	Regulated / transparent	Horizon	Reveal	Overhang	Total for heating case	Horizon	Reveal	Overhang	Total for cooling case	Total for cooling load
		[Degree]	[Degree]		w_G [m]	h_G [m]	A_G [m²]	h_{Hori} [m]	d_{Hori} [m]	o_{Reveal} [m]	d_{Reveal} [m]	o_{over} [m]	d_{over} [m]	$r_{other,w}$ [%]	$r_{other,s}$ [%]	z [%]		r_H [%]	r_R [%]	r_O [%]	r_S [%]	r_H [%]	r_R [%]	r_O [%]	$r_{S,1}$ [%]	$r_{S,2}$ [%]
1	Win_N1	2	90	North	1.92	0.35	0.7	121.00	513.00	1.18	2.829	2.88	0.26	90%	92%			82%	91%	33%	22%	83%	92%	40%	28%	28%
1	Win_N2	2	90	North	0.91	1.82	1.7	121.00	513.00	1.18	4.220	2.88	0.26	90%	91%			82%	93%	54%	37%	83%	93%	56%	40%	40%
1	Win_N3.1	2	90	North	0.85	2.31	2.0	121.00	513.00	4.84	5.454	2.88	0.28	90%	91%			82%	79%	60%	35%	83%	81%	61%	38%	38%
1	Win_N3.2	2	90	North	0.45	2.48	1.1	121.00	513.00	4.84	5.654	2.88	0.21	90%	91%			82%	79%	60%	35%	83%	81%	61%	38%	38%
1	Win_N4	2	90	North	1.52	0.35	0.5	121.00	513.00	1.18	6.417	2.88	0.26	90%	92%			82%	95%	33%	23%	83%	95%	40%	29%	29%
1	Win_N5	2	90	North	0.55	1.01	0.6	121.00	513.00	0.12	0.105	2.88	0.26	90%	91%			82%	91%	44%	29%	83%	91%	48%	33%	33%
1	Win_N6.1	2	90	North	0.56	1.92	1.1	121.00	513.00	4.84	9.549	1.39	2.85	90%	91%			82%	87%	90%	58%	83%	88%	96%	64%	64%
1	Win_N6.2	2	90	North	1.11	2.02	2.2	121.00	513.00	4.84	9.273	1.39	2.80	90%	91%			82%	87%	90%	58%	83%	88%	96%	64%	64%
1	Win_E12	92	90	East	1.41	0.39	0.6	3.50	91.00	0.12	0.058	1.08	2.19	36%	42%			96%	93%	88%	28%	97%	97%	92%	37%	37%
1	Win_S10.1	182	90	South	0.82	1.37	1.1			0.12	0.735	1.38	0.67	46%	73%	21%			98%	86%	39%		97%	51%	16%	10%
1	Win_S10.2	182	90	South	1.16	1.46	1.7			0.12	0.561	1.38	0.62	46%	73%	21%			98%	86%	39%		97%	51%	16%	10%
1	Win_S11.1	182	90	South	0.82	1.92	1.6			0.12	0.735	1.38	0.67	44%	70%	22%			98%	89%	38%		97%	59%	18%	12%
1	Win_S11.2	182	90	South	1.16	2.02	2.3			0.12	0.561	1.38	0.62	43%	70%	23%			98%	89%	38%		97%	59%	18%	12%
1	Win_S17.1	182	90	South	0.82	1.62	1.3	0.56	31.94	1.64	6.281	1.38	4.02	42%	76%			100%	95%	96%	38%	99%	93%	92%	65%	65%
1	Win_S17.2	182	90	South	1.93	1.71	3.3	0.66	31.94	1.64	6.257	1.38	3.97	42%	76%			100%	95%	96%	38%	99%	94%	92%	65%	65%
1	Win_S18.1	182	90	South	0.82	1.26	1.0	0.26	31.94	1.64	4.591	3.16	0.52	43%	76%			100%	93%	68%	27%	100%	91%	21%	15%	15%
1	Win_S18.2	182	90	South	1.32	1.36	1.8	0.35	31.94	1.64	3.783	3.16	0.47	43%	76%			100%	92%	68%	27%	100%	90%	21%	15%	15%
1	Win_S19.1	182	90	South	0.75	2.01	1.5	0.61	3.21	1.64	2.473	3.16	0.52	42%	76%			93%	88%	75%	25%	93%	85%	26%	16%	16%
1	Win_S19.2	182	90	South	1.16	2.17	2.5	0.70	3.21	1.64	1.715	3.16	0.47	41%	76%			91%	85%	75%	24%	93%	81%	27%	15%	15%
1	Win_S20.1	182	90	South	0.82	1.26	1.0	0.45	3.21	1.64	1.240	3.16	0.52	43%	76%			96%	80%	68%	22%	95%	76%	21%	12%	12%
1	Win_S20.2	182	90	South	1.16	1.36	1.6	0.50	3.21	1.64	1.066	3.16	0.47	43%	76%			95%	80%	68%	22%	95%	76%	21%	12%	12%
1	Win_S8.1	182	90	South	0.82	1.92	1.6			0.12	1.116	1.38	0.52	47%	78%				98%	88%	40%		98%	55%	42%	42%
1	Win_S8.2	182	90	South	1.93	2.02	3.9			0.12	0.561	1.38	0.47	47%	78%				98%	88%	40%		98%	55%	42%	42%
1	Win_S9.1	182	90	South	0.75	2.31	1.7			0.12	0.843	1.38	0.67	30%	71%				98%	90%	26%		97%	64%	44%	44%
1	Win_S9.2	182	90	South	1.32	2.48	3.3	151.00	1699.00	0.12	0.561	1.38	0.62	29%	70%			98%	98%	90%	25%	97%	97%	65%	43%	43%
1	Win_W13	272	90	West	0.55	1.16	0.6	151.00	1699.00	0.12	0.105	1.08	5.78	61%	69%			92%	87%	95%	47%	94%	95%	99%	61%	61%
1	Win_W14	272	90	West	0.80	2.01	1.6	151.00	1699.00	0.12	0.132	2.30	0.21	60%	68%			92%	90%	60%	30%	94%	96%	54%	33%	33%
0																										
1	Win_W7	272	90	West	2.32	0.49	1.1	151.00	1699.00	0.12	0.058	1.08	1.19	67%	74%			92%	96%	81%	48%	94%	98%	83%	56%	56%
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Ventilation data

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Treated floor area A_{TFA}	m²	312		*('Areas' worksheet)*
Room height h	m	2.50	2.50	
Volume of ventilated space (A_{TFA}*h) = V_V	m³	780		*(Worksheet 'Annual heating')*

Ventilation type

Please select: **1-Balanced PH ventilation with HR**

Infiltration air change rate

Wind protection coefficients e and f	Several side exposed	One side exposed
Coefficient e for wind protection class		
No protection	0.10	0.03
Moderate protection	0.07	0.02
High protection	0.04	0.01
Coefficient f	15	20

			For annual demand:	For heating load:				
Wind protection coefficient, e			0.04	0.10				
Wind protection coefficient, f			15	15	Net air volume for press. test V_{n50}		Air permeability q_{50}	
Air change rate at press. test	n_{50}	1/h	0.30	0.30	990	m³	0.36	m³/(hm²)

			For annual demand:	For heating load:
Excess extract air		1/h	0.00	0.00
Infiltration air change rate	$n_{V,Rest}$	1/h	**0.015**	**0.038**

Selection of ventilation input - Results

PHPP offers two methods for dimensioning air quantities and choosing the ventilation unit. With "Standard data input for balanced ventilation", supply or extract air quantities for residential buildings and parameters for ventilation systems with a maximum of 1 ventilation unit can be planned. Projects with up to 10 different ventilation units and air quantities determined according to rooms or zones can be entered in the 'Addl vent' worksheet. Please select your design method here:

	Ventilation unit / Heat recovery efficiency design		Average air flow rate m³/h	Average air change rate 1/h	Extract air excess (extract air system) 1/h	Effective heat recovery efficiency unit [-]	Humidity recovery efficiency [-]	Specific power input Wh/m³	Heat recovery efficiency SHX [-]
	Standard design	*('Ventilation' worksheet, see below)*							
x	Multiple ventilation units, non-res	*('Addl vent' worksheet)*	**270**	**0.35**	**0.00**	**85.6%**	**0.0%**	**0.28**	**0.0%**

Cooling recovery:

Efficiency SHX η^*_{SHX}: 0%

Average interior humidity during winter operation

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
41%	40%	43%	47%	55%	-	-	-	-	54%	46%	41%

Standard data input for balanced ventilation (worksheet inactive. Calculation in 'Addl

Dimensioning of ventilation system with only one ventilation unit

			Kitchen	Bathroom	Bathroom (shower only)	WC	Mech
Occupancy	m²/P	53					
Number of occupants	P	5.9					
Supply air per person	m³/(P*h)	30					
Supply air requirement	m³/h	177					
Extract air rooms			Kitchen	Bathroom	Bathroom (shower only)	WC	Mech
Quantity			2	4		2	
Extract air requirement per room	m³/h		60	40	20	20	
Total extract air requirement	m³/h	320					

Design air flow rate (maximum) m³/h **320** Recommended: 320 m³/h

Average air change rate calculation

Type of operation	Daily operation times h/d	Factors referenced to maximum	Air flow rate m³/h	Air change rate 1/h
maximum		1.00	320	0.41
Standard	**24.0**	**0.77**	246	0.32
Basic ventilation		**0.54**	172	0.22
Minimum		**0.40**	128	0.16
	Average value	0.77	Average air flow rate (m³/h)	Average air change rate (1/h)

Selection of ventilation unit with heat recovery

Location of ventilation unit: **1-Inside thermal envelope**

	Go to ventilation units list 1-Sorting: LIKE LIST	Heat recovery efficiency	Humidity recovery efficiency	Specific efficiency [Wh/m³]	Application [m³/h]	Frost power input
Ventilation unit selection	**01ud-Zehnder Q450**	0.88	0.00	0.21	70 - 345	yes

Conductivity outdoor air duct	Ψ	W/(mK)		Implementation of frost protection	2-Elec.
Length of outdoor air duct		m	3.2	Limit temperature [°C]	0
Conductivity exhaust air duct	Ψ	W/(mK)		Useful energy [kWh/a]	0
Length of exhaust air duct		m	2.2		
Temperature of mechanical services room		°C		Room temperature (°C)	20
(Enter only if the central unit is outside of the thermal envelope)				Avg. ambient temp. heat. period (°C)	6.2
				Avg. ground temp (°C)	10.9

Effective heat recovery efficiency $\eta_{HR,eff}$

Effective heat recovery efficiency subsoil heat exchanger

SHX efficiency η^*_{SHX}

Heat recovery efficiency SHX η_{SHX} 0%

Secondary calculation
Ψ-value supply or outdoor air duct

Nominal width	180	mm
Insulation thick	100	mm
Reflective coating?		Yes
	x	No
Thermal conductivity	0.040	W/(mK)
Nominal air flow rate		m³/h
Δϑ	14	K
Exterior duct diameter	0.180	m
Exterior diameter	0.380	m
α–Interior		W/(m²K)
α-Surface		W/(m²K)
Ψ–value		**W/(mK)**
Surface temperature difference		K

Secondary calculation
Ψ-value extract or exhaust air duct

Nominal width:	180	mm
Insulation thickness	100	mm
Reflective coating?		yes
	x	no
Thermal conductivity	0.040	W/(mK)
Nominal air flow rate		m³/h
Δϑ	14	K
Exterior duct diameter	0.180	m
Exterior diameter	0.380	m
α–Interior		W/(m²K)
α-Surface		W/(m²K)
Ψ–value		**W/(mK)**
Surface temperature difference		K

Extended input for balanced ventilation

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Planning ventilation systems with multiple ventilation units

Ventilation unit / Heat recovery efficiency design			
In Ventilation sheet (standard design)			*('Ventilation' worksheet)*
In 'Addl vent worksheet (this worksheet)		x	*(Addl vent)*
Treated floor area A_{TFA}	m²	312	*('Areas' worksheet)*
Room height h	m	2.50	*(Worksheet 'Annual heating')*
Room air volume for ventilation (A_{TFA}*h) = V_V	m³	780	*(Worksheet 'Annual heating')*
Number of occupants	P	5.9	*('Ventilation' worksheet)*
Room temperature	°C	20	*(Worksheet 'Annual heating')*
Average external temp. heating period	°C	6.2	*('Ventilation' worksheet)*
Average ground temp.	°C	10.9	*('Ground' worksheet)*
Length of the heating period	d/a	220	*('Heating' worksheet)*
Ventilation type	1-Balanced PH ventilation with HR		*('Ventilation' worksheet)*

Results of ventilation design and unit selection:

Venti-lation unit no.	Description of the unit	Design V_{SUP} m³/h	Design V_{ETA} m³/h	Annual average value V_{SUP} m³/h	Annual average value V_{ETA} m³/h	Air ch.rt. 1/h	Effective heat recovery efficiency	Humidity recovery efficiency	Spec. input power	Heat recov. efficiency SHX
1	House	178	168	178	168	---	86%	0%	0.21	0%
2	Suite HRV	92	91	92	91	---	85%	0%	0.42	0%
3						---				
4						---				
5						---				
6						---				
7						---				
8						---				
9						---				
10						---				
Result for overall vent. syst.		**270**	**259**	**270**	**259**	**0.35**	**86%**	**0%**	**0.28**	**0%**

Recommendations for dimensioning air quantities

Use of low odour and low VOCs building materials/furnishings:
It is strongly recommended to use building materials that cause no or very low VOCs/odours instead of increasing the outdoor air volume in order to clear the air.
This holds true independently from the chosen approach to determine air quality; emissions of all sources in the room should be considered, e.g. furniture, carpets and ventilation or air-conditioning unit.

Assessment of volume flow rates according to the number of persons
Also in non-residential buildings, the number of persons is fundamentally important for assessing the volume air flow rates. For good indoor air quality volumes between 20 to 30 m³/h/person are sufficient.
Higher outdoor air amounts may lead to excessively dry indoor air in winter. The air flow rates are specified by classification according to EN 13779. The classification must be agreed with the client in advance.
IDA 3 is adequate for office buildings. IDA 4 has proven satisfactory for school buildings as flushing ventilation is carried out during breaks anyway. For typical outdoor air CO_2 concentrations of around 400-500 ppm, it is possible to comply even with 1500 ppm. Exceeding this figure temporarily is permissible.

Outdoor air flow rates per person:
- Recommended for residential buildings: around 30 m³/(h person)
- Recommended for offices and similar uses: around 30 m³/(h person) (AMEV: 28 m³/(h person); EN 13779 / IDA 3: at least 24 m³/(h person))
- Recommended for schools and day care centres: 15 to 20 m³/(h person) (Source: Guidelines for energy-efficient educational buildings, Passive House Institute, 2010)
- Recommendation for sport halls: 60 m³/(h person) (DIN 18032-1)

Flushing phase for intermittent ventilation operation
In case the ventilation is to be used intermittently (turned off at night), then it should be flushed in the morning, approx. 1 to 2 hours before building is occupied. This should be done in order to refresh air from emissions such as VOCs. Flushing the building causes that the ventilation system works for a longer period (utilisation time + flushing phase). Please consider this at design stage.

Dimensioning of air quantities

When dimensioning the air quantities, please consider the design recommendations given above.
The operation period of the ventilation can be determined on the basis of daily utilisation hours, including flushing phase if applicable. In addition, time periods with reduced ventilation requirements (operation modes) can be taken into account by means of reduction factors.

Room no.	Amount a	Room name	Allocation to ventilation unit (No.)	Area A m²	Clear height h m	Room vol. A x h m³	Volume flow per room V_{SUP} m³/h	V_{ETA} m³/h	V_{TRANS} m³/h	Air chng. rt. per room n 1/h	Utilisation times h/d h	d/week d	Duration of holidays d	Reduction factor 1	Operation red. 1	Reduction factor 2	Operation red. 2	Reduction factor 3	Operation red. 3	Annual average value: V_{SUP} m³/h	V_{ETA} m³/h	V_{TRANS} m³/h	Change rate 1/h
1	1	main residence	1	234	2.50	584	178	168	168	0.31	24	7	0	100%	100%					178	168	168	0.31
2	1	basement suite	2	78	2.50	196	92	91	91	0.47	24	7	0	100%	100%					92	91	91	0.47
3														100%	100%								
4														100%	100%								
5														100%	100%								
6														100%	100%								
7														100%	100%								
8														100%	100%								
9														100%	100%								
10														100%	100%								
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Ventilation unit selection

Up to 10 different ventilation units are considered. By changing the amount, identical units can be considered. The data from PHI certified ventilation units
as well as the entry data lines for user data for other ventilation units can also be found in the worksheet 'Components'. When choosing to use a compact unit the standard design in the 'Ventilation' worksheet has to be used.

Go to ventilation units list

Ventilation unit no.	Quantity [-]	Description of ventilation units	Selection of type of ventilation	Design vol. flow per unit m³/h	Application range for volume flow rate from m³/h	to m³/h	Electrical efficiency Wh/m³	Pressure loss calculation ODA-SUP Δp_{Duct} Pa	ETA-EHA Δp_{Duct} Pa	Additional Δp_{Intern} Pa	Application range per line $\Delta p_{External}$ Pa	Subtraction Δp_{Intern} Pa	Interior location (x)	Exterior location (x)	Heat recovery efficiency Unit [-]	Effective [-]	Energy recovery efficiency [-]	Frost protection necessary	Subsoil HX Efficiency of heat recovery	Effective efficiency of heat recovery	Frost protection (electr. / hydr.) Tipe perature	Limit temperature °C	Useful Energy kWh/a
			Change sorting type																				
1	1	House	01ud-Zehnder Q450	178	70	345	0.21				100	-	x		0.88	86%	0%	yes		0%	2-elektr.	0	114
2	1	Suite HRV	0327vs03-Zehnder - ComfoAir200, C	92	60	150	0.42				100	-	x		0.92	85%	0%	yes		0%	2-elektr.	0	58
3																					2-elektr.		0
4																					2-elektr.		0
5																					2-elektr.		0
6																					2-elektr.		0
7																					2-elektr.		0
8																					2-elektr.		0
9																					2-elektr.		0
10																					2-elektr.		0
																						Total (directly electric)	172
																						Total (hydraulic and heat generator)	0

Data entries for duct sections between the ventilation unit and the thermal envelope

The duct sections between the ventilation unit and the thermal envelope should be as short as possible and should be well insulated, whether the ventilation unit is located indoors
or outdoors. The dimensions of these duct sections can be entered here. The heat losses of the overlying duct sections will be considered for the effective heat recovery efficiency.
One section of a duct entered here may also be used for multiple ventilation units.
If in the section "Ventilation unit - selection" (above) a ventilation unit is selected as multiple units (amount larger than 1 for identical units), then the corresponding duct sections may simply be entered (duct sections for one ventilation unit).

Temperature of installation location: (only enter when at least one unit is installed outside of the thermal envelope)

Quantity	Round duct ins. diameter mm	Rectangular duct Width mm	Height mm	Insulation thickness mm	Thermal conductivity W/(m K)	Reflective insulation duct (x)	Duct transmittance W/(m K)	Length of supply air duct m	Outdoor or supply air duct (1)	Exhaust or extract air duct (1)	Duct type	Design volume rate	Assignment to ventilation unit (enter 1 for the corresponding ventilation unit) Vent. unit 1	Vent. unit 2	Vent. unit 3	Vent. unit 4	Vent. unit 5	Vent. unit 6	Vent. unit 7	Vent. unit 8	Vent. unit 9	Vent. unit 10
1	180			102	0.039	x	0.275	3	1		Outdoor air	178	1									
1	180			102	0.039	x	0.275	2.16		1	Exhaust air	178	1									
1	150			101.6	0.039	x	0.239	6	1		Outdoor air	92		1								
1	150			101.6	0.039	x	0.239	5.04		1	Exhaust air	92		1								
												0										
												0										
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Specific energy for heating (annual method)

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Interior temperature: 20.0 °C
Building type: SINGLE FAMILY DWELLING
Treated floor area A_{TFA}: 312.0 m²

Building assembly	Temperature zone	Area m²		U-Value W/(m²K)		Temp. factor f_t		G_t kKh/a		kWh/a	Per m² of treated floor area
External wall - Ambient	A	288.6	*	0.097	*	1.00	*	75.5	=	2105	6.75
External wall - Ground	B	112.9	*	0.143	*	0.60	*	75.5	=	731	2.34
Roof/Ceiling - Ambient	A	186.6	*	0.088	*	1.00	*	75.5	=	1236	3.96
Floor slab / Basement ceiling	B	184.1	*	0.113	*	0.60	*	75.5	=	940	3.01
	A		*		*	1.00	*		=		
	A		*		*	1.00	*		=		
	X		*		*	0.75	*		=		
Windows	A	58.7	*	0.771	*	1.00	*	75.5	=	3419	10.96
Exterior door	A		*		*	1.00	*		=		
Exterior TB (length/m)	A	140.2	*	0.009	*	1.00	*	75.5	=	94	0.30
Perimeter TB (length/m)	P	61.5	*	0.021	*	0.60	*	75.5	=	58	0.18
Ground TB (length/m)	B		*		*	0.60	*		=		0.00
Total of all building envelope areas		831.0									kWh/(m²a)
Transmission heat losses Q_T									Total	8583	27.5

		A_{TFA} m²		Clear room height m	=	m^3	
Ventilation system:	Effective air volume, V_v	312.0	*	2.50	=	779.9	
Effective heat recovery efficiency	η_{eff} 86%						
Efficiency of subsoil heat exchanger							
Heat recovery efficiency of SHX	η_{SHX} 0%	$n_{V,system}$ 1/h		η_{HR}		$n_{V,Res}$ 1/h	
Energetically effective air changes nV		0.346	* (1 -	0.86	) +	0.015	= 0.065

	V_V m³		n_V 1/h		c_{Air} Wh/(m³K)		G_t kKh/a	=	kWh/a	kWh/(m²a)
Ventilation heat losses Q_V	779.9	*	0.065	*	0.33	*	75.5	=	1267	4.1

	Q_T kWh/a		Q_V kWh/a		Reduction factor night/weekend Saving	=	kWh/a	kWh/(m²a)
Total heat losses Q_L	(8583	+	1267	)	1.0	=	9850	**31.6**

Orientation of the area	Reduction factor See 'Windows' sheet		g-Value (perp. radiation)		Area m²		Radiation HP kWh/(m²a)	=	kWh/a
North	0.24	*	0.33	*	13.93	*	118	=	127
East	0.16	*	0.33	*	0.77	*	270	=	11
South	0.21	*	0.33	*	39.06	*	478	=	1291
West	0.22	*	0.33	*	4.97	*	281	=	100
Horizontal	0.00	*	0.00	*	0.00	*	419	=	0
Available solar heat gains Q_S								Total	1529 kWh/a, 4.9 kWh/(m²a)

	kh/d		Length heating period d/a		Spec. power q_I W/m²		A_{TFA} m²	=	kWh/a	kWh/(m²a)
Internal heat gains Q_I	0.024	*	220	*	2.42	*	312.0	=	3990	12.8

		kWh/a	kWh/(m²a)
Free heat Q_F	Q_S + Q_I =	5519	17.7
Ratio of free heat to losses	Q_F / Q_V =	0.56	
Utilisation factor heat gains h_G	(1 - (Q_F / Q_L)^5) / (1 - (Q_F / Q_L)^6) =	97%	
Heat gains Q_G	η_G * Q_F =	5381	**17.2**

		kWh/a	kWh/(m²a)
Annual heating demand Q_H	Q_L - Q_G =	4469	**14**

	kWh/(m²a)	(Yes/No)
Limiting value	15	**Requirement met?** Yes

Specific energy for heating (monthly method)

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

The sum of the heating periods calculated through the monthly method will be presented on this side.

Interior temperature:	20	°C
Building type:	SINGLE FAMILY DWELLING	
Treated floor area A_{TFA}:	312.0	m²
Spec. Capacity:	100	Wh/(m²K)

Building assembly	Temperature zone	Area m²		U-Value W/(m²K)		Month. red. fac.		G_t kKh/a		kWh/a	Per m² of treated floor area
External wall - Ambient	A	288.6	*	0.097	*	1.00	*	80	=	2227	7.14
External wall - Ground	B	112.9	*	0.143	*	1.00	*	50	=	803	2.58
Roof/Ceiling - Ambient	A	186.6	*	0.088	*	1.00	*	80	=	1308	4.19
Floor slab / Basement ceiling	B	184.1	*	0.113	*	1.00	*	50	=	1032	3.31
	A		*		*	1.00	*		=		
	A		*		*	1.00	*		=		
	X		*		*	0.75	*		=		
Windows	A	58.7	*	0.771	*	1.00	*	80	=	3618	11.60
Exterior door	A		*		*	1.00	*		=		
Exterior TB (length/m)	A	140.2	*	0.009	*	1.00	*	80	=	100	0.32
Perimeter TB (length/m)	P	61.5	*	0.021	*	1.00	*	50	=	63	0.20
Ground TB (length/m)	B		*		*	1.00	*		=		0.00

Transmission heat losses Q_T — Total: 9152 kWh/a; 29.3 kWh/(m²a)

	A_{TFA} m²		Clear room height m		m³
Effective air volume V_V	312	*	2.50	=	780

	$n_{V,system}$ 1/h		η^*_{SHX}		η_{HR}		$n_{V,Res}$ 1/h		$n_{V,equi,fraction}$ 1/h
Effective air change rate Ambient nV,e	0.346	*(1-	0%	)*(1-	0.86	)+	0.015	=	0.065
Effective air change rate Ground nV,g	0.346	*	0%	*(1-	0.86	)		=	0.000

	V_V m³		$n_{V,equi,fraction}$ 1/h		c_{Air} Wh/(m³K)		G_t kKh/a		kWh/a	kWh/(m²a)
Ventilation losses ambient Q_V	780	*	0.065	*	0.33	*	80	=	1340	4.3
Ventilation losses ground $Q_{V,e}$	780	*	0.000	*	0.33	*	53	=	0	0.0

Ventilation heat losses Q_V — Total: 1340 kWh/a; 4.3 kWh/(m²a)

	Q_T kWh/a		Q_V kWh/a		Reduction factor night/weekend saving		kWh/a	kWh/(m²a)
Total heat losses Q_L	(9152	+	1340	) *	1.0	=	10492	**33.6**

Orientation of the area	Reduction factor see 'Windows' worksheet		g-Value (perp. radiation)		Area m²		Global radiation kWh/(m²a)		kWh/a
North	0.24	*	0.33	*	13.9	*	156	=	169
East	0.16	*	0.33	*	0.8	*	361	=	15
South	0.21	*	0.33	*	39.1	*	568	=	1535
West	0.22	*	0.33	*	5.0	*	364	=	129
Horizontal	0.00	*	0.00	*	0.0	*	562	=	0
Sum opaque areas									532

Available solar heat gains Q_S — Total: 2379 kWh/a; 7.6 kWh/(m²a)

	kh/d		Length Heat. Period d/a		Spec. Power q_I W/m²		A_{TFA} m²		kWh/a	kWh/(m²a)
Internal heat gains Q_I	0.024	*	243	*	2.4	*	312.0	=	4404	14.1

			kWh/a	kWh/(m²a)
Free heat Q_F	Q_S + Q_I	=	6783	21.7
Ratio free heat to losses	Q_F / Q_L	=	0.65	
Utilisation factor heat gains h_G		=	97%	
Heat gains Q_G	η_G * Q_F	=	6550	**21.0**

		kWh/a	kWh/(m²a)
Annual heating demand Q_H	Q_L - Q_G =	3941	**13**

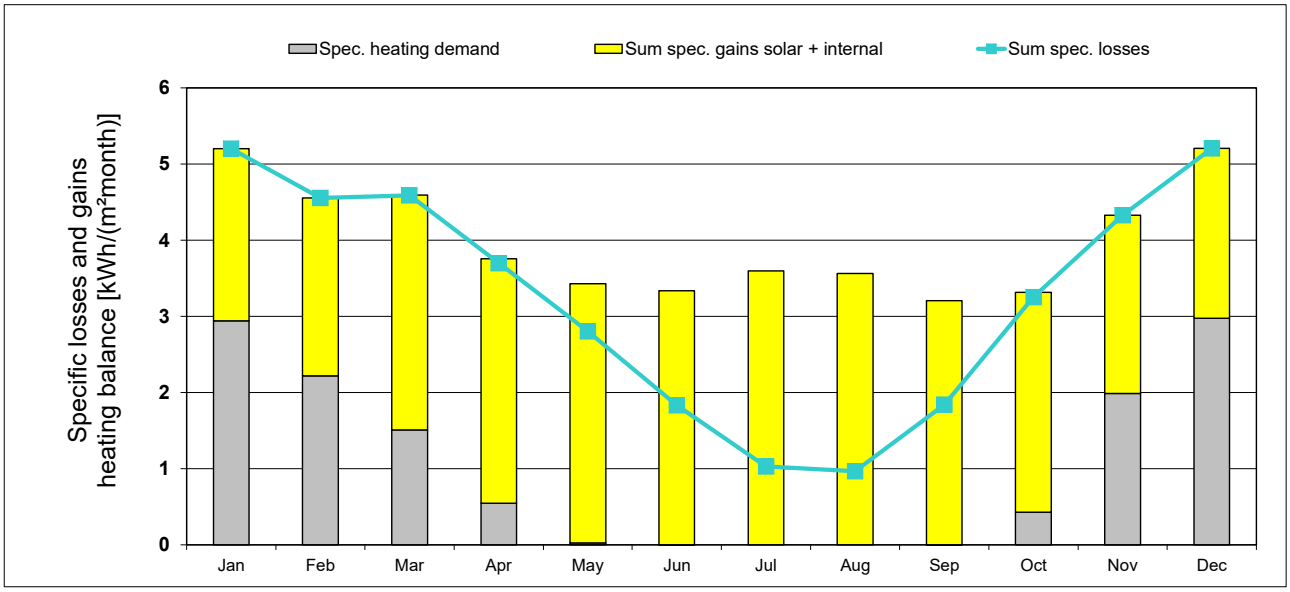
Limiting value	kWh/(m²a) 15	**Requirement met?**	(Yes/No) Yes

Specific energy for heating (monthly method)

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Interior temperature: 20 °C
Building type: SINGLE FAMILY DWELLING
Treated floor area A_{TFA}: 312 m²

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Heating degree hours - Externa	12.6	10.8	10.7	8.3	5.9	3.5	1.6	1.6	4.0	7.9	10.8	12.9	91	kKh
Heating degree hours - Ground	6.9	6.7	7.5	6.8	6.2	5.1	3.9	3.4	3.8	4.4	5.0	6.1	66	kKh
Losses - Exterior	1357	1164	1147	894	636	375	173	172	428	847	1158	1389	9741	kWh
Losses - Ground	265	257	285	260	238	196	148	130	146	168	192	234	2519	kWh
Sum spec. losses	5.2	4.6	4.6	3.7	2.8	1.8	1.0	1.0	1.8	3.3	4.3	5.2	39.3	kWh/m²
Solar gains - North	9	14	26	35	50	57	59	40	27	18	10	7	352	kWh
Solar gains - East	1	1	2	3	5	4	5	4	3	2	1	0	32	kWh
Solar gains - South	103	154	265	275	270	251	292	321	297	235	135	97	2696	kWh
Solar gains - West	6	10	21	28	34	38	42	37	25	17	8	6	272	kWh
Solar gains - Horiz.	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Solar gains - Opaque	25	42	86	115	141	146	163	146	105	67	33	22	1091	kWh
Internal heat gains	562	507	562	544	562	544	562	562	544	562	544	562	6615	kWh
Sum spec. gains solar + interna	2.3	2.3	3.1	3.2	3.4	3.3	3.6	3.6	3.2	2.9	2.3	2.2	35.4	kWh/m²
Utilisation factor	100%	100%	100%	98%	82%	55%	29%	27%	57%	98%	100%	100%	75%	
Annual heating demand	917	692	470	171	9	0	0	0	0	134	620	928	3941	kWh
Spec. heating demand	**2.9**	**2.2**	**1.5**	**0.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	**2.0**	**3.0**	**12.6**	kWh/m²



Annual heating demand: Comparison

Monthly method	*('Heating')*	3941	kWh/a	12.6	**kWh/(m²a)** reference to treated floor area according to PHPP
Annual method	*('Annual heati*	4469	kWh/a	14.3	**kWh/(m²a)** reference to treated floor area according to PHPP
		#REF!	kWh/a	#REF!	

Heating load

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Interior temperature: 20 °C
Building type: SINGLE FAMILY DWELLING
Treated floor area A_{TFA}: 312.0 m²

	Design temperature		Radiation:	North	East	South	West	Horizontal	
Weather 1:	-5.7	°C		13	23	68	23	39	W/m²
Weather 2:	1.2	°C		6	7	8	6	13	W/m²
Ground design temp.	10.0	°C							

Building assembly	Temperature zone	Area m²		U-Value W/(m²K)		Factor always 1 (except "X")		TempDiff 1 K		TempDiff 2 K		PT 1 W		PT 2 W
External wall - Ambient	A	288.6	*	0.097	*	1.00	*	25.7	or	18.8	=	716	or	523
External wall - Ground	B	112.9	*	0.143	*	1.00	*	10.0	or	10.0	=	162	or	162
Roof/Ceiling - Ambient	A	186.6	*	0.088	*	1.00	*	25.7	or	18.8	=	420	or	307
Floor slab / Basement ceiling	B	184.1	*	0.113	*	1.00	*	10.0	or	10.0	=	208	or	208
	A		*		*	1.00	*	25.7	or	18.8	=		or	
	A		*		*	1.00	*	25.7	or	18.8	=		or	
	X		*		*	0.75	*	25.7	or	18.8	=		or	
Windows	A	58.7	*	0.771	*	1.00	*	25.7	or	18.8	=	1162	or	850
Exterior door	A		*		*	1.00	*	25.7	or	18.8	=		or	
Exterior TB (length/m)	A	140.2	*	0.009	*	1.00	*	25.7	or	18.8	=	32	or	23
Perimeter TB (length/m)	P	61.5	*	0.021	*	1.00	*	10.0	or	10.0	=	13	or	13
Ground TB (length/m)	B		*		*	1.00	*	10.0	or	10.0	=		or	
Building element towards neighbour	I		*		*	1.00	*	3.0	or	3.0	=		or	

Transmission heat load P_T

Total = 2713 or 2087

Ventilation system:

Effective air volume, V_V: A_{TFA} 312.0 m² * Clear room height 2.50 m = 780 m³

Heat recovery efficiency of the heat exchanger η_{HR} 86%

Heat recovery efficiency SHX 0% Heat recovery efficiency SHX $\eta_{SHX\ 1}$ 0% or $\eta_{SHX\ 2}$ 0%

	$n_{V,Res}$ (Heating Load) 1/h		$n_{V,system}$ 1/h		Φ_{HP}		Φ_{HP}		PT 1 1/h		PT 2 1/h
Energetically effective air changes n_V	0.038	+	0.346	*(1-	0.86	or	0.86	) =	0.088	or	0.088

Ventilation heat load P_V

V_V m³		n_V 1/h		n_V 1/h	c_{Air} Wh/(m³K)		TempDiff 1 K		TempDiff 2 K		P_V 1 W		P_V 2 W
779.9	*	0.088	or	0.088	* 0.33	*	25.7	or	18.8	=	582	or	425

Total heating load P_L

	PL 1 W		PL 2 W
$P_T + P_V$ =	3295	or	2512

Orientation of the area	Area m²		g-Value (perp. radiation)		Reduction factor (see 'Windows' worksheet)		Radiation 1 W/m²		Radiation 2 W/m²		PT 1 W		PT 2 W
North	13.9	*	0.3	*	0.24	*	13	or	6	=	14	or	7
East	0.8	*	0.3	*	0.16	*	24	or	7	=	1	or	0
South	39.1	*	0.3	*	0.21	*	68	or	8	=	184	or	22
West	5.0	*	0.3	*	0.22	*	22	or	6	=	8	or	2
Horizontal	0.0	*	0.0	*	0.40	*	39	or	13	=	0	or	0

Solar heating power P_S

Total = 206 or 30

Internal heating load P_I

Spec. power 1.9 W/m² * A_{TFA} 312 m² = P_I 1 599 W or P_I 2 599 W

Heating power (gains) P_G

$P_T + P_I$ = P_G 1 806 W or P_G 2 630 W

$P_L - P_G$ = 2489 or 1882

Heating load P_H = **2489 W**

Area specific space heating load P_H / A_{TFA} = **8.0 W/m²**

Input max. supply air temperature 52 °C

Max. supply air temperature $\vartheta_{Supply,Max}$ 52 °C

Supply air temperature without heating $\vartheta_{Supply,Min}$ 16.3 °C or 17.3 °C

For comparison: heating load transportable by the supply Air $P_{Supply\ Air,Max}$ = 3183 W specific: 10.2 W/m²

Supply air heating: Sufficient? (Yes/No) **Yes**

Summer ventilation

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

			Building type:	SINGLE FAMILY DWELLING	
Building volume:	780	m³	Heat recovery efficiency:	86%	
Max. indoor absolute humidity:	12	g/kg	Humidity recovery efficiency:	0%	
Internal humidity sources:	100	g/(P*h)	Subsoil heat exchanger efficiency:	0%	

Results passive cooling			Results active cooling		
Frequency of overheating:	0.5%	at the overheating limit ϑ_{max} = 25 °C	Useful cooling demand:	0.3	kWh/(m²a)
max. humidity:	13.7	g/kg	Dehumidification demand:	0.0	kWh/(m²a)
Frequency of exceeded humidity:	0.3%		Frequency of exceeded humidity:	0.3%	

Summer basic ventilation to ensure adequate air quality

Air change rate via vent. system with supply ai	0.35	1/h	HRV/ERV in summer (check only one field)	
			None	
			Automatic bypass, controlled by temperature difference	x
			Automatic bypass, controlled by enthalpy difference	
			Always	
Air change rate via extract air system:		1/h		
			Specific power consumption (for extract air system)	0.20 Wh/m³
Window ventilation air change rate:	0.00	1/h		

Effective air change rate

	$n_{V,system}$ 1/h		η^*_{SHX}		η_{HP}		$n_{V,equi,fraction}$ 1/h
Exterior $n_{V,e}$	0.346	*(1-	0%	)*(1-	0.86	) =	0.050
without HR	0.346	*(1-	0%	)		=	0.346
Ground $n_{L,g}$	0.346	*	0%	*(1-	0.86	) =	0.000
without HR	0.346	*	0%			=	0.000

Ventilation conductance

	V_V m³		$n_{V,equi,fraction}$ 1/h		c_{Air} Wh/(m³K)			
exterior $H_{V,e}$	780	*	0.050	*	0.33	=	12.9	W/K
without HR	780	*	0.346	*	0.33	=	89.1	W/K
ground $H_{V,g}$	780	*	0.000	*	0.33	=	0.0	W/K
without HR	780	*	0.000	*	0.33	=	0.0	W/K
Infiltration, window, extract air system	780	*	0.015	*	0.33	=	3.9	W/K

Additional summer ventilation for cooling

Additional ventilation regulation

Minimum acceptable indoor temp. 22.0 °C

Type of additional ventilation

Window night ventilation, manual	Night ventilation value	0.40	1/h	
	Corresponding air change rate		1/h	Controlled by (please check)
Mechanical, automatically	during operation, in addition to basic air change			Temperature diff.
Controlled ventilation	Specific power consumption		Wh/m³	Humidity diff. x

Secondary calculation: Hygienic air change rate through window ventilation

Estimation for window air change rate to ensure sufficient air quality

Description		**1: Main Floor**	**2: Master Bed**	**3: Bsmt**	**4: Bsmt Suite**			
	Open duration [h/d]	**0**	**0**	**0**	**0**			
Climate boundary conditions								
	Temperature diff interior - exterior	**4**	**4**	**4**	**4**			K
	Wind velocity	**1**	**1**	**1**	**1**			m/s
Window group 1								
	Quantity	**1**	**1**	**1**	**1**			
	Clear width	**1.61**	**0.81**	**2.42**	**1.61**			m
	Clear height	**3.29**	**1.92**	**4.60**	**2.88**			m
	Tilting window (check if appropriate)	**x**	**x**	**x**	**x**			
	Opening width (for tilting windows)	**0.076**	**0.076**	**0.076**	**0.076**			m
Window group 2 (cross ventilation)								
	Quantity	**1**	**1**	**1**	**1**			
	Clear width	**2.62**	**1.92**	**0.91**	**0.55**			m
	Clear height	**3.28**	**0.35**	**1.82**	**1.16**			m
	Tilting window (check if appropriate)	**x**	**x**	**x**	**x**			
	Opening width (for tilting windows)	**0.076**	**0.076**	**0.076**	**0.076**			m
	Difference in height to window 1	**0.00**	**0.00**	**3.25**	**0.00**			m
							Total	
Result: Air change rate		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1/h**

Secondary calculation: Additional night ventilation for cooling

Air change value during additional window night ventilation

Description		**main floor**	**master bed**	**bsmt suite**	**bsmt**			
	Reduction factor	**80%**	**80%**	**80%**	**80%**			
Climate boundary conditions								
	Temperature diff interior - exterior	1	1	1	1	1	1	K
	Wind velocity	0	0	0	0	0	0	m/s
Window group 1								
	Quantity	**1**	**1**	**1**	**1**			
	Clear width	**1.61**	**0.81**	**2.42**	**1.61**			m
	Clear height	**3.29**	**1.92**	**4.60**	**2.88**			m
	Tilting window (check if appropriate)	**x**	**x**	**x**	**x**			
	Opening width (for tilting windows)	**0.076**	**0.076**	**0.076**	**0.076**			m
Window group 2 (cross ventilation)								
	Quantity	**1**	**1**	**1**	**1**			
	Clear width	**2.62**	**1.92**	**0.91**	**0.55**			m
	Clear height	**3.28**	**0.35**	**1.82**	**1.16**			m
	Tilting window (check if appropriate)	**x**	**x**	**x**	**x**			
	Opening width (for tilting windows)	**0.076**	**0.076**	**0.076**	**0.076**			m
	Difference in height to window 1	**0.00**	**0.00**	**3.25**	**0.00**			m
							Total	
Result: Night ventilation values		**0.14**	**0.03**	**0.16**	**0.07**	**0.00**	**0.00**	**0.40**	**1/h**

Summer: Passive cooling

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Building type:	SINGLE FAMILY DWELLING		Treated floor area A_{TFA}:	312.0	m²
Upper temperature limit:	25	°C	Building volume:	780	m³
Nominal humidity:	12	g/kg	Internal humidity sources:	1.9	g/(m²h)
Spec. capacity:	100	Wh/(m²K)			

Building assembly	Temperature zone	Area m²		U-Value W/(m²K)		Red. factor $f_{T,Summer}$		H_{Summer} heat conductance	
External wall - Ambient	A	288.6	*	0.097	*	1.00	=	27.9	
External wall - Ground	B	112.9	*	0.143	*	1.00	=	16.2	
Roof/Ceiling - Ambient	A	186.6	*	0.088	*	1.00	=	16.4	
Floor slab / Basement ceiling	B	184.1	*	0.113	*	1.00	=	20.8	
	A		*		*	1.00	=		
	A		*		*	1.00	=		
	X		*		*	0.75	=		
Windows	A	58.7	*	0.771	*	1.00	=	45.3	
Exterior door	A		*		*	1.00	=		
Exterior TB (length/m)	A	140.2	*	0.009	*	1.00	=	1.3	
Perimeter TB (length/m)	P	61.5	*	0.021	*	1.00	=	1.3	
Ground TB (length/m)	B		*		*	1.00	=		

Exterior thermal transmittance, $H_{T,e}$	90.8	W/K
Ground thermal transmittance, $H_{T,g}$	38.2	W/K

Summer ventilation

from 'SummVent' worksheet

Ventilation unit conductance

exterior $H_{V,e}$	12.9	W/K
without HR	89.1	W/K
ground $H_{V,g}$	0.0	W/K
without HR	0.0	W/K

Ventilation conductance, others

exterior	3.9	W/K

Ventilation parameter

Temperature amplitude summer	9.5	K
Minimum acceptable indoor temperature	22.0	°C
Heat capacity air	0.33	Wh/(m³K)
Supply air changes	0.35	1/h
Outdoor air changes	0.02	1/h
Window night ventilation air change rate, manual @ 1K	0.40	1/h
Air change rate due to mech. automatically controlled vent.	0.00	1/h
Specific power consumption for	0.00	Wh/m³
η_{HR}	86%	
η_{ERV}	0%	
η^*_{SHX}	0%	

Summer ventilation regulation

	HRV/ERV
None	
Controlled by temperature	x
Controlled by enthalpy	
Always	
	Additional ventilation
Controlled by temperature	
Controlled by humidity	x

Solar aperture

Orientation of the area	Angle factor Summer		Shading factor Summer		Shading dirt		g-Value (perp. radiation)		Area m²		Portion of glazing		**Aperture** m²	
North	0.9	*	0.45	*	0.95	*	0.33	*	13.9	*	71%	=	1.3	
East	0.9	*	0.37	*	0.95	*	0.33	*	0.8	*	71%	=	0.1	
South	0.9	*	0.31	*	0.95	*	0.33	*	39.1	*	80%	=	2.7	
West	0.9	*	0.46	*	0.95	*	0.33	*	5.0	*	68%	=	0.4	
Horizontal	0.9	*	1.00	*	0.95	*	0.00	*	0.0	*	0%	=	0.0	
Sum opaque areas													1.1	
												Total	5.5	m²/m² 0.02

Internal heat gains Q_I

Specif. power q_I W/m²		A_{TFA} m²		W	W/m²
2.4	*	312	=	755	2.4

Frequency of overheating $h_{\vartheta \geq Jmax}$

0.5%

At the overheating limit ϑ_{max} = 25 °C

If the "frequency over 25°C" exceeds 10%, additional measures to protect against the heat during the summer are necessary.

Daily internal temperature fluctuation

Transmission kWh/d		Ventilation kWh/d		Solar load kWh/d		1/k	Spec. capacity Wh/(m²K)		A_{TFA}: m²			
(10.4	+	6.4	+	26.2	) *	1000	/ (100	*	312	) =	**1.4**	K

Heat distribution and domestic hot water (DHW) system

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Interior temperature:	20	°C	Interior temperature summer:	25	°C
Building type:	SINGLE FAMILY DWELLING				
Treated floor area A_{TFA}:	312	m²			
Occupancy:	5.9	Pers			
Number of dwelling units:	2				
Annual heating demand $q_{Heating}$	3941	kWh/a	Annual useful cooling dem. q_{Cool}	86	kWh/a
Length of heating period:	220	d	Length cooling period:	48	d
Average heating load P_{ave}:	0.7	kW	Average cooling load $P_{Average}$:	0.1	kW
Marginal usability of additional heat gains:	88%		Marginal utility of additional heat losses:	8%	

Space heat distribution

			Inside thermal envelope					Outside thermal envelope					Total values	
			1	2	3	4	5	1	2	3	4	5	Absolute	Specific
Length of distribution pipes	L_H	m	33.2											
Nominal width of pipe		mm	17											
Insulation thickness		mm	0											
Insulation reflective coating?		-												
Thermal conductivity of insulation		W/(mK)	0.039											
Heat loss coefficient per m of insulated pipe		W/(mK)	0.388											
Insulation quality of mountings, pipe suspensions, etc.		-	2 - Moderate	1-None	1-None	1-None	1-None	1-None	1-None	1-None	1-None	1-None		
Thermal bridge supplement		W/K	1.762											
Total heating loss coefficient per m of pipe	Ψ	W/(mK)	0.441											
Temp. of the room through which the pipes pass	ϑ_X	°C	20	20	20	20	20							
Design forward flow temperature	ϑ_V	°C	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0		
Design system heating load	$P_{heating}$	kW	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5		
Forward flow temperature control ('x' if appropriate)			x	x	x	x	x	x	x	x	x	x		
Design return flow temperature	ϑ_R	°C	22.1											
Annual heat emission per m of plumbing	q^*_{HL}	kWh/(m·a)	2											
Possible utilisation factor of released heat	η_G	-	88%											
Annual heat losses of heating distribution	Q_{HL}	kWh/a	10										kWh/a: 10	kWh/(m²a): 0.0
Annual heat losses of heating storage		kWh/a											0	0.0
Annual heat losses of heating		kWh/a											10	0.0
Performance ratio of heat distribution	$ea_{,HL}$	-											100%	

DHW useful heat

DHW demand for showers, per person and day (with 60°C)		litre/person/d	16.0
DHW demand others, per person and day (with 60°C)		litre/person/d	9.0
Performance of shower drain-water heat recovery		-	0%
Effective DHW demand	V_{DHW}	litre/person/d	25
Average cold water temperature of the supply	ϑ_{TW}	°C	10.9
DHW demand for washing machines and dishwashers non-elec		kWh/a	0
Effective useful heat DHW	Q_{DHW}	kWh/a	3068

kWh/a	kWh/(m²a)
3068	9.8

Auxiliary calculation - DHW demand calculation (for non-res)

DHW distribution

			Inside thermal envelope					Outside thermal envelope					Total values	
			1	2	3	4	5	1	2	3	4	5	Absolute	Specific
Temp. of room through which the pipes pass	ϑ_X	°C	20.0	20.0	20.0	20.0	20.0							
Design forward flow temperature	ϑ_{dist}	°C	**66.0**	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0		
DHW circulation pipes														
Length of circulation pipes (forward + return flow)	L_{HS}	m	**43.1**											
Nominal width of pipe		mm	**17**											
Insulation thickness		mm	**0**											
Insulation reflective coating?		-												
Thermal conductivity of insulation		W/(mK)	**0.039**											
Heat loss coefficient per m of insulated pipe		W/(mK)	0.597											
Insulation quality of mountings, pipe suspensions, etc.		-	**2 - Moderate**	**1-None**	**1-None**	**1-None**	**1-None**	**1-None**	**1-None**	**1-None**	**1-None**	**1-None**		
Thermal bridge supplement		W/K	2.109											
Total heating loss coefficient per m of pipe	Ψ	W/(mK)	**0.646**											
Daily circulation period of operation.	td_{Circ}	h/d	**1.3**											
Design return flow temperature	ϑ_R	°C	60											
Circulation period of operation per year	t_{Circ}	h/a	485											
Annual heat released per m of pipe	q^*_Z	kWh/m/a	14										kWh/a	kWh/(m²a)
Annual heat loss from circulation lines	QZ	kWh/a	**583**										**583**	**1.9**
DHW individual pipes														
Exterior pipe diameter	d_{U_Pipe}	m	**0.013**											
Accumulated length per single pipes	L_U	m	**68.45**											
Amount of tapping points in building	$n_{tapping\ poin}$	-	**17.00**											
Average pipe length per tapping point	$L_{U,\ average}$	m	4.0											
Tap openings per person per day		-	**6**											
Utilisation days per year		d	**365**											
Heat loss per tap opening	$q_{Individual}$	'h/tap opening	0.0189											
Amount of tap openings per year and person	n_{Tap}	nings per year	2190										kWh/a	kWh/(m²a)
Annual heat loss of individual pipes	Q_U	kWh/a	**245**										**245**	**0.8**
													kWh/a	kWh/(m²a)
Total heat losses of DHW distribution	Q_{WL}												**828**	**2.7**
Performance ratio of DHW distribution pipes	$ea_{,HL}$	-											**127%**	

Storage heat losses

		Storage 1	Storage 2	Buffer storage tank (only heating)	Compact unit		
Selection of storage tank		1-DHW and heating	0-No storage tank	0-No storage tank	0-No		
Storage necessary for HP		x		(x)			
Solar DHW connection							
Heat loss rate	W/K	2.5					
Storage volume	litre	450			---		
Standby fraction	-	30%					
Location of storage tank, inside or outside of thermal envelope		1-Inside	1-Inside	1-Inside			
Temperature of mechanical room	°C	20.0					
Typical storage tank temperature	°C	66.0					
Manual entry of storage temperature	°C						
Average standby heat losses storage tank	W	35					
Additional heat losses storage tank, solar operation	W			---	---		
Possibly utilisation factor of heat losses		---	---		---		
Annual heat losses DHW storage tank	kWh/a	302		---		kWh/a	kWh/(m²a)
						302	1.0
Annual heat losses buffer storage tank		---	---		---		

Auxiliary calculation - heat losses through storage tank according to EU efficiency classes

Total energy demand of domestic hot water

		kWh/a	kWh/(m²a)
Heat losses of DHW distribution and storage	Q_{WL}	1130	3.6
Performance ratio DHW-distribution + storage	$e_{a,WL}$	137%	
Total heating demand of DHW system		kWh/a	kWh/(m²a)
Including storage tank	Q_{gDHW}	4198	13.5

Cooling distribution

			Inside thermal envelope					Outside thermal envelope					Total values	
			1	2	3	4	5	1	2	3	4	5	Absolute	Specific
Length of distribution pipes	L_H	m												
Nominal width of pipe		mm												
Insulation thickness		mm												
Insulation reflective coating?		-												
Thermal conductivity of insulation		W/(mK)												
Heat loss coefficient per m pipe	Ψ	W/(mK)												
Temp. of room through which the pipes pass	ϑ_X	°C	25.0	25.0	25.0	25.0	25.0	**25.0**	25.0	25.0	25.0	25.0		
Design forward flow temperature	ϑ_V	°C	**6.0**	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0		
Dimensioning of cooling load of the system	$P_{cooling}$	kW												
Forward flow temperature control ('x' if appropriate)														
Design return flow temperature	ϑ_R	°C												
Annual heat absorption per m of pipe	q^*_{HL}	kWh/(m·a)												
Possibly utilisation factor of this heat absorption	η_G	-												
Annual heat losses of cooling distribution	Q_{HL}	kWh/a											kWh/a **0**	kWh/(m²a) **0.0**
Performance ratio cold water distribution pipes	$ea_{,HL}$	-											**100%**	

Electricity demand for residential buildings

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Households	2
Persons	5.9
Living area (m²)	312
Heating demand [kWh/(m²a)]	12.6

PER and PE factors (kWh/kWh)		
Electricity:	1.20	2.6
Non-electric energy carrier for cooking, drying:	1.20	2.6
Energy carrier for heating:	1.19	2.6
Energy carrier for DHW:	1.15	2.6

Solar fraction of DHW Laundry&Dish	
Marginal performance ratio DHW	31%
Marginal performance ratio Heating	62%

Column no.	1	2	3			4		5		6			7		8	8a		9		10		11		12		13
Application	Used ? (1/0)	Within the thermal envelope? (1/0)	Norm demand			Utilisation factor		Frequency		Reference quantity			Useful energy (kWh/a)		Electric fraction	Non-electric fraction		**Electricity demand (kWh/a)**		Additional demand		Marginal performance ratio		Solar fraction		Non-electric demand (kWh/a)
Dishwashing	1	1	1.64	kWh/Use		* 1.00	*	65	/(P*a)	* 5.9	P	=	629	*	100%		=	629								
2-Cold water connection														*		0%				* (1+	0.30	) *	0.31	*(1-		) =	
Clothes washing	1	1	0.73	kWh/Use		* 1.00	*	57	/(P*a)	* 5.9	P	=	245	*	100%		=	245								
2-Cold water connection														*		0%				* (1+	0.05	) *	0.31	*(1-		) =	
Clothes drying with:	1	1	0.90	kWh/Use	Residual dampness	0.88	*	57	/(P*a)	* 5.9	P	=	265		100%		=	265								
4-Condensation dryer					0.60							=	0			0%							1.00	*			0
Energy consumed by evaporation	0	1	3.13	kWh/Use		* 0.60	*	57	/(P*a)	* 5.9	P	=	0	*		100%				* (1+	0.00	) *	0.62	*(1-	0.60	) =	0
Refrigerating	0	1	0.78	kWh/d		* 1.00	*	365	d/a	* 2	HH	=	0	*	100%		=	0								
Freezing	0	1	0.88	kWh/d		* 1.00	*	365	d/a	* 2	HH	=	0	*	100%		=	0								
or combination	1	1	1.20	kWh/d		* 1.00	*	365	d/a	* 2	HH	=	876	*	100%		=	876								
Cooking with:	1	1	0.20	kWh/Use		* 1.00	*	500	/(P*a)	* 5.9	P	=	590	*	100%		=	590								
1-Electricity					Average lamp efficiency [lm/W]									*		0%											0
Lighting	1	1	14	W	50	* 1.00	*	2.90	kh/(P*a)	* 5.9	P	=	246	*	100%		=	246								
Consumer electronics	1	1	80	W		* 1.00	*	0.55	kh/(P*a)	* 5.9	P	=	260	*	100%		=	260								
Small appliances, etc.	1	1	50	kWh		* 1.00	*	1.00	/(P*a)	* 5.9	P	=	295	*	100%		=	295								
Total aux. electricity													1349					1349								
Other:																										
				kWh/a									0					0								
				kWh/a									0					0								
				kWh/a									0					0								
Total													4755	kWh				4755	kWh			DHW Non-Electric - Wash&Dish 0			kWh	0
Specific demand																		15.2	kWh/(m²a)			Non-Renewable Non-Electric DHW Wash&Dish 0.0			kWh/(m²a)	0.0
Recommended maximum value																		18								

Aux Electricity

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Treated floor area	312	m²
Heating period	220	d
Air volume	780	m³
Dwelling units	2	HH

Heat recovery efficiency ventilation unit	0.86	
Operation vent. system Winter	5.28	kh/a
Operation vent. system Summer	3.48	kh/a
Air change rate	0.35	h^{-1}

Annual space heating demand	13	kWh/(m^2a)
Boiler rated power	15	kW
DHW system heating demand	4198	kWh/a
Design forward flow temperature	23	°C

Column no.	1	2	3		4		5		6		7		8		9		10	11
Application	Existing [1/0]	Within the thermal envelope [1/0]	Norm demand		Utilisation factor		Period of operation		Reference size		Electricity demand [kWh/a]		Available as interior heat		Utilisation period [h/a]		Internal heat gains winter [W]	Internal heat gains summer [W]
Ventilation system																		
Winter ventilation	1		0.28	Wh/m³	* 0.35	h^{-1}	* 5.3	kh/a	* 780	m³	= 402		considered in heat recovery efficiency					
Defroster HX	1	1	Data entries in 'Ventilation' worksheet or in 'Addl vent'								172	*	0.1	/	5.28	=	5	
Summer ventilation	1	0.55	0.28	Wh/m³	* 0.35	h^{-1}	* 3.5	kh/a	* 780	m³	= 264	*	1.0	/	3.48	=		42
																	Internal heat sources ' Additional summer ventilation'	0.0
Additional vent. summer	0	0.55	0.00	Wh/m³	* 0.00	h^{-1}	* 3.5	kh/a	* 780	m³	= 0	*	1.0	/	3.48	=		0.0
Heating system					Controlled / non controlled [1/0]													
Enter the rated power of the pump			30	W	1													
Circulator pump heating	1	1	30	W	* 0.7		* 5.3	kh/a	* 1		= 117	*	1.0	/	5.28	=	22	
Boiler electricity consumption at 30% load				W														
Aux. energy - Heat. boiler	0	0	55	W	* 1.00		* 0.00	kh/a	* 1		= 0	*	1.0	/	5.28	=	0	
Aux. energy - Wood fired/Pellet boiler	0	0	Data entries in 'Boiler' worksheet. Aux. energy demand including possible drinking water production.								0	*	1.0	/	5.28	=	0	
DHW system																		
Enter average power consumption of pump				W														
Circulation pump DHW	1	1	30	W	* 1.00		* 5.5	kh/a	* 1		= 168	*	1.0	/	8.76	=	19	19
Enter the rated power of the pump				W														
Storage load pump DHW			68	W	* 1.00		* 0.3	kh/a	* 1		= 0	*	1.0	/	8.76	=	0	0
Boiler electricity consumption at 100% load				W														
DHW boiler aux. energy	0	0	165	W	* 1.00		* 0.0	kh/a	* 1		= 0	*	1.0	/	8.76	=	0	0
Enter the rated power of the solar DHW pump				W														
Solar aux. electricity	0		50	W	* 1.00		* 1.8	kh/a	* 1		= 0	*	1.0	/	8.76	=	0	0
Aux. electricity cooling and dehumidification																		
Aux. electricity cooling				kWh/a	* 1.00		* 1.0		* 2		= 0	*	1.0	/	3.48	=		0
Aux. electricity dehum.				kWh/a	* 1.00		* 1.0		* 2		= 0	*	1.0	/	3.48	=		0
Misc. aux. electricity																		
Misc. aux. electricity	1	1	113	kWh/a	* 1.00		* 1.0		* 2		= 226	*	1.0	/	8.76	=	26	26
Total											1349						72	87
Specific demand	kWh/(m²a) (treated floor area)										4.3							

Primary Energy Renewable PER

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

Building type: SINGLE FAMILY DWELLING
Treated floor area A_{TFA}: 312 m²
Projected building footprint $A_{Projected}$: 184 m²
Heating demand incl. distribution & hydr. frost protection: 13 kWh/(m²a)
Cooling energy dem. incl. dehumidification: kWh/(m²a)
DHW demand including distribution: 13 kWh/(m²a)

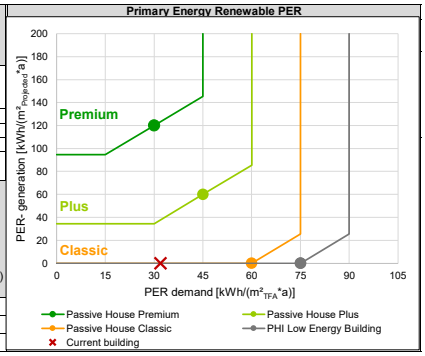
Selection of heat generation system(s)	Contribution margin (useful energy)		
Primary heat generation type	Heating	DHW	Addl. input in following worksheets
2-Heat pump(s)	55%	100%	HP, possibly HP ground
Secondary heat generation type (optional & different)			
5-Direct electricity	45%	0%	-

Energy demand Reference: Treated floor area	Efficiency Calculation -	 User defined value -	Final energy Contribution (final energy) -	 Final energy demand kWh/(m²a)	PER PER factor kWh/kWh	 Effective PER factor (including biomass kWh/kWh	 PER specific value kWh/(m²a)	PE PE factor kWh/kWh	 PE value kWh/(m²a)	CO_2 CO_2 emissions factor (CO_2-eq) kg/kWh	 CO_2eq emissions kg/(m²a)
								1-PE factors (non-renewable) PHI Certification		1-CO2 factors GEMIS (Germany)	
							32.0		70.2		14.4
Heating			100%			1.19	**11.9**	2.60	**25.9**		**5.3**
Electricity (HP compact unit)					1.45			2.60		0.532	
Electricity (heat pump)	3.43		55%	2.0	1.45	1.10	2.2	2.60	5.3	0.532	1.1
District heating: 1-None					2.8|4.5|3.3					0.000	
Wood and other biomass					1.10			-		-	
Natural gas / RE gas					1.75			1.10		0.250	
Heating oil / RE methanol					2.30			1.10		0.320	
Solar thermal system											
Electricity (direct)	1.00		45%	5.7	1.45	1.13	6.4	2.60	14.8	0.532	3.0
Aux. electricity (heating, wintertime ventilation)				2.2	1.45	1.45	3.2	2.60	5.8	0.532	1.2
Cooling and dehumidification					1.00		**0.8**		**2.2**		**0.5**
Electricity cooling (heat pump)					1.00			2.60		0.532	
Auxiliary electricity cooling, ventilation summer				0.8	1.00		0.8	2.60	2.2	0.532	0.5
Electricity dehumidification (heat pump)					1.00			2.60		0.532	
Auxiliary electricity (dehumidification)					1.00			2.60		0.532	
DHW generation			100%			1.15	**5.3**	2.60	**11.9**		**2.4**
Electricity (HP compact unit)					1.15			2.60		0.532	
Electricity (heat pump)	3.32		100%	4.0	1.15	1.15	4.7	2.60	10.5	0.532	2.2
District heating: 1-None					2.8|4.5|3.3					0.000	
Wood and other biomass					1.10			-		-	
Natural gas / RE gas					1.75			1.10		0.250	
Heating oil / Methanol					2.30			1.10		0.320	
Solar thermal system											
Electricity (direct)					1.15			2.60		0.532	
Aux. electricity (DHW + solar DHW)				0.5	1.15	1.15	0.6	2.60	1.4	0.532	0.3
Household electricity				**11.6**		1.20	**14.0**		**30.3**		**6.2**
Electricity (household or non-residential lighting, etc.)				10.9	1.20	1.20	13.1	2.60	28.4	0.532	5.8
Auxiliary electricity (other)				0.7	1.20	1.20	0.9	2.60	1.9	0.532	0.4
Gas / RE gas dry/cook				**0.0**	1.75		**0.0**	2.60	**0.0**	0.270	**0.0**

Energy generation Reference: Projected building footprint area	Final energy Final energy generation kWh/a	 Final energy generation kWh/(m²$A_{Projected}$*a)	PER PER factor kWh/kWh	 PER specific value kWh/(m²$A_{Projected}$a)	PE PE factor kWh/kWh	 PE Value kWh/(m²a)	CO_2 Emission factor (CO_2-eq) kg/kWh	 CO_2eq emissions kg/a
				0.0		0.0		0.0
PV electricity	0	0.0	1.00	0.0	-		-	
Solar thermal system	0	0.0	-	0.0	1.22	0.0		
		0.0						

PE demand requirement in case of verification through PE (non-renewable) [kWh/(m²a)]	-	Current building reaches following class for aspect	70	Requirement met?	-

Achievable energy standard through the verification of renewable primary energy (assessment of individual aspects)	Useful energy, performance Annual heat. dem. Treated floor area kWh/(m²a)	 Heating load Treated floor area W/m²	 Useful cool. energy Treated floor area kWh/(m²a)	 Cooling load Treated floor area W/m²	Airtightness n_{50} 1/h
Requirement Passive House Premium					
Requirement Passive House Plus	15	10	-	-	0.60
Requirement Passive House Classic					
Requirement PHI Low Energy Building	30		-		1.00
Current building reaches following class for aspec	13	8	-	-	0.3
	Premium		Premium		Premium



Summary Though, from the scientific point of view, not entirely correct, different energy carriers will be added together here. This is done to meet the criteria of other energy standards.	Final energy MWh/a	PER specific value MWh/a	PE value 1-PE factors (non-renewable) PHI Certification MWh/a	CO2eq emissions 1-CO2 factors GEMIS (Germany) kg/a	CO_2eq substitution balance 1-CO2 factors GEMIS (Germany) kg/a
Demand	**8.4**	**10.0**	21.91	4484	4484
Generation	**0.0**	**0.0**	0.00	0	0
Demand, cumulative generation (annual balance)	8.43	9.97	21.91	4484	4484
Demand w/o household electricity	**5.0**	**5.9**	13.06	2672	2672
Demand w/o household electricity, cum. generation	5.02	5.88	13.06	2672	2672

Heat pump

MUNSELL RESIDENCE / Climate: CA0065a-Nanaimo / TFA: 312 m² / Heating: 12.6 kWh/(m²a) / Freq. overheating: 0 % / PER: 32 kWh/(m²a)

			Building type:	SINGLE FAMILY DWELLING	
			Treated floor area A_{TFA}:	312	m²
Covered fraction of space heating demand			*('PER' worksheet)*	55%	
Space heating demand + distribution losses		Q_H+Q_{HL}:	*(DHW+Distribution)*	3951	kWh/a
Solar fraction for space heat		$\eta_{Solar,\ H}$	*('SolarDHW' worksheet)*	0%	
Effective annual heating demand	$Q_{H,Wi}=Q_H*(1-\eta_{Solar,\ H})$			**2173**	kWh/a
Covered fraction of DHW demand			*('PER' worksheet)*	100%	
Total heating demand of DHW system		Q_{gDHW}	*(DHW+Distribution)*	4903	kWh/a
Solar fraction for DHW		$\eta_{Solar,\ DHW}$	*('SolarDHW' worksheet)*	0%	
Effective DHW demand	$Q_{DHW,Wi}=Q_{DHW}*(1-\eta_{Solar,\ DHW})$			**4903**	kWh/a
Number of heat pumps in the system				1	
Functionality				Heating & DHW	
Heating					
Selection of HP: 4-Sanden DHW HP		Heat source:		1-Outdoor air	
Selection of distribution system				1-Underfloor heating	
Design distribution temperature		θ_{design}	*(DHW+Distribution)*	23.00	°C
Nominal power of distribution system		P_{nom}		1.37	kW
Distribution system (to be completed by experienced users only)					
Nominal power of distribution system		P_{nom}			kW
Radiator exponent		n			
Heat storage tank (buffer storage tank 'DHW+Distribution' worksheet)				0-No	
Specific heat losses storage		U * A $_{Storage}$			W/K
Storage location in thermal envelope				1-Inside	
Room temperature (storage location: outside of thermal envelope)			*(DHW+Distribution)*		°C
Sink temperature of heat pump for heating		θ_{snk}		67.50	°C
Entries in relation to the domestic hot water system					
Selection of HP: 4-Sanden DHW HP		Heat source:		1-Outdoor air	
DHW temperature			*(DHW+Distribution)*	66.00	°C
Orientation of DHW storage tank ('storage 1' in 'DHW+Distribution' worksheet)				1-Inside	
Specific heat losses storage		U * A $_{Storage}$		2.5	W/K
Room temperature (storage location: outside of thermal envelope)			*(DHW+Distribution)*	20.00	°C
Type of backup heater				1-Elec. Immersion heater	
Δθ of electric continuous flow water heater					K
Additional options in case of <u>one</u> heat pump for both functions: Heating & DHW					
Same heat pump's sink temperature for Heating and for DHW				1-Yes	
Heat pump priority			*(Manufacturer, tech. data)*	1-DHW-priority	
Control strategy					
Heat pump control strategy				1-On/Off	
Heating					
Depth ground water / Ground collector / Ground probe		z			m
Power of pump for ground heat exchanger		P_{pump}			kW

-

Heating

Heat pump: Sanden DHW HP

Source: 1-Outdoor air

	θ_source °C	θ_sink °C	Heating capacity kW	COP
Test point 1	-25.0	76.7	3.5	1.7
Test point 2	-20.0	76.7	4.0	2.0
Test point 3	-15.0	76.7	4.5	2.2
Test point 4	-10.0	76.7	4.5	2.5
Test point 5	-5.0	76.7	4.5	3.0
Test point 6	0.0	76.7	4.5	3.2
Test point 7	5.0	76.7	4.5	3.7
Test point 8	10.0	76.7	4.5	4.5
Test point 9	15.0	76.7	4.5	4.7
Test point 10	20.0	76.7	4.5	5.2
Test point 11	25.0	76.7	4.5	4.9
Test point 12	30.0	76.7	4.5	4.6
Test point 13	35.0	76.7	4.6	4.4
Test point 14	40.0	76.7	4.6	4.0
Test point 15	45.0	76.7	4.7	3.8

Temperature difference in sink $\Delta\theta_{Sink}$ K

DHW

Heat pump: Sanden DHW HP

Source: 1-Outdoor air

	θ_source °C	θ_sink °C	Heating capacity kW	COP
Test point 1	-25.0	76.7	3.5	1.7
Test point 2	-20.0	76.7	4.0	2.0
Test point 3	-15.0	76.7	4.5	2.2
Test point 4	-10.0	76.7	4.5	2.5
Test point 5	-5.0	76.7	4.5	3.0
Test point 6	0.0	76.7	4.5	3.2
Test point 7	5.0	76.7	4.5	3.7
Test point 8	10.0	76.7	4.5	4.5
Test point 9	15.0	76.7	4.5	4.7
Test point 10	20.0	76.7	4.5	5.2
Test point 11	25.0	76.7	4.5	4.9
Test point 12	30.0	76.7	4.5	4.6
Test point 13	35.0	76.7	4.6	4.4
Test point 14	40.0	76.7	4.6	4.0
Test point 15	45.0	76.7	4.7	3.8

Temperature difference in sink $\Delta\theta_{Sink}$ K

Electr. energy consumption pump (grnd. water / ground)	$Q_{El,Pump}$	0	kWh/a
Energy by direct electricity	$Q_{El,dir}$	0	kWh/a
Space heat supplied by HP	$Q_{HP,Heating}$	1824	kWh/a
Winter DHW supplied by HP	$Q_{HP,DHW,Winter}$	1777	kWh/a
Summer DHW supplied by HP	$Q_{HP,DHW,Summer}$	3126	kWh/a
Space heating supplied by HP without storage losses	$Q_{HP,Heating}$	2158	kWh/a
Winter DHW supplied by HP without storage losses	$Q_{HP,DHW,Winter}$	1412	kWh/a
Summer DHW supplied by HP without storage losses	$Q_{HP,DHW,Summer}$	2484	kWh/a
Electrical consumption of HP	Qel_{HP}	2108	kWh/a

		1. HP: Heating or heating & DHW	2. HP: Domestic hot
Seasonal performance factor of heat pump	SPF_{H-1}	3.19	
		kWh/a	kWh/(m²a)
Final electrical energy demand heat generation	Q_{final}	2108	6.8
Annual primary energy demand		5480	17.6
		kg/a	kg/(m²a)
Annual CO_2-equivalent emissions		1121	3.6