133 Union Street,
Brooklyn,
NY 11231.

Authorised by:
Passivhaus Institut
Dr. Wolfgang Feist
Rheinstr. 44/46
D-64283 Darmstadt

Certificate

Passive House Academy hereby certifies the following building as a

Quality Approved Passive House

Park Passive, 4211 East Lee Street, Seattle, WA, USA

Client: **Ritchie/Cascade Built, 4111 E. Madison St. Suite 104, Seattle, WA, USA**

Architect: **Marie Ljubojevic and Lauren McCunney/NK Architects, 310 First Avenue S., Suite 4S, Seattle, WA, USA**

Passive House Consultant: **Rob Harrison/HARRISON architects, 1402 3rd Avenue, Suite 515, Seattle, WA, USA**

This building was designed to meet Passive House criteria as defined by the Passive House Institute. With appropriate on-site implementation, this building will have the following characteristics:

- Excellent thermal insulation and optimised connection details with respect to building physics. High thermal comfort during the summer has been considered and the heating demand or heating load will be limited to
  - ***15 kWh per m² of living area and year or 10 W/m², respectively***
- A highly airtight building envelope, which eliminates draughts and reduces the heating energy demand: The air change rate through the envelope at a 50 Pascal pressure difference, as verified in accordance with ISO 9972, is less than

0.6 air changes per hour with respect to the building's volume

- A controlled ventilation system with high quality filters, highly efficient heat recovery and low electricity consumption, ensuring excellent indoor air quality with low energy consumption
- A total primary energy demand for heating, domestic hot water, ventilation and all other electric appliances during normal use of less than

120 kWh per m² of living area and year

This certificate is to be used only in combination with the associated certification documents, which describe the exact characteristics of the building.

Passive Houses offer high comfort throughout the year and can be heated with little effort, for example, by heating the supply air. The building envelope of a Passive House is evenly warm on the inside and the internal surface temperatures hardly differ from indoor air temperatures. Due to the highly airtight envelope, draughts are eliminated during normal use. The ventilation system constantly provides fresh air of excellent quality. Heating costs in a Passive House are very low. Thanks to their low energy consumption, Passive Houses offer security against energy scarcity and future rises in energy prices. Moreover, the climate impact of Passive Houses is low as they reduce energy use, thereby resulting in the emission of comparatively low levels of carbon dioxide (CO_2) and other pollutants.

issued:
Broomhall Business Park Wicklow, May 27th, 2013

Tomás O'Leary
Director
Passive House Academy

Certificate-ID: 6115_MosArt_PH_20130527_TOL

Certification Documentation

Specific building demands with reference to the treated floor area				use: Monthly method	
	Treated floor area	181.7	m²	Requirements	Fulfilled?*
Space heating	Annual heating demand	**15**	**kWh/(m²a)**	15 kWh/(m²a)	**yes**
	Heating load	**13**	**W/m²**	10 W/m²	**-**
Space cooling	Overall specific space cooling demand	**15**	**kWh/(m²a)**	15 kWh/(m²a)	**yes**
	Cooling load	**18**	**W/m²**	-	**-**
	Frequency of overheating (> 25 °C)		%	-	**-**
Primary Energy	Space heating and cooling, dehumidification, DHW, household electricity.	**116**	**kWh/(m²a)**	120 kWh/(m²a)	**yes**
	DHW, space heating and auxiliary electricity	58	kWh/(m²a)	-	**-**
	Specific primary energy reduction through solar electricity		kWh/(m²a)	-	**-**
Airtightness	Pressurization test result n_{50}	**0.6**	**1/h**	0.6 1/h	**yes**

* empty field: data missing; "-": no requirement

This building has been awarded the

Quality Approved Passive House

certificate by Passive House Academy.

This certification is based solely on the design data and specifications provided to Passive House Academy by the client for the purpose of certification. Passive House Academy has checked and approved the building's energy balances according to these data.

This certification does not cover quality assurance of the construction work or design implementation. Passive House Academy hereby takes no responsibility for any faults in the above.

Passive House verification

Photo or Drawing

Building:	Park Passive
Street:	4211 E. Lee Street
Postcode/City:	Seattle, WA 98122
Country:	USA
Building Type:	Single Family Residential
Climate:	Seattle
Home Owner(s) / Client(s):	Sloan Ritchie - CascadeBuilt
Street:	
Postcode/City:	Seattle, WA 98122
Architect:	Nicholson Kovalchick Architects Marie Ljubojevic
Street:	4302 SW Alaska Street, Suite 200
Postcode/City:	Seattle, WA 98116
Mechanical System:	ImaginEnergy Jonathan Cohen
Street:	4039 N Broadway
Postcode/City:	Portland, OR 97227

Year of Construction:	2012	Interior Temperature:	20.0 °C
Number of Dwelling Units:	1	Internal Heat Gains:	2.1 W/m²
Enclosed Volume V_e:	616.1		
Number of Occupants:	5.2		

Specific building demands with reference to the treated floor area — use: Monthly method

				Requirements	Fulfilled?*
	Treated floor area	181.7	m²		
Space heating	Annual heating demand	**15**	**kWh/(m²a)**	15 kWh/(m²a)	yes
	Heating load	**13**	**W/m²**	10 W/m²	-
Space cooling	Overall specific space cooling demand	**15**	**kWh/(m²a)**	15 kWh/(m²a)	yes
	Cooling load	**18**	**W/m²**	-	-
	Frequency of overheating (> 25 °C)		%	-	-
Primary Energy	Space heating and cooling, dehumidification, DHW, household electricity.	**116**	**kWh/(m²a)**	120 kWh/(m²a)	yes
	DHW, space heating and auxiliary electricity	58	kWh/(m²a)	-	-
	Specific primary energy reduction through solar electricity		kWh/(m²a)	-	-
Airtightness	Pressurization test result n_{50}	**0.6**	**1/h**	0.6 1/h	yes

***** empty field: data missing; '-': no requirement

Passive House? yes

We 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 application.

Name:	**Registration number PHPP:**
Surname:	**Issued on:**
Company:	**Signature:**

room no:	room name:	area ft2	area m2	tfa ft2	tfa m2	adjustmen
0.01	entry	116.93	10.863	116.93	10.863	100%
0.02	powder rm	34.35	3.191	34.35	3.191	100%
0.03	mudroom	47.15	4.380	47.15	4.380	100%
0.04	mech rm	31.66	2.941	31.66	2.941	100%
0.05	living/dining/kitchen	442.29	41.089	442.28	41.089	100%
1.06	bedroom1	125.71	11.678	125.71	11.678	100%
1.07	closet	18.94	1.760	18.94	1.760	100%
1.08	landing	229.44	21.315	229.43	21.315	100%
1.09	linnen closet	63.10	5.862	63.10	5.862	100%
1.10	bedroom3	127.84	11.876	127.84	11.876	100%
1.11	closet	18.94	1.760	18.94	1.760	100%
1.12	bathroom	63.10	5.862	63.10	5.862	100%
1.13	bedroom2	93.75	8.709	93.75	8.709	100%
1.14	closet	19.97	1.855	19.97	1.855	100%
2.15	den	193.04	17.933	193.03	17.933	100%
2.16	closet	21.75	2.021	21.75	2.021	100%
2.17	master bedroom	227.77	21.160	227.76	21.160	100%
2.18	master bath	79.65	7.399	79.65	7.399	100%
0.01	void	60.30	5.602			0%
1.02	void	62.75	5.829			0%
1.03	void	132.16	12.278			0%
2.04	void	57.50	5.342			0%
				1955.32 TFA ft²	181.655 TFA m²	

Wall Area's

wall no	description	area ft2	area m2
w-n-1	wood siding	412.78	38.347
w-n-2	fiber cement cladding	976.42	90.709
w-n-3	fiber cement cladding	199.61	18.544
w-e-1	hard wood siding	186.09	17.288
w-e-2	wood siding	144.77	13.449
w-e-3	fiber cement cladding	54.40	5.054
w-e-4	fiber cement cladding	178.72	16.603
w-e-5	fiber cement cladding	161.73	15.025
w-s-1	hard wood siding	642.02	59.644
w-s-2	wood siding	74.67	6.937
w-s-3	fiber cement cladding	91.75	8.524
w-s-4	fiber cement cladding	538.19	49.998
w-w-1	fiber cement cladding	54.35	5.049
w-w-2	wood siding	143.40	13.322
w-w-3	hard wood siding	168.68	15.670
w-w-4	fiber cement cladding	340.45	31.628

roof light wall 1	5.96	0.554
roof light wall 2	13.11	1.218
roof light wall 3	16.00	1.486
roof light wall 4	13.11	1.218
flat roof 1	748.00	69.489
flat roof 2	124.67	11.582
flat roof 3	16.00	1.486
sloped roof	378.80	35.191
roof light roof	37.37	3.472
floor slab	911.08	84.639
floor over car port	187.42	17.411
floor for stairs	24.00	2.230
floor @ 2nd floor	57.17	5.311
floor slab perimeter		**40.03**

height m	volume ft3	volume m3
2.50	958.66	27.15
2.50	281.62	7.97
2.50	386.56	10.95
2.50	259.57	7.35
2.75	3994.70	113.12
2.65	1093.33	30.96
2.65	164.73	4.66
2.65	1995.49	56.51
2.65	548.79	15.54
2.35	983.93	27.86
2.65	164.73	4.66
2.65	548.79	15.54
2.65	815.36	23.09
2.65	173.68	4.92
2.42	1534.52	43.45
2.42	172.90	4.90
2.42	1810.59	51.27
2.42	633.15	17.93
2.79	552.73	15.65
2.95	606.48	17.17
2.95	1277.33	36.17
2.42	457.08	12.94
	18957.65 Volume V n_{50}	**536.82** Volume V n_{50}

area m²	height m²	Volume V e Estimated
		616.09

Passive House verification

AREAS DETERMINATION

Building: Park Passive Heating demand 15 kWh/(m²a)

Summary

Group Nr.	Area group	Temp. zone	Area	Unit	Comments		Building element overview	Average U-Value [W/(m²K)]
1	Treated Floor Area		181.65	m²	*Living area or useful area within the thermal envelope*			
2	North Windows	A	24.24	m²	Results are from the Windows worksheet.		North Windows	0.989
3	East Windows	A	17.34	m²			East Windows	0.914
4	South Windows	A	19.26	m²			South Windows	0.943
5	West Windows	A	17.47	m²			West Windows	0.894
6	Horizontal Windows	A	1.60	m²			Horizontal Windows	1.055
7	Exterior Door	A	0.00	m²	*Please subtract area of door from respective building element*		Exterior Door	
8	Exterior Wall - Ambient	A	334.54	m²	*Window areas are subtracted from the individual areas specified in the "Windows" worksheet.*		Exterior Wall - Ambient	0.104
9	Exterior Wall - Ground	B	0.00	m²	*Temperature Zone "A" is ambient air.*		Exterior Wall - Ground	
10	Roof/Ceiling - Ambient	A	141.98	m²	*Temperature zone "B" is the ground.*		Roof/Ceiling - Ambient	0.097
11	Floor slab / basement ceiling	B	84.64	m²			Floor slab / basement ceiling	0.048
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		
14		X	0.00	m²	*Temperature zone "X": Please provide user-defined reduction factor (0 < f, < 1):*	75%		
							Thermal Bridge Overview	Ψ [W/(mK)]
15	Thermal Bridges Ambient	A	138.74	m	*Units in m*		Thermal Bridges Ambient	-0.053
16	Perimeter Thermal Bridges	P	40.03	m	*Units in m; temperature zone "P" is perimeter (see Ground worksheet).*		Perimeter Thermal Bridges	0.038
17	Thermal Bridges Floor Slab	B	0.00	m	*Units in m*		Thermal Bridges Floor Slab	
18	Partition Wall to Neighbour	I	0.00	m²	*No heat losses, only considered for the heating load calculation.*		Partition Wall to Neighbour	
Total thermal envelope			641.08	m²			Average Therm. Envelope	0.190

Area input

Area Nr.	Building element description	Group Nr.	Assigned to group	Quantity	x (	a [m]	x	b [m]	+	User-Determined [m²]	-	User Subtraction [m²]	- -	Subtraction window areas [m²]	) =	Area [m²]	Selection of the corresponding building element assembly	Nr.	U-Value [W/(m²K)]
	Treated Floor Area	1	Treated Floor Area	1	x (		x		+	181.65	-				) =	181.7			
	North Windows	2	North Windows													24.2	From Windows sheet		0.989
	East Windows	3	East Windows													17.3	From Windows sheet		0.914
	South Windows	4	South Windows													19.3	From Windows sheet		0.943
	West Windows	5	West Windows													17.5	From Windows sheet		0.894
	Horizontal Windows	6	Horizontal Windows													1.6	From Windows sheet		1.055
	Exterior Door	7	Exterior Door		x (		x		+		-		) -		=		U-Value Exterior Door		
1	w-n-1 wood siding	8	Exterior Wall - Ambient	1	x (		x		+	38.35	-		) -	15.0	=	23.4	external wall	1	0.104
2	w-n-2 fiber cement cladding	8	Exterior Wall - Ambient	1	x (		x		+	90.71	-		) -	5.6	=	85.2		1	0.104
3	w-n-3 fiber cement cladding	8	Exterior Wall - Ambient	1	x (		x		+	18.54	-		) -	3.7	=	14.8		1	0.104
4	w-e-1 hard wood siding	8	Exterior Wall - Ambient	1	x (		x		+	17.29	-		) -	3.5	=	13.8		1	0.104
5	w-e-2 wood siding	8	Exterior Wall - Ambient	1	x (		x		+	13.45	-		) -	2.8	=	10.7		1	0.104
6	w-e-3 fiber cement cladding	8	Exterior Wall - Ambient	1	x (		x		+	5.05	-		) -	0.0	=	5.1		1	0.104
7	w-e-4 fiber cement cladding	8	Exterior Wall - Ambient	1	x (		x		+	16.60	-		) -	5.1	=	11.5		1	0.104
8	w-e-5 fiber cement cladding	8	Exterior Wall - Ambient	1	x (		x		+	15.02	-		) -	6.0	=	9.1		1	0.104
9	w-s-1 hard wood siding	8	Exterior Wall - Ambient	1	x (		x		+	59.64	-		) -	2.1	=	57.5		1	0.104
10	w-s-2 wood siding	8	Exterior Wall - Ambient	1	x (		x		+	6.94	-		) -	1.2	=	5.7		1	0.104
11	w-s-3 fiber cement cladding	8	Exterior Wall - Ambient	1	x (		x		+	8.52	-		) -	0.0	=	8.5		1	0.104
12	w-s-4 fiber cement cladding	8	Exterior Wall - Ambient	1	x (		x		+	50.00	-		) -	13.4	=	36.6		1	0.104
13	w-w-1 fiber cement cladding	8	Exterior Wall - Ambient	1	x (		x		+	5.05	-		) -	0.0	=	5.0		1	0.104
14	w-w-2 wood siding	8	Exterior Wall - Ambient	1	x (		x		+	13.32	-		) -	2.4	=	10.9		1	0.104
15	w-w-3 hard wood siding	8	Exterior Wall - Ambient	1	x (		x		+	15.67	-		) -	1.0	=	14.6		1	0.104
16	w-w-4 fiber cement cladding	8	Exterior Wall - Ambient	1	x (		x		+	31.63	-		) -	14.0	=	17.6		1	0.104
17	roof light wall 1	8	Exterior Wall - Ambient	1	x (		x		+	0.55	-		) -	0.0	=	0.6		2	0.106
18	roof light wall 2	8	Exterior Wall - Ambient	1	x (		x		+	1.22	-		) -	0.0	=	1.2		2	0.106
19	roof light wall 3	8	Exterior Wall - Ambient	1	x (		x		+	1.49	-		) -	0.0	=	1.5		2	0.106
20	roof light wall 4	8	Exterior Wall - Ambient	1	x (		x		+	1.22	-		) -	0.0	=	1.2		2	0.106
21					x (		x		+		-		) -	0.0	=			0	
22	flat roof 1	10	Roof/Ceiling - Ambient	1	x (		x		+	69.49	-		) -	0.0	=	69.5		3	0.091
23	flat roof 2	10	Roof/Ceiling - Ambient	1	x (		x		+	11.58	-		) -	0.0	=	11.6		4	0.110
24	flat roof 3	10	Roof/Ceiling - Ambient	1	x (		x		+	1.49	-		) -	0.0	=	1.5		5	0.102
25	sloped roof	10	Roof/Ceiling - Ambient	1	x (		x		+	35.19	-		) -	2.6	=	32.6		7	0.113
26	roof light roof	10	Roof/Ceiling - Ambient	1	x (		x		+	3.47	-		) -	1.6	=	1.9		2	0.106
27					x (		x		+		-		) -	0.0	=			0	
28	floor slab	11	Floor slab / basement ceiling	1	x (		x		+	84.64	-		) -	0.0	=	84.6		8	0.048
29	floor over car port	10	Roof/Ceiling - Ambient	1	x (		x		+	17.41	-		) -	0.0	=	17.4		6	0.079
30	floor for stairs	10	Roof/Ceiling - Ambient	1	x (		x		+	2.23	-		) -	0.0	=	2.2		5	0.102
31	floor @ 2nd floor	10	Roof/Ceiling - Ambient	1	x (		x		+	5.31	-		) -	0.0	=	5.3		5	0.102
32					x (		x		+		-		) -	0.0	=			0	
33					x (		x		+		-		) -	0.0	=			0	
34					x (		x		+		-		) -	0.0	=			0	
35					x (		x		+		-		) -	0.0	=			0	
36					x (		x		+		-		) -	0.0	=			0	
37					x (		x		+		-		) -	0.0	=			0	
38					x (		x		+		-		) -	0.0	=			0	
39					x (		x		+		-		) -	0.0	=			0	
40					x (		x		+		-		) -	0.0	=			0	
41					x (		x		+		-		) -	0.0	=			0	
42					x (		x		+		-		) -	0.0	=			0	
43					x (		x		+		-		) -	0.0	=			0	
44					x (		x		+		-		) -	0.0	=			0	
45					x (		x		+		-		) -	0.0	=			0	
46					x (		x		+		-		) -	0.0	=			0	
47					x (		x		+		-		) -	0.0	=			0	
48					x (		x		+		-		) -	0.0	=			0	
49					x (		x		+		-		) -	0.0	=			0	
50					x (		x		+		-		) -	0.0	=			0	
51					x (		x		+		-		) -	0.0	=			0	
52					x (		x		+		-		) -	0.0	=			0	
53					x (		x		+		-		) -	0.0	=			0	
54					x (		x		+		-		) -	0.0	=			0	
55					x (		x		+		-		) -	0.0	=			0	
56					x (		x		+		-		) -	0.0	=			0	
57					x (		x		+		-		) -	0.0	=			0	
58					x (		x		+		-		) -	0.0	=			0	
59					x (		x		+		-		) -	0.0	=			0	
60					x (		x		+		-		) -	0.0	=			0	
61					x (		x		+		-		) -	0.0	=			0	
62					x (		x		+		-		) -	0.0	=			0	
63					x (		x		+		-		) -	0.0	=			0	
64					x (		x		+		-		) -	0.0	=			0	
65					x (		x		+		-		) -	0.0	=			0	
66					x (		x		+		-		) -	0.0	=			0	
67					x (		x		+		-		) -	0.0	=			0	
68					x (		x		+		-		) -	0.0	=			0	
69					x (		x		+		-		) -	0.0	=			0	
70					x (		x		+		-		) -	0.0	=			0	
71					x (		x		+		-		) -	0.0	=			0	
72					x (		x		+		-		) -	0.0	=			0	

Please complete in Windows worksheet only!

Passive House verification

AREAS DETERMINATION

Building: Park Passive Heating demand 15 kWh/(m²a)

Summary

Group Nr.	Area group	Temp. zone	Area	Unit	Comments		Building element overview	Average U-Value [W/(m²K)]
1	Treated Floor Area		181.65	m²	*Living area or useful area within the thermal envelope*			
2	North Windows	A	24.24	m²	Results are from the Windows worksheet.		North Windows	0.989
3	East Windows	A	17.34	m²			East Windows	0.914
4	South Windows	A	19.26	m²			South Windows	0.943
5	West Windows	A	17.47	m²			West Windows	0.894
6	Horizontal Windows	A	1.60	m²			Horizontal Windows	1.055
7	Exterior Door	A	0.00	m²	*Please subtract area of door from respective building element*		Exterior Door	
8	Exterior Wall - Ambient	A	334.54	m²	*Window areas are subtracted from the individual areas specified in the "Windows" worksheet.*		Exterior Wall - Ambient	0.104
9	Exterior Wall - Ground	B	0.00	m²	*Temperature Zone "A" is ambient air.*		Exterior Wall - Ground	
10	Roof/Ceiling - Ambient	A	141.98	m²	*Temperature zone "B" is the ground.*		Roof/Ceiling - Ambient	0.097
11	Floor slab / basement ceiling	B	84.64	m²			Floor slab / basement ceiling	0.048
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		
14		X	0.00	m²	*Temperature zone "X": Please provide user-defined reduction factor (0 < f, < 1):*	75%		
							Thermal Bridge Overview	Ψ [W/(mK)]
15	Thermal Bridges Ambient	A	138.74	m	*Units in m*		Thermal Bridges Ambient	-0.053
16	Perimeter Thermal Bridges	P	40.03	m	*Units in m; temperature zone "P" is perimeter (see Ground worksheet).*		Perimeter Thermal Bridges	0.038
17	Thermal Bridges Floor Slab	B	0.00	m	*Units in m*		Thermal Bridges Floor Slab	
18	Partition Wall to Neighbour	I	0.00	m²	*No heat losses, only considered for the heating load calculation.*		Partition Wall to Neighbour	
Total thermal envelope			641.08	m²			Average Therm. Envelope	0.190

Thermal Bridge Inputs

No.	Thermal bridge description	Group Nr.	Assigned to group	Quantity	x (	User determined length [m]	-	Subtraction user-determined length [m]	)=	Length ℓ [m]	Input of thermal bridge heat loss coefficient W/(mK)	Ψ W/(mK)
1	Footing	16	Perimeter Thermal Bridges	1	x (	40.03	-		) =	40.03	Footing	0.038
2	Eaves at Slope	15	Thermal Bridges Ambient	1	x (	10.97	-		) =	10.97	Eaves at Slope	-0.019
3	Eaves Internal	15	Thermal Bridges Ambient	1	x (	10.97	-		) =	10.97	Eaves Internal	0.000
4	Eaves/Verge	15	Thermal Bridges Ambient	1	x (	41.96	-		) =	41.96	Eaves/Verge	-0.080
5	External Wall Corner	15	Thermal Bridges Ambient	1	x (	47.18	-		) =	47.18	External Wall Corner	-0.073
6	Internal Wall Corner	15	Thermal Bridges Ambient	1	x (	11.13	-		) =	11.13	Internal Wall Corner	0.038
7	Overhang	15	Thermal Bridges Ambient	1	x (	12.07	-		) =	12.07	Overhang	-0.074
8	Overhang/Projection Intern	15	Thermal Bridges Ambient	1	x (	4.45	-		) =	4.45	Overhang/Projection Internal Corne	0.026
9					x (		-		) =			
10					x (		-		) =			
11					x (		-		) =			
12					x (		-		) =			
13					x (		-		) =			
14					x (		-		) =			
15					x (		-		) =			
16					x (		-		) =			
17					x (		-		) =			
18					x (		-		) =			
19					x (		-		) =			
20					x (		-		) =			
21					x (		-		) =			
22					x (		-		) =			
23					x (		-		) =			
24					x (		-		) =			
25					x (		-		) =			
26					x (		-		) =			
27					x (		-		) =			
28					x (		-		) =			
29					x (		-		) =			
30					x (		-		) =			
31					x (		-		) =			
32					x (		-		) =			
33					x (		-		) =			
34					x (		-		) =			
35					x (		-		) =			
36					x (		-		) =			
37					x (		-		) =			
38					x (		-		) =			
39					x (		-		) =			
40					x (		-		) =			
41					x (		-		) =			
42					x (		-		) =			
43					x (		-		) =			
44					x (		-		) =			
45					x (		-		) =			
46					x (		-		) =			
47					x (		-		) =			
48					x (		-		) =			
49					x (		-		) =			
50					x (		-		) =			
51					x (		-		) =			
52					x (		-		) =			
53					x (		-		) =			
54					x (		-		) =			
55					x (		-		) =			
56					x (		-		) =			
57					x (		-		) =			
58					x (		-		) =			
59					x (		-		) =			
60					x (		-		) =			
61					x (		-		) =			
62					x (		-		) =			
63					x (		-		) =			
64					x (		-		) =			
65					x (		-		) =			
66					x (		-		) =			
67					x (		-		) =			
68					x (		-		) =			
69					x (		-		) =			
70					x (		-		) =			
71					x (		-		) =			
72					x (		-		) =			
73					x (		-		) =			
74					x (		-		) =			

Passive House verification

U - L I S T

Compilation of the building elements calculated in the U-Values worksheet and other construction types from databases.

	Type		
Assembly No.	Assembly description	Total thickness	U-Value
		m	W/(m²K)
1	external wall	0.425	0.104
2	skylight wall/roof	0.333	0.106
3	flat roof 1	0.479	0.091
4	flat roof 2	0.371	0.110
5	floor/roof at stairs	0.425	0.102
6	floor over car port	0.590	0.079
7	sloped roof	0.359	0.113
8	floor slab	0.813	0.048
9	Polyiso Bridged Conductivity	1.000	0.030
10	Blown Fiber Glass Bridged Conductivity	1.000	0.040
11	Blown Fiber Glass Bridged Conductivity	1.000	0.046
12			
13			
14			
15			
16			
17			
18			
19			
20			

Passive House verification

U-VALUES OF BUILDING ELEMENTS

Building: Park Passive

Wedge shaped building element layers and still air spaces -> Secondary calculation to the right

Assembly No. 1 | Building assembly description: external wall | Interior insulation?

Heat transfer resistance [m²K/W] — interior Rsi: 0.13 — 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]
1.	osb board	0.130					13
2.	fiberglass blow in ins	0.038	tji 35x57 @600ccs	0.130			35
3.	fiberglass blow in ins	0.038			tji 171x10 @600ccs	0.130	171
4.	fiberglass blow in ins	0.038	tji 35x57 @600ccs	0.130			35
5.	osb board	0.130					13
6.	fiberglass blow in ins	0.038	2x6 stud @600ccs 38x	0.130			140
7.	finished plywood	0.130					19
8.	fiber cement/wood cladding						

Percentage of Sec. 2: 9.3% — Percentage of Sec. 3: 1.7% — Total: 42.5 cm

U-Value: 0.104 W/(m²K)

Assembly No. 2 | Building assembly description: skylight wall/roof | Interior insulation?

Heat transfer resistance [m²K/W] — interior Rsi: 0.13 — 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]
1.	polyiso insulation	0.023					102
2.	osb board	0.130					13
3.	fiberglass blow in ins	0.038	2x8 stud @ 600ccs 51	0.130			203
4.	plaster board	0.250					16
5.							
6.							
7.							
8.							

Percentage of Sec. 2: 8.4% — Percentage of Sec. 3: — Total: 33.3 cm

U-Value: 0.106 W/(m²K)

Assembly No. 3 | Building assembly description: flat roof 1 | Interior insulation?

Heat transfer resistance [m²K/W] — interior Rsi: 0.10 — exterior Rse: 0.04

	Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
1.	roxul insulation	0.037					102
2.	plywood sheating	0.130					13
3.	fiberglass blow in ins	0.038	57x417 stud @ 600ccs	0.130			356
4.	osb board	0.130					10
5.	2x4 furring						
6.	5/8" gwb						
7.							
8.							

Percentage of Sec. 2: 9.3% — Percentage of Sec. 3: — Total: 47.9 cm

U-Value: 0.091 W/(m²K)

Passive House verification

U-VALUES OF BUILDING ELEMENTS

Building: Park Passive

Wedge shaped building element layers and still air spaces -> Secondary calculation to the right

Assembly No. 4 — Building assembly description: flat roof 2 — Interior insulation?

Heat transfer resistance [m²K/W]: interior Rsi: 0.10; 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]
1.	roxul insulation	0.037					102
2.	plywood sheating	0.130					19
3.	fiberglass blow in ins	0.038	tji 35x57 @600ccs	0.130			35
4.	fiberglass blow in ins	0.038			tji 171x10 @600ccs	0.130	171
5.	fiberglass blow in ins	0.038	tji 35x57 @600ccs	0.130			35
6.	osb board	0.130					10
7.	2x4 furring						
8.	5/8" gwb						

Percentage of Sec. 2: 9.3% — Percentage of Sec. 3: 1.7% — Total: 37.1 cm

U-Value: 0.110 W/(m²K)

Assembly No. 5 — Building assembly description: floor/roof at stairs — Interior insulation?

Heat transfer resistance [m²K/W]: interior Rsi: 0.17; 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]
1.	eps15 foam insulation	0.040					102
2.	fiberglass blow in ins	0.038	2x12 stud @600ccs 51	0.130			305
3.	plywood sheating	0.130					19
4.	finishh floor						
5.							
6.							
7.	eps 15	0.040					
8.	eps 29	0.034					

Percentage of Sec. 2: 8.4% — Percentage of Sec. 3: — Total: 42.5 cm

U-Value: 0.102 W/(m²K)

Assembly No. 6 — Building assembly description: floor over car port — Interior insulation?

Heat transfer resistance [m²K/W]: interior Rsi: 0.17; 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]
1.	plywood sheating	0.130					19
2.	fiberglass blow in ins	0.038	tji 35x57 @600ccs	0.130			35
3.	fiberglass blow in ins	0.038			tji 171x10 @600ccs	0.130	171
4.	fiberglass blow in ins	0.038	tji 35x57 @600ccs	0.130			35
5.	osb board	0.130					13
6.	fiberglass blow in ins	0.038	soffit framing	0.130			305
7.	sheating	0.130					13
8.	furring/fiber cement cladding						

Percentage of Sec. 2: 15.0% — Percentage of Sec. 3: 1.7% — Total: 59.0 cm

U-Value: 0.079 W/(m²K)

Passive House verification

U-VALUES OF BUILDING ELEMENTS

Building: Park Passive

Wedge shaped building element layers and still air spaces -> Secondary calculation to the right

Assembly No. 7 | Building assembly description: sloped roof | Interior insulation?

Heat transfer resistance [m²K/W] — interior Rsi: 0.10 — 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]
1.	roxul insulation	0.037					102
2.	plywood sheating	0.130					13
3.	fiberglass blow in ins	0.038	tji 35x57 @600ccs	0.130			35
4.	fiberglass blow in ins	0.038			tji 165x10 @600ccs	0.130	165
5.	fiberglass blow in ins	0.038	tji 35x57 @600ccs	0.130			35
6.	osb board	0.130					10
7.	2x4 furring						
8.	5/8" gwb						

Percentage of Sec. 2: 9.5% — Percentage of Sec. 3: 1.7% — Total: 35.9 cm

U-Value: 0.113 W/(m²K)

Assembly No. 8 | Building assembly description: floor slab | Interior insulation?

Heat transfer resistance [m²K/W] — interior Rsi: 0.17 — 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]
1.	concrete pour	1.100					102
2.	eps 29	0.034					508
3.	eps 29	0.034					203
4.							
5.							
6.							
7.							
8.							

Percentage of Sec. 2: — Percentage of Sec. 3: — Total: 81.3 cm

U-Value: 0.048 W/(m²K)

Assembly No. 9 | Building assembly description: Polyiso Bridged Conductivity | Interior insulation?

Heat transfer resistance [m²K/W] — interior Rsi: 0.00 — 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]
1.		0.023		0.130			1000
2.							
3.							
4.							
5.							
6.							
7.							
8.							

Percentage of Sec. 2: 6.3% — Percentage of Sec. 3: — Total: 100.0 cm

U-Value: 0.030 W/(m²K)

Passive House verification

U-VALUES OF BUILDING ELEMENTS

Building: Park Passive

Wedge shaped building element layers and still air spaces -> Secondary calculation to the right

Assembly No. 10 | Building assembly description: Blown Fiber Glass Bridged Conductivity | Interior insulation?

Heat transfer resistance [m²K/W] interior Rsi: 0.00 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]
1.		0.038		0.130			1000
2.							
3.							
4.							
5.							
6.							
7.							
8.							

Percentage of Sec. 2: 1.6% | Percentage of Sec. 3: | Total: 100.0 cm

U-Value: 0.040 W/(m²K)

Assembly No. 11 | Building assembly description: Blown Fiber Glass Bridged Conductivity | Interior insulation?

Heat transfer resistance [m²K/W] interior Rsi: 0.00 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]
1.		0.038		0.130			1000
2.							
3.							
4.							
5.							
6.							
7.							
8.							

Percentage of Sec. 2: 8.3% | Percentage of Sec. 3: | Total: 100.0 cm

U-Value: 0.046 W/(m²K)

Assembly No. 12 | Building assembly description: | Interior insulation?

Heat transfer resistance [m²K/W] interior Rsi: 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]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

Percentage of Sec. 2: | Percentage of Sec. 3: | Total: cm

U-Value: W/(m²K)

Passive House verification

HEAT LOSSES VIA THE GROUND

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			
Av. Indoor Temp. Winter	T_i	20.0	°C
Av. Indoor Temp. Summer	T_i	25.0	°C
Average Ground Surface Temperatur	$T_{g,ave}$	11.7	°C
Amplitude of $T_{g,ave}$	$T_{g,\wedge}$	6.1	°C
Length of the Heating Period	n	6.8	months
Heating Degree Hours - Exterior	G_t	64.9	kKh/a

Building Data							
Floor Slab Area	A	84.6	m²	U-value floor slab/basement ceiling	U_f	0.048	W/(m²K)
Floor Slab Perimeter	P	40.0	m	Thermal bridges floor slab/basement	Ψ_B*l	0.00	W/K
Charact. Dimension of Floor Slab	B'	4.23	m	U-value floor slab/basement ceiling in	U_f'	0.048	W/(m²K)
				Eq. Thickness Floor	d_t	41.94	m

Floor Slab Type (select only one)

	Heated Basement or Underground Floor Slab		Unheated basement
x	Slab on Grade		Suspended Floor

For Basement or Underground Floor Slab							
Basement Depth	z		m	U-Value Belowground Wall	U_{wB}		W/(m²K)
Additionally for Unheated Basements				Height Aboveground Wall	h		m
Air Change Unheated Basement	n		h^{-1}	U-Value Aboveground Wall	U_W		W/(m²K)
Basement Volume	V		m³	U-Value Basement Floor Slab	U_{fB}		W/(m²K)

For Perimeter Insulation for Slab on Grade				For Suspended Floor			
Perimeter Insulation Width/Depth	D		m	U-Value Crawl Space	U_{Crawl}		W/(m²K)
Perimeter Insulation Thickness	d_n		m	Height of Crawl Space Wall	h		m
Conductivity Perimeter Insulation	λ_n		W/(mK)	U-Value Crawl Space Wall	U_W		W/(m²K)
				Area of Ventilation Openings	εP		m²
Orientation of the Perimeter Ins.	horizontal			Wind Velocity at 10 m Height	v	4.0	m/s
(check only one field)	vertical			Wind Shield factor	f_W	0.05	-

Additional Thermal Bridge Heat Losses at Perimeter							
				Steady-State Fraction	$\Psi_{P,stat}$*l	1.524	W/K
Phase Shift	β		months	Harmonic Fraction	$\Psi_{P,harm}$*l	1.524	W/K

Groundwater Correction							
Depth of the Groundwater Table	z_w	3.0	m	Transm. Belowground El. (w/o Ground)	L_{reg}	5.56	W/K
Groundwater Flow Rate	q_w	0.05	m/d	Relative Insulation Standard	d_t/B'	7.20	-
				Relative Groundwater Depth	z_w/B'	0.71	-
Groundwater Correction Factor	G_w	1.0007538	-	Relative Groundwater Velocity	l/B'	0.20	-

Basement or Underground Floor Slab						
Eq. Thickness Floor Slab	d_t		m	Phase Shift	β	months
U-Value Floor Slab	U_{bf}		W/(m²K)	Exterior Periodic Transmittance	L_{pe}	W/K
Eq. Thickness Basement Wall	d_w		m			
U-Value Wall	U_{bw}		W/(m²K)			
Steady-State Transmittance	L_S		W/K			

Unheated Basement						
Steady-State Transmittance	L_S		W/K	Phase Shift	β	months
				Exterior Periodic Transmittance	L_{pe}	W/K

Slab on Grade							
Heat Transfer Coefficient	U_0	0.05	W/(m²K)	Phase Shift	β	1.47	months
Eq. Ins. Thickness Perimeter Ins.	d'	0.00	m	Exterior Periodic Transmittance	L_{pe}	2.16	W/K
Perimeter Insulation Correction	$\Delta\Psi$		W/(mK)				
Steady-State Transmittance	L_S	3.86	W/K				

Suspended Floor Above a Ventilated Crawl Space (at max. 0.5 m Below Ground)					
Eq. Ins. Thickness Crawl Space	d_g		m	Phase Shift	β	months
U-Value Crawl Space Floor Slab	U_g		W/(m²K)	Exterior Periodic Transmittance	L_{pe}	W/K
U-Value Crawl Space Wall & Vent.	U_X		W/(m²K)			
Steady-State Transmittance	L_S		W/K			

Interim Results

Phase Shift	β	1.47	months	Steady-State Heat Flow	Φ_{stat}	44.7	W
Steady-State Transmittance	L_S	5.38	W/K	Periodic Heat Flow	Φ_{harm}	8.7	W
Exterior Periodic Transmittance	L_{pe}	3.68	W/K	Heat Losses During Heating Period	Q_{tot}	267	kWh

Ground reduction factor for "Annual Heating Demand" sheet **0.74**

Monthly Average Ground Temperatures for Monthly Method

Month	1	2	3	4	5	6	7	8	9	10	11	12	Average Val
Winter	9.1	8.1	8.1	9.2	11.0	13.1	14.8	15.9	15.8	14.8	12.9	10.9	12.0
Summer	9.2	8.2	8.3	9.3	11.1	13.2	15.0	16.0	16.0	14.9	13.1	11.0	12.1

Design Ground Temperature for Heating Load Sheet 8.1 **for Cooling Load Sheet** 16.0

Passive House verification

REDUCTION FACTOR SOLAR RADIATION, WINDOW U-VALUE

Building: Park Passive

Annual heating demand: 15 kWh/(m²a)

Heating degree hours: 64.9

Climate: Seattle

Window area orientation	Global radiation (cardinal points)	Shading	Dirt	Non-perpendicular incident radiation	Glazing fraction	g-Value	Reduction factor for solar radiation	Window area	Window U-Value	Glazing area	Average global radiation	Transmission losses	Heat gains solar radiation
maximum:	kWh/(m²a)	0.75	0.95	0.85				m²	W/(m²K)	m²	kWh/(m²a)	kWh/a	kWh/a
North	115	0.74	0.95	0.85	0.674	0.53	0.40	24.24	0.99	16.3	115	1557	595
East	256	0.53	0.95	0.85	0.744	0.57	0.32	17.34	0.91	12.9	257	1029	811
South	456	0.61	0.95	0.85	0.751	0.60	0.37	19.26	0.94	14.5	469	1179	2011
West	265	0.55	0.95	0.85	0.763	0.59	0.34	17.47	0.89	13.3	264	1014	922
Horizontal	410	0.97	0.95	0.85	0.739	0.44	0.58	1.60	1.06	1.2	495	110	202
Total or Average Value for All Windows.						0.57	0.37	79.91	0.94	58.2		4888	4541

Glazing inclination ≠ 90°: Please check Ug value manually!

Quantity	Description	Deviation from north	Angle of inclination from the horizontal	Orientation	Window rough openings: Width	Window rough openings: Height	Installed: in Area in the Areas worksheet	Glazing: Nr.	Glazing: Select glazing from the WinType worksheet	Frame: Nr.	Frame: Select window from the WinType worksheet	g-Value: Nr.	g-Value: Perpendicular Radiation	U-Value: Glazing	U-Value: Frames (centre)	Ψ-Spacer: Ψspacer (centre)	Installation: Left 1/0	Right 1/0	Bottom 1/0	Top 1/0	Ψinstallation left	Ψinstallation right	Ψinstallation bottom	Ψinstallation top	Ψinstallation Average value	Results: Window Area	Glazing Area	U-Value Window	Glazed Fraction per Window
		Degrees	Degrees		m	m	Select:		Select:		Select:		-	W/(m²K)	W/(m²K)	W/(mK)					W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	m²	m²	W/(m²K)	%
1	wi-n-1	0	90	North	1.422	0.838	w-n-1	1		1		1	0.62	0.60	0.95	0.038	1	1	1	1	0.031	0.031	0.061	0.026	0.039	1.2	0.89	0.96	75%
1	wi-n-2	0	90	North	1.035	2.515		1		2		4	0.49	0.60	1.30	0.038	1	0	1	1	0.031		0.061	0.026	0.037	2.6	1.53	1.04	59%
1	wi-n-3	0	90	North	1.035	2.515		1		2		5	0.49	0.60	1.30	0.038	0	0	1	1			0.061	0.026	0.043	2.6	1.84	0.93	71%
1	wi-n-4	0	90	North	1.035	2.515		1		2		5	0.49	0.60	1.30	0.038	0	0	1	1			0.061	0.026	0.043	2.6	1.84	0.93	71%
1	wi-n-5	0	90	North	1.035	2.515		1		2		4	0.49	0.60	1.30	0.038	0	1	1	1		0.031	0.061	0.026	0.037	2.6	1.53	1.04	59%
1	wi-n-6	0	90	North	0.445	2.235		1		2		1	0.49	0.60	0.95	0.038	1	0	1	1	0.031		0.061	0.026	0.035	1.0	0.64	1.02	64%
1	wi-n-7	0	90	North	1.054	2.235		1		2		3	0.49	0.60	1.48	0.038	0	1	1	1		0.031	0.061	0.026	0.037	2.4	1.32	1.14	56%
1	wi-n-8	0	90	North	0.711	1.294		3		2		1	0.49	0.60	0.95	0.038	1	1	1	1	0.050	0.050	0.087	0.059	0.058	0.9	0.66	1.10	72%
1	wi-n-9	0	90	North	0.914	1.259		2		1		2	0.62	0.60	0.95	0.038	1	1	1	1	0.031	0.031	0.054	0.029	0.036	1.2	0.69	0.99	60%
1	wi-n-10	0	90	North	1.676	1.295		2		1		7	0.62	0.60	0.95	0.038	1	0	1	1	0.031		0.054	0.029	0.039	2.2	1.81	0.84	84%
1	wi-n-11	0	90	North	0.838	1.295		2		1		8	0.62	0.60	0.95	0.038	0	1	1	1		0.031	0.054	0.029	0.037	1.1	0.69	0.95	64%
1	wi-n-12	0	90	North	1.118	1.981		3		2		1	0.49	0.60	0.95	0.038	1	1	1	1	0.050	0.050	0.087	0.059	0.058	2.2	1.80	0.93	81%
1	wi-n-13	0	90	North	0.914	1.259		2		1		2	0.62	0.60	0.95	0.038	1	1	1	1	0.031	0.031	0.054	0.029	0.036	1.2	0.69	0.99	60%
1	wi-n-14	0	90	North	0.711	0.838		3		1		1	0.62	0.60	0.95	0.038	1	1	1	1	0.050	0.050	0.087	0.059	0.061	0.6	0.40	1.19	67%
1	wi-e-1	90	90	East	1.092	2.286		4		2		3	0.49	0.60	1.48	0.038	1	1	1	1	0.031	0.031	0.061	0.026	0.035	2.5	1.43	1.15	57%
1	wi-e-2	90	90	East	3.327	0.838		5		1		1	0.62	0.60	0.95	0.038	1	1	1	1	0.031	0.031	0.061	0.026	0.041	2.8	2.22	0.90	80%
1	wi-e-3	90	90	East	1.219	0.838		4		1		1	0.62	0.60	0.95	0.038	1	1	1	1	0.031	0.031	0.061	0.026	0.038	1.0	0.75	0.98	74%
1	wi-e-4	90	90	East	0.838	1.295		7		1		8	0.62	0.60	0.95	0.038	1	0	1	1	0.031		0.054	0.029	0.037	1.1	0.69	0.95	64%
1	wi-e-5	90	90	East	2.235	1.295		7		1		9	0.62	0.60	0.95	0.038	0	0	1	1			0.054	0.029	0.042	2.9	2.50	0.80	86%
1	wi-e-6	90	90	East	0.838	1.295		7		1		8	0.62	0.60	0.95	0.038	0	1	1	1		0.031	0.054	0.029	0.037	1.1	0.69	0.95	64%
1	wi-e-7	90	90	East	0.838	1.295		8		1		8	0.62	0.60	0.95	0.038	1	0	1	1	0.031		0.054	0.029	0.037	1.1	0.69	0.95	64%
1	wi-e-8	90	90	East	2.159	1.295		8		2		9	0.49	0.60	0.95	0.038	0	0	1	1			0.054	0.029	0.042	2.8	2.41	0.80	86%
1	wi-e-9	90	90	East	0.914	2.286		8		2		8	0.49	0.60	0.95	0.038	0	1	1	1		0.031	0.054	0.029	0.036	2.1	1.50	0.87	72%
1	wi-s-1	180	90	South	0.914	1.259		9		1		2	0.62	0.60	0.95	0.038	1	1	1	1	0.031	0.031	0.061	0.026	0.036	1.2	0.69	0.99	60%
1	wi-s-2	180	90	South	1.372	0.711		9		1		2	0.62	0.60	0.95	0.038	1	1	1	1	0.031	0.031	0.061	0.026	0.039	1.0	0.53	1.05	55%
1	wi-s-3	180	90	South	1.422	0.838		10		1		1	0.62	0.60	0.95	0.038	1	1	1	1	0.031	0.031	0.061	0.026	0.039	1.2	0.89	0.96	75%
1	wi-s-4	180	90	South	2.007	1.295		12		1		7	0.62	0.60	0.95	0.038	1	0	1	1	0.031		0.054	0.029	0.039	2.6	2.20	0.82	85%
1	wi-s-5	180	90	South	0.838	1.295		12		1		8	0.62	0.60	0.95	0.038	0	1	1	1		0.031	0.054	0.029	0.037	1.1	0.69	0.95	64%
1	wi-s-6	180	90	South	1.727	1.295		12		1		1	0.62	0.60	0.95	0.038	1	1	1	1	0.031	0.031	0.054	0.029	0.037	2.2	1.83	0.86	82%
1	wi-s-7	180	90	South	2.896	1.295		12		1		1	0.62	0.60	0.95	0.038	1	1	1	1	0.031	0.031	0.054	0.029	0.038	3.8	3.18	0.82	85%
1	wi-s-8	180	90	South	0.838	1.295		12		1		8	0.62	0.60	0.95	0.038	1	0	1	1	0.031		0.054	0.029	0.037	1.1	0.69	0.95	64%
1	wi-s-9	180	90	South	2.007	1.295		12		1		7	0.62	0.60	0.95	0.038	0	1	1	1		0.031	0.054	0.029	0.039	2.6	2.20	0.82	85%
1	wi-rf-s-10	180	40	South	0.660	0.981		25		3		6	0.44	0.50	1.20	0.043	1	1	1	1	0.080	0.080	0.080	0.080	0.080	0.6	0.39	1.36	60%
1	wi-rf-s-11	180	40	South	0.660	0.981		25		3		6	0.44	0.50	1.20	0.043	1	1	1	1	0.080	0.080	0.080	0.080	0.080	0.6	0.39	1.36	60%
1	wi-rf-s-12	180	40	South	0.660	0.981		25		3		6	0.44	0.50	1.20	0.043	1	1	1	1	0.080	0.080	0.080	0.080	0.080	0.6	0.39	1.36	60%
1	wi-rf-s-13	180	40	South	0.660	0.981		25		3		6	0.44	0.50	1.20	0.043	1	1	1	1	0.080	0.080	0.080	0.080	0.080	0.6	0.39	1.36	60%
1	wi-rf-s-14	180	16	Horizontal	1.141	1.402		26		3		6	0.44	0.50	1.20	0.043	1	1	1	1	0.080	0.080	0.080	0.080	0.080	1.6	1.18	1.06	74%
1	wi-w-1	270	90	West	1.219	0.838		15		1		1	0.62	0.60	0.95	0.038	1	1	1	1	0.031	0.031	0.061	0.026	0.038	1.0	0.75	0.98	74%
1	wi-w-2	270	90	West	0.838	1.295		16		1		8	0.62	0.60	0.95	0.038	1	0	1	1	0.031		0.054	0.029	0.037	1.1	0.69	0.95	64%
1	wi-w-3	270	90	West	2.235	1.295		16		1		9	0.62	0.60	0.95	0.038	0	0	1	1			0.054	0.029	0.042	2.9	2.50	0.80	86%
1	wi-w-4	270	90	West	0.838	1.295		16		1		8	0.62	0.60	0.95	0.038	0	1	1	1		0.031	0.054	0.029	0.037	1.1	0.69	0.95	64%

Glazing inclination ≠ 90°: Please check Ug value manually!

					Window rough openings		Installed		Glazing		Frame		g-Value	U-Value		Ψ-Spacer	Installation									Results (unhide cells to make U- & Ψ-values from WinType worksheet visible)			
Quantity	Description	Deviation from north	Angle of inclination from the horizontal	Orientation	Width	Height	in Area in the Areas worksheet	Nr.	Select glazing from the WinType worksheet	Nr.	Select window from the WinType worksheet	Nr.	Perpendicular Radiation	Glazing	Frames (centre)	Ψ_{spacer} (centre)	Left 1/0	Right 1/0	Bottom 1/0	Top 1/0	$\Psi_{installation}$ left	$\Psi_{installation}$ right	$\Psi_{installation}$ bottom	$\Psi_{installation}$ top	$\Psi_{installation}$ Average value	Window Area	Glazing Area	U-Value Window	Glazed Fraction per Window
		Degrees	Degrees		m	m	Select:		Select:		Select:		-	$W/(m^2K)$	$W/(m^2K)$	W/(mK)					W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	m^2	m^2	$W/(m^2K)$	%
1	wi-w-5	270	90	West	0.838	1.067	w-w-4	16	[illegible]	1	[illegible]	9	0.62	0.60	0.95	0.038	1	0	1	0	0.031		0.054		0.041	0.9	0.71	0.90	80%
1	wi-w-6	270	90	West	2.235	1.067	[illegible]	16	[illegible]	2	[illegible]	10	0.49	0.60	0.95	0.038	0	0	1	0			0.054		0.054	2.4	2.08	0.80	87%
1	wi-w-7	270	90	West	0.838	1.067	[illegible]	16	[illegible]	1	[illegible]	9	0.62	0.60	0.95	0.038	0	1	1	0		0.031	0.054		0.041	0.9	0.71	0.90	80%
1	wi-w-8	270	90	West	0.838	1.219	[illegible]	16	[illegible]	1	[illegible]	11	0.62	0.60	0.95	0.038	1	0	0	1	0.031			0.029	0.030	1.0	0.68	0.90	67%
1	wi-w-9	270	90	West	2.235	1.219	[illegible]	16	[illegible]	1	[illegible]	10	0.62	0.60	0.95	0.038	0	0	0	1				0.029	0.029	2.7	2.41	0.76	89%
1	wi-w-10	270	90	West	0.838	1.219	[illegible]	16	[illegible]	1	[illegible]	11	0.62	0.60	0.95	0.038	0	1	0	1		0.031		0.029	0.030	1.0	0.68	0.90	67%
1	wi-w-11	270	90	West	1.092	2.235	[illegible]	14	[illegible]	2	[illegible]	3	0.49	0.60	1.48	0.038	1	1	1	1	0.031	0.031	0.061	0.026	0.035	2.4	1.39	1.15	57%
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Passive House verification

GLAZING ACCORDING TO CERTIFICATION

Go to curtain wall facades / window frames from line 99 onwards

	Type		
Assem-bly No.	Glazing	g-Value	U_g-Value
			W/(m²K)
1	Triple glazed unit low-e(intus)	0.62	0.60
2	tempered triple glazed unit low-e(intus)	0.49	0.60
3	fakro glazing	0.44	0.50
4			
5			
6			
7			
8			
9			
10			
11			

glazing taken from the final v

fakro glazing taken from ema

Passive House verification

CURTAIN WALL FACADE / WINDOW FRAME AS PER CERTIFICATE

Go to glazing from line 2 onwards

	Type	U_f-Value				Frame Dimensions				Thermal bridges								
Assem-bly No.	Window frame	Frame left	Frame right	Frame bottom	Frame top	Width - Left	Width - Right	Width - Below	Width - Above	Glazing edge thermal bridge				Installation thermal bridge				Curtain wall facades:
	Curtain wall facade	Post left	Post right	Beam bottom	Beam top	Post left	Post right	Beam bottom	Beam top	$\Psi_{Glazing\ edge}$ 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
1	fixed E-forte (intus)	0.95	0.95	0.95	0.95	0.070	0.070	0.070	0.070	0.038	0.038	0.038	0.038	0.040	0.040	0.040	0.040	
2	tilt/turn E-forte (intus)	0.95	0.95	0.95	0.95	0.120	0.120	0.120	0.120	0.038	0.038	0.038	0.038	0.040	0.040	0.040	0.040	
3	prestige door (intus)	1.48	1.48	1.48	1.48	0.176	0.176	0.176	0.176	0.038	0.038	0.038	0.038	0.040	0.040	0.040	0.040	
4	lift & slide (frame + sash)(intus)	1.30	1.30	1.30	1.30	0.167	0.167	0.167	0.167	0.038	0.038	0.038	0.038	0.040	0.040	0.040	0.040	
5	lift & slide (sash only)(intus)	1.30	1.30	1.30	1.30	0.115	0.115	0.115	0.115	0.038	0.038	0.038	0.038	0.040	0.040	0.040	0.040	
6	fakro skylight	1.20	1.20	1.20	1.20	0.089	0.089	0.100	0.075	0.043	0.043	0.043	0.043	0.040	0.040	0.040	0.040	
7	fixed hs E-forte (intus)	0.95	0.95	0.95	0.95	0.035	0.070	0.070	0.070	0.038	0.038	0.038	0.038	0.040	0.040	0.040	0.040	
8	tilt/turn hs E-forte (intus)	0.95	0.95	0.95	0.95	0.060	0.120	0.120	0.120	0.038	0.038	0.038	0.038	0.040	0.040	0.040	0.040	
9	fixed hbs E-forte (intus)	0.95	0.95	0.95	0.95	0.035	0.035	0.070	0.070	0.038	0.038	0.038	0.038	0.040	0.040	0.040	0.040	
10	fixed hbs&b/t E-forte (intus)	0.95	0.95	0.95	0.95	0.035	0.035	0.035	0.070	0.038	0.038	0.038	0.038	0.040	0.040	0.040	0.040	
11	tilt/turn hs/b E-forte (intus)	0.95	0.95	0.95	0.95	0.060	0.120	0.120	0.060	0.038	0.038	0.038	0.038	0.040	0.040	0.040	0.040	

Passive House verification

CALCULATING SHADING FACTORS

Climate: Seattle

Building: Park Passive

Latitude: 47.58 °

Orientation	Glazing area	Reduction factor
	m²	r_S
North	16.33	74%
East	12.91	53%
South	14.47	61%
West	13.32	55%
Horizontal	1.18	97%

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 shading reduction factor	Horizontal shading reduction factor	Reveal Shading Reduction Factor	Overhang shading reduction factor	Total shading reduction factor
		Degrees	Degrees		m	m		m	m	m	m	m	m	%	%	%	%	%
					w_G	h_G	A_G	h_{Hori}	d_{Hori}	o_{Reveal}	d_{Reveal}	o_{over}	d_{over}	r_{other}	r_H	r_R	r_O	r_S
1	wi-n-1	0	90	North	1.28	0.70	0.9	15.00	15.08	0.11	0.013	0.60	0.04		53%	95%	67%	34%
1	wi-n-2	0	90	North	0.70	2.18	1.5	15.00	15.08	0.39	1.623	0.69	0.14		53%	94%	86%	43%
1	wi-n-3	0	90	North	0.80	2.28	1.8			0.39	1.597	0.69	0.14		100%	94%	86%	81%
1	wi-n-4	0	90	North	0.80	2.28	1.8			0.39	1.597	0.69	0.14		100%	94%	86%	81%
1	wi-n-5	0	90	North	0.70	2.18	1.5			0.39	1.616	0.69	0.14		100%	94%	86%	81%
1	wi-n-6	0	90	North	0.30	2.09	0.6			0.35	0.565	0.69	0.05		100%	87%	84%	73%
1	wi-n-7	0	90	North	0.70	1.88	1.3			0.35	0.269	0.69	0.14		100%	85%	84%	71%
1	wi-n-8	0	90	North	0.57	1.15	0.7			0.37	0.184	0.37	0.14	94%	100%	80%	87%	65%
1	wi-n-9	0	90	North	0.67	1.02	0.7			0.15	0.100	0.15	0.100		100%	90%	93%	84%
1	wi-n-10	0	90	North	1.57	1.15	1.8			0.15	0.442	0.15	0.013		100%	96%	93%	90%
1	wi-n-11	0	90	North	0.66	1.06	0.7			0.15	0.882	0.15	0.10		100%	96%	93%	90%
1	wi-n-12	0	90	North	0.98	1.84	1.8			0.37	0.159	0.37	0.14		100%	85%	91%	77%
1	wi-n-13	0	90	North	0.67	1.02	0.7			0.15	0.100	0.15	0.100		100%	90%	93%	84%
1	wi-n-14	0	90	North	0.57	0.70	0.4			0.37	0.185	0.37	0.14		100%	80%	81%	65%
1	wi-e-1	90	90	East	0.74	1.93	1.4	13.68	20.83	0.35	0.178	0.35	0.178		57%	77%	92%	40%
1	wi-e-2	90	90	East	3.19	0.70	2.2	12.09	18.81	0.11	0.013	0.60	0.04		58%	97%	65%	37%
1	wi-e-3	90	90	East	1.08	0.70	0.8	10.53	20.77	0.35	0.013	0.35	0.013		64%	77%	77%	38%
1	wi-e-4	90	90	East	0.66	1.06	0.7	9.71	18.33	0.15	1.581	0.15	0.10		63%	97%	93%	57%
1	wi-e-5	90	90	East	2.16	1.15	2.5	9.76	18.33	0.15	0.870	0.15	0.013		63%	97%	93%	56%
1	wi-e-6	90	90	East	0.66	1.06	0.7	9.71	18.33	0.15	1.581	0.15	0.10		63%	97%	93%	57%
1	wi-e-7	90	90	East	0.66	1.06	0.7	6.74	20.77	0.15	1.581	0.15	0.10		75%	97%	93%	67%
1	wi-e-8	90	90	East	2.09	1.15	2.4	6.74	20.77	0.15	0.899	0.15	0.013		75%	97%	93%	67%
1	wi-e-9	90	90	East	0.73	2.05	1.5	7.68	20.77	0.15	1.581	0.15	0.10		72%	97%	96%	67%
1	wi-s-1	180	90	South	0.67	1.02	0.7	8.10	2.44	0.35	0.100	0.35	0.100		9%	84%	92%	7%
1	wi-s-2	180	90	South	1.13	0.47	0.5	6.07	5.64	0.35	0.100	0.35	0.100		28%	89%	85%	22%
1	wi-s-3	180	90	South	1.28	0.70	0.9	5.86	8.56	0.11	0.013	0.60	0.04		52%	96%	78%	39%
1	wi-s-4	180	90	South	1.90	1.15	2.2	2.34	4.96	0.15	0.442	0.15	0.013		70%	98%	96%	66%
1	wi-s-5	180	90	South	0.66	1.06	0.7	2.29	4.96	0.15	1.047	0.15	0.10		71%	97%	96%	67%
1	wi-s-6	180	90	South	1.59	1.15	1.8	2.34	4.96	0.15	0.013	0.15	0.013		70%	96%	96%	65%
1	wi-s-7	180	90	South	2.76	1.15	3.2	2.34	4.96	0.15	0.013	0.15	0.013		70%	98%	96%	66%
1	wi-s-8	180	90	South	0.66	1.06	0.7	2.29	4.96	0.15	1.047	0.15	0.10		71%	97%	96%	67%
1	wi-s-9	180	90	South	1.90	1.15	2.2	0.51	8.16	0.15	0.442	0.15	0.013		99%	98%	96%	93%
1	wi-rf-s-10	180	40	South	0.48	0.81	0.4	3.87	3.43	0.03	0.03	0.03	0.03		40%	96%	99%	39%
1	wi-rf-s-11	180	40	South	0.48	0.81	0.4	3.87	3.43	0.03	0.03	0.03	0.03		40%	96%	99%	39%
1	wi-rf-s-12	180	40	South	0.48	0.81	0.4	3.87	3.43	0.03	0.03	0.03	0.03		40%	96%	99%	39%
1	wi-rf-s-13	180	40	South	0.48	0.81	0.4	3.87	3.43	0.03	0.03	0.03	0.03		40%	96%	99%	39%
1	wi-rf-s-14	180	16	Horizontal	0.96	1.23	1.2			0.03	0.03	0.03	0.03		100%	98%	100%	97%
1	wi-w-1	270	90	West	1.08	0.70	0.8	4.90	8.59	0.35	0.013	0.35	0.013		61%	77%	77%	36%
1	wi-w-2	270	90	West	0.66	1.06	0.7	4.09	4.93	0.15	1.587	0.15	0.10	91%	50%	97%	93%	41%
1	wi-w-3	270	90	West	2.16	1.15	2.5	4.14	4.93	0.15	0.883	0.15	0.013	91%	50%	97%	93%	40%
1	wi-w-4	270	90	West	0.66	1.06	0.7	4.09	4.93	0.15	1.587	0.15	0.10	91%	50%	97%	93%	41%
1	wi-w-5	270	90	West	0.77	0.93	0.7	2.11	4.93	0.15	1.524	0.15	1.25	91%	68%	97%	98%	59%
1	wi-w-6	270	90	West	2.16	0.96	2.1	2.11	4.93	0.15	0.883	0.15	1.25	91%	68%	97%	98%	59%
1	wi-w-7	270	90	West	0.77	0.93	0.7	2.11	4.93	0.15	1.524	0.15	1.25	91%	68%	97%	98%	59%
1	wi-w-8	270	90	West	0.66	1.04	0.7	1.07	4.93	0.15	1.587	0.15	0.10	92%	82%	97%	93%	68%

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 shading reduction factor	Horizontal shading reduction factor	Reveal Shading Reduction Factor	Overhang shading reduction factor	Total shading reduction factor
		Degrees	Degrees		m	m		m	m	m	m	m	m	%	%	%	%	%
					w_G	h_G	A_G	h_{Hori}	d_{Hori}	o_{Reveal}	d_{Reveal}	o_{over}	d_{over}	r_{other}	r_H	r_R	r_O	r_S
1	wi-w-9	270	90	West	2.16	1.11	2.4	1.12	4.93	0.15	0.883	0.15	0.013	92%	81%	97%	93%	67%
1	wi-w-10	270	90	West	0.66	1.04	0.7	1.07	4.93	0.15	1.587	0.15	0.10	92%	82%	97%	93%	68%
1	wi-w-11	270	90	West	0.74	1.88	1.4			0.35	0.178	0.35	0.178		100%	77%	92%	71%

Passive House verification

VENTILATION DATA

Building: Park Passive

Treated floor area A_{TFA}		m²	182	*(Areas worksheet)*
Room height h		m	2.5	*(Annual Heating Demand worksheet)*
Room ventilation volume (A_{TFA}*h) =	V_V	m³	454	*(Annual Heating Demand worksheet)*

Type of ventilation system

x	Balanced PH ventilation	*Please Check*
	Pure extract air	

Infiltration air change rate

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

			for Annual Demand:	for Heating Load:	Net Air Volume for Press. Test	V_{n50}	Air permeability	q_{50}
Wind protection coefficient, e			0.07	0.18				
Wind protection coefficient, f			15	15				
Air Change Rate at Press. Test	n_{50}	1/h	0.60	0.60	537	m³	0.50	m³/(hm²)

			for Annual Demand:	for Heating Load:
Excess extract air		1/h	0.00	0.00
Infiltration air change rate	$n_{V,Res}$	1/h	0.050	0.124

Selection of ventilation data input - Results

The PHPP offers two methods for dimensioning the air quantities and choosing the ventilation unit. Fresh air or extract air quantities for residential buildings and parameters for ventilation can be determined using the standard planning option in the 'Ventilation' sheet. The 'Additional Vent' sheet has been created for more complex ventilation systems and allows up to 10 diff Furthermore, air quantities can be determined on a room-by-room or zone-by-zone basis. Please select your design method here.

	Ventilation unit / Heat recovery efficiency design		Mean Air exchange m³/h	Mean Air Change Rate 1/h	Extract air excess (Extract air system) 1/h	Effective heat recovery efficiency Unit [-]	Specific power input Wh/m³	Heat recovery efficiency SHX
x	Sheet Ventilation (Standard design)	*(Sheet Ventilation see below)*						
	Sheet Extended ventilation	*(Sheet Additional Vent)*						
	(Multiple ventilation units, non-residential buildings)		139	0.31	0.00	80.9%	0.29	0.0%

SHX efficiency η^*_{SHX} 0%

STANDARD INPUT FOR BALANCED VENTILATION

Ventilation dimensioning for systems with one ventilation unit

Occupancy	m²/P	35				
Number of occupants	P	5.2				
Supply air per person	m³/(P*h)	30				
Supply air requirement	m³/h	156		Bathroom		
Extract air rooms		Kitchen	Bathroom	(shower only)	WC	mech room
Quantity		1	2	1		1
Extract air requirement per room	m³/h	60	40	20	20	20
Total Extract Air Requirement	m³/h	180				

Design air flow rate (maximum) m³/h: 180

Average air change rate calculation

Type of operation	Daily operation duration h/d	Factors referenced to maximum	Air flow rate m³/h	Air change rate 1/h
Maximum		1.00	180	0.40
Standard	24.0	0.77	139	0.31
Basic		0.54	97	0.21
Minimum		0.40	72	0.16
	Average value	0.77	Average air flow rate (m³/h): 139	Average air change rate (1/h): 0.31

Selection of ventilation unit with heat recovery

x	Central unit within the thermal envelope.
	Central unit outside of the thermal envelope.

Ventilation unit selection	Heat recovery efficiency Unit η_{HR}	Specific power input [Wh/m³]	Application range [m³/h]	Frost protection required	Unit noise level < 35dB(A)
ComfoAir 350 - Zehnder	0.84	0.29	71 - 293	yes	no

Conductance value of outdoor air duct Ψ	W/(mK)	0.719	See calculation below
Length of outdoor air duct	m	1	
Conductance value of exhaust air duct Ψ	W/(mK)	0.719	See calculation below
Length of exhaust air duct	m	1.5	
Temperature of mechanical services room (Enter only if the central unit is outside of the thermal envelope.)	°C		

Room Temperature (°C)	20
Av. Ambient Temp. Heating P. (°C)	7.7
Av. Ground Temp (°C)	11.7

Effective heat recovery efficiency $\eta_{HR,eff}$: **80.9%**

Effective heat recovery efficiency subsoil heat exchanger

SHX efficiency	η^*_{SHX}	
Heat recovery efficiency SHX	η_{SHX}	0%

Secondary calculation

Ψ-value supply or ambient air duct

Nominal width:	160	mm
Insul. Thickness	15	mm
Reflective? Please mark with an "x"!		
x Yes		
No		
Thermal conductivity	0.042	W/(mK)
Nominal air flow rate	139	m³/h
Δϑ	12	K
Exterior duct diameter	0.160	m
Exterior diameter	0.190	m
α-Interior	9.35	W/(m²K)
α–Surface	3.18	W/(m²K)
Ψ-value	**0.719**	**W/(mK)**
Surface temperature difference	4.643	K

Secondary calculation

Ψ-value extract or exhaust air duct

Nominal width:	160	mm
Insul. Thickness:	15	mm
Reflective? Please mark with an "x"!		
x Yes		
No		
Thermal conductivity	0.042	W/(mK)
Nominal air flow rate	139	m³/h
Δϑ	12	K
Exterior duct diameter	0.160	m
Exterior diameter	0.190	m
α-Interior	9.35	W/(m²K)
α–Surface	3.18	W/(m²K)
Ψ-value	**0.719**	**W/(mK)**
Surface temperature difference	4.643	K

Passive House verification

SPECIFIC ANNUAL HEATING DEMAND

Climate: Seattle
Building: Park Passive

Interior Temperature: 20.0 °C
Building Type/Use: Single Family Residenti
Treated Floor Area A_{TFA}: 181.7 m²

Building Element	Temperature Zone	Area m²		U-Value W/(m²K)		Temp. Factor f_t		G_t kKh/a		kWh/a	per m² Treated Floor Area
Exterior Wall - Ambient	A	334.5	*	0.104	*	1.00	*	64.9	=	2253	12.40
Exterior Wall - Ground	B		*		*	0.74	*		=		
Roof/Ceiling - Ambient	A	142.0	*	0.097	*	1.00	*	64.9	=	895	4.92
Floor slab / basement ceiling	B	84.6	*	0.048	*	0.74	*	64.9	=	194	1.07
	A		*		*	1.00	*		=		
	A		*		*	1.00	*		=		
	X		*		*	0.75	*		=		
Windows	A	79.9	*	0.942	*	1.00	*	64.9	=	4888	26.91
Exterior Door	A		*		*	1.00	*		=		
Exterior TB (length/m)	A	138.7	*	-0.053	*	1.00	*	64.9	=	-476	-2.62
Perimeter TB (length/m)	P	40.0	*	0.038	*	0.74	*	64.9	=	73	0.40
Ground TB (length/m)	B		*		*	0.74	*		=		
Total of All Building Envelope Areas		641.1									kWh/(m²a)

Transmission Heat Losses Q_T — Total: 7826 kWh/a; 43.1 kWh/(m²a)

Ventilation System:

		A_{TFA} m²		Clear Room Height m	=	m^3
Effective Air Volume, V_V		181.7	*	2.50	=	454.1
Effective Heat Recovery Efficiency	η_{eff} 81%					
of Heat Recovery						
Efficiency of Subsoil Heat Exchanger	η_{SHX} 0%					

	$n_{V,system}$ 1/h		Φ_{HR}	+	$n_{V,Res}$ 1/h	=	1/h
Energetically Effective Air Exchange n_v	0.305	* (1 -	0.81	) +	0.050	=	0.108

Ventilation Heat Losses Q_V

V_V m³		n_V 1/h		c_{Air} Wh/(m³K)		G_t kKh/a	=	kWh/a	kWh/(m²a)
454	*	0.108	*	0.33	*	64.9	=	1049	5.8

Total Heat Losses Q_L

	Q_T kWh/a		Q_V kWh/a		Reduction Factor Night/Weekend Saving	=	kWh/a	kWh/(m²a)
	(7826	+	1049	)	1.0	=	8875	48.9

Available Solar Heat Gains Q_S

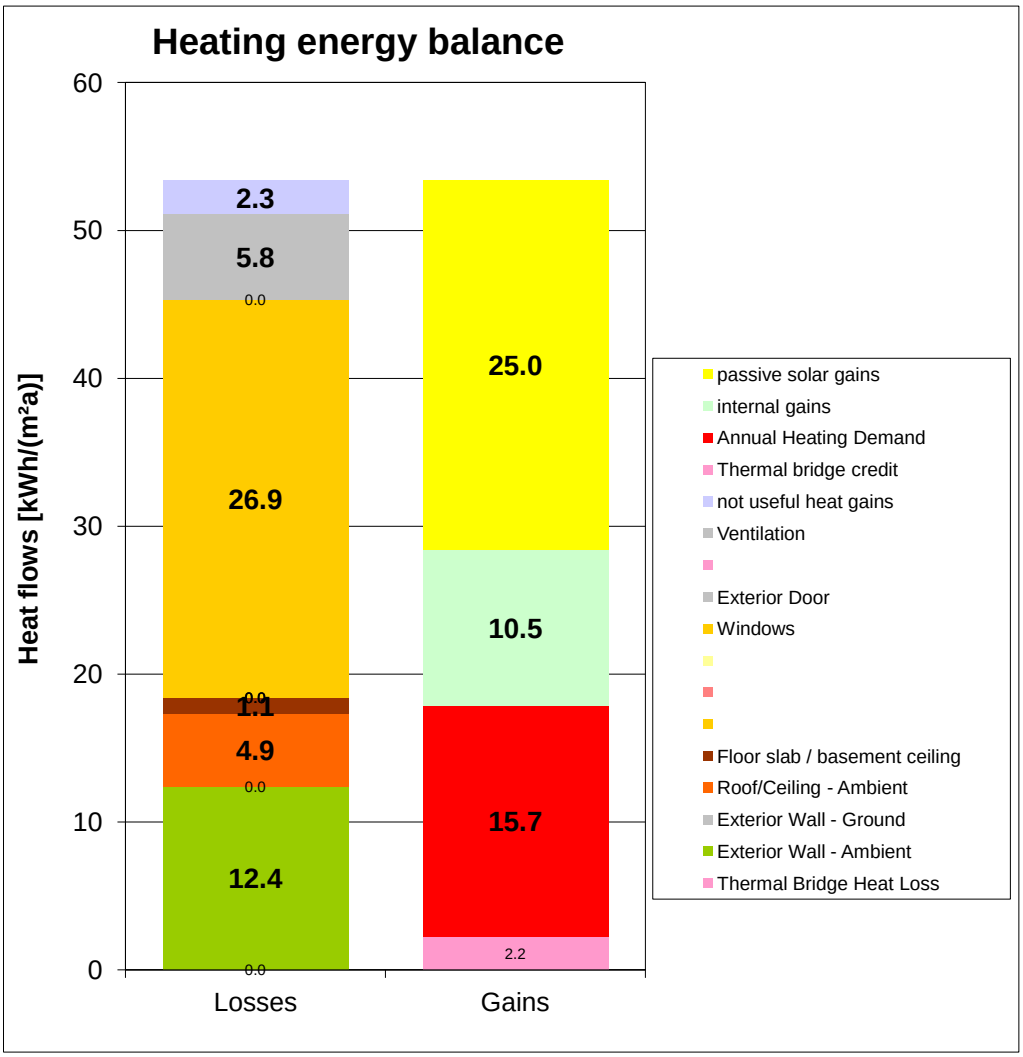
Orientation of the Area	Reduction Factor See Windows Sheet		g-Value (perp. radiation)		Area m²		Radiation HP kWh/(m²a)	=	kWh/a	kWh/(m²a)
1. North	0.40	*	0.53	*	24.24	*	115	=	595	
2. East	0.32	*	0.57	*	17.34	*	257	=	811	
3. South	0.37	*	0.60	*	19.26	*	469	=	2011	
4. West	0.34	*	0.59	*	17.47	*	264	=	922	
5. Horizontal	0.58	*	0.44	*	1.60	*	495	=	202	
							Total		4541	kWh/(m²a) 25.0

Internal Heat Gains Q_I

kh/d		Length Heat. Period d/a		Spec. Power q_I W/m²		A_{TFA} m²	=	kWh/a	kWh/(m²a)
0.024	*	208	*	2.10	*	181.7	=	1907	10.5

		=	kWh/a	kWh/(m²a)
Free Heat Q_F	Q_S + Q_I	=	6448	35.5
Ratio of Free Heat to Losses	Q_F / Q_L	=	0.73	
Utilisation Factor Heat Gains η_G	$(1 - (Q_F / Q_L)^5) / (1 - (Q_F / Q_L)^6)$	=	94%	
Heat Gains Q_G	η_G * Q_F	=	6030	33.2
Annual Heating Demand QH	Q_L - Q_G	=	2846	16

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


Heating energy balance
Heat flows [kWh/(m²a)]
60
50
40
30
20
10
0
2.3
5.8
0.0
26.9
0.0
1.1
4.9
0.0
12.4
0.0
25.0
10.5
15.7
2.2
Losses
Gains
passive solar gains
internal gains
Annual Heating Demand
Thermal bridge credit
not useful heat gains
Ventilation
Exterior Door
Windows
Floor slab / basement ceiling
Roof/Ceiling - Ambient
Exterior Wall - Ground
Exterior Wall - Ambient
Thermal Bridge Heat Loss

Passive House verification

SPECIFIC ANNUAL HEATING DEMAND
MONTHLY METHOD

(This page displays the sums of the monthly method over the heating period)

Climate: Seattle
Building: Park Passive
Spec. Capacity: 132 Wh/(m²K) (Enter in "Summer" worksheet.)

Interior Temperature: 20 °C
Building Type/Use: Single Family Residential
Treated Floor Area A_{TFA}: 181.7 m²

Building Element	Temperature Zone	Area m²		U-Value W/(m²K)		Month. Red. Fac.		G_t kKh/a		kWh/a	per m² Treated Floor Area
Exterior Wall - Ambient	A	334.5	*	0.104	*	1.00	*	70	=	2416	
Exterior Wall - Ground	B		*		*	1.00	*		=		
Roof/Ceiling - Ambient	A	142.0	*	0.097	*	1.00	*	70	=	959	
Floor slab / basement ceiling	B	84.6	*	0.048	*	1.00	*	55	=	223	
	A		*		*	1.00	*		=		
	A		*		*	1.00	*		=		
	X		*		*	0.75	*		=		
Windows	A	79.9	*	0.942	*	1.00	*	70	=	5241	
Exterior Door	A		*		*	1.00	*		=		
Exterior TB (length/m)	A	138.7	*	-0.053	*	1.00	*	70	=	-511	
Perimeter TB (length/m)	P	40.0	*	0.038	*	1.00	*	55	=	84	
Ground TB (length/m)	B		*		*	1.00	*		=		

Transmission Heat Losses Q_T — Total: 8413 kWh/a; 46.3 kWh/(m²a)

Effective Air Volume V_{RAX}: A_{TFA} 182 m² * Clear Room Height 2.50 m = 454 m³

	$n_{V,system}$ 1/h		η*$_{SHX}$		η_{HR}		$n_{V,Res}$ 1/h		$n_{V,equi,fraction}$ 1/h
Effective Air Change Rate Ambient $n_{v,e}$	0.305	*(1-	0%	)*(1-	0.81	)+	0.050	=	0.108
Effective Air Change Rate Ground $n_{V,g}$	0.305	*	0%	*(1-	0.81	)		=	0.000

	V_{RAX} m³		$n_{V,equi,fraction}$ 1/h		c_{Air} Wh/(m³K)		G_t kKh/a		kWh/a	kWh/(m²a)
Ventilation Losses Ambient Q_V	454	*	0.108	*	0.33	*	70	=	1125	6.2
Ventilation Losses Ground $Q_{V,e}$	454	*	0.000	*	0.33	*	48	=	0	0.0

Ventilation Heat Losses Q_V — Total: 1125 kWh/a; 6.2 kWh/(m²a)

Total Heat Losses Q_L = (Q_T 8413 kWh/a + Q_V 1125 kWh/a) * Reduction Factor Night/Weekend Saving 1.0 = 9538 kWh/a; 52.5 kWh/(m²a)

Orientation of the Area	Reduction Factor See Windows worksheet		g-Value (perp. radiation)		Area m²		Global Radiation kWh/(m²a)		kWh/a
North	0.40	*	0.53	*	24.2	*	160	=	829
East	0.32	*	0.57	*	17.3	*	358	=	1127
South	0.37	*	0.60	*	19.3	*	611	=	2618
West	0.34	*	0.59	*	17.5	*	368	=	1285
Horizontal	0.58	*	0.44	*	1.6	*	677	=	277
Sum Opaque Areas									0

Available Solar Heat Gains Q_S — Total: 6136 kWh/a; 33.8 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	*	2.1	*	181.7	=	2225	12.2

Free Heat Q_F: Q_S + Q_I = 8361 kWh/a; 46.0 kWh/(m²a)

Ratio Free Heat to Losses: Q_F / Q_L = 0.88

Utilisation Factor Heat Gains η_G = 82%

Heat Gains Q_G: η_G * Q_F = 6818 kWh/a; 37.5 kWh/(m²a)

Annual Heating Demand QH: Q_L - Q_G = 2720 kWh/a; 15 kWh/(m²a)

Limiting Value: 15 kWh/(m²a)

Requirement met? yes (Yes/No)

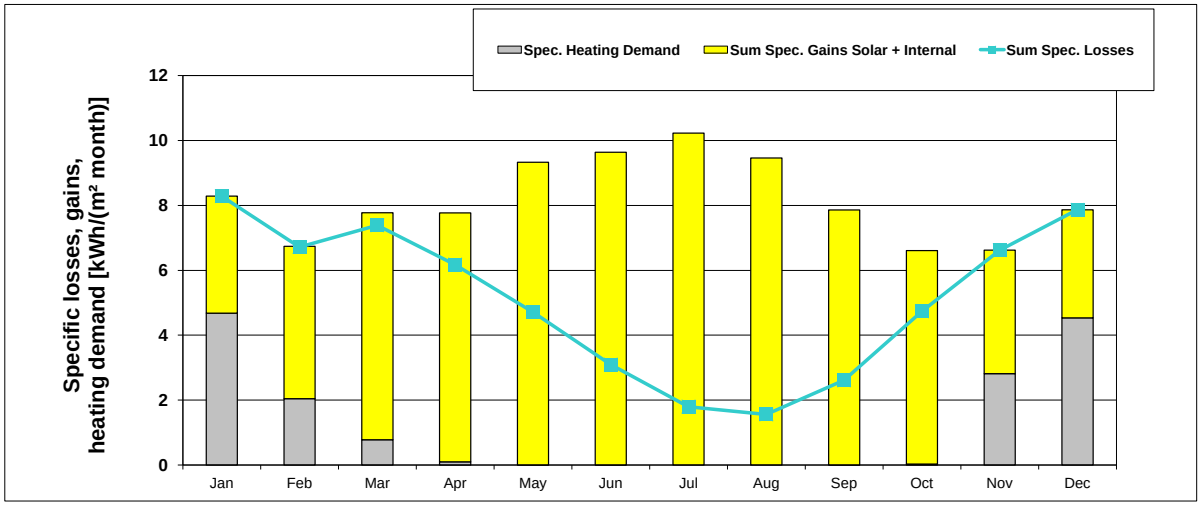
Passive House verification

SPECIFIC ANNUAL HEAT DEMAND
MONTHLY METHOD

Climate: Seattle
Building: Park Passive

Interior Temperature: 20 °C
Building Type/Use: Single Family Residential
Treated Floor Area A_{TFA}: 182 m²

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Heating Degree Hours - E	11.0	8.9	9.7	8.1	6.2	4.0	2.3	2.0	3.5	6.3	8.9	10.5	81	kKh
Heating Degree Hours - G	8.1	8.0	8.8	7.8	6.7	5.0	3.7	3.0	2.9	3.9	5.1	6.8	70	kKh
Losses - Exterior	1460	1176	1292	1079	819	535	306	266	458	839	1174	1391	10796	kWh
Losses - Ground	45	45	49	43	37	28	21	17	16	22	28	38	388	kWh
Sum Spec. Losses	8.3	6.7	7.4	6.2	4.7	3.1	1.8	1.6	2.6	4.7	6.6	7.9	61.6	kWh/m²
Solar Gains - North	42	73	124	155	244	259	254	192	140	98	57	36	1675	kWh
Solar Gains - East	60	98	181	209	306	328	347	319	231	155	67	51	2353	kWh
Solar Gains - South	201	294	433	418	451	438	492	523	478	443	208	171	4548	kWh
Solar Gains - West	55	107	205	282	338	373	397	327	250	177	69	52	2632	kWh
Solar Gains - Horiz.	14	24	44	56	72	78	84	74	54	38	17	12	566	kWh
Solar Gains - Opaque	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Internal Heat Gains	284	256	284	275	284	275	284	284	275	284	275	284	3342	kWh
Sum Spec. Gains Solar +	3.6	4.7	7.0	7.7	9.3	9.6	10.2	9.5	7.9	6.6	3.8	3.3	83.2	kWh/m²
Utilisation Factor	100%	100%	94%	79%	51%	32%	18%	16%	33%	72%	100%	100%	56%	
Annual Heating Demand	850	371	141	18	0	0	0	0	0	5	511	824	2720	kWh
Spec. Heating Demand	**4.7**	**2.0**	**0.8**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.8**	**4.5**	**15.0**	kWh/m²



Passive House verification

SPECIFIC SPACE HEATING LOAD

Building: Park Passive
Climate (HL): Seattle
Building Type/Use: Single Family Residential
Treated Floor Area A_{TFA}: 181.7 m² Interior Temperature: 20 °C

	Design Temperature		Radiation:	North	East	South	West	Horizontal	
Weather Condition 1:	-1.6	°C		25	50	75	35	55	W/m²
Weather Condition 2:	0.8	°C		10	10	15	10	15	W/m²
Ground Design Temp.	8.1	°C							

	Building Element	Temperature Zone	Area m²		U-Value W/(m²K)		Factor Always 1 (except "X")		TempDiff 1 K		TempDiff 2 K		P_T 1 W		P_T 2 W
1.	Exterior Wall - Ambient	A	334.5	*	0.104	*	1.00	*	21.6	or	19.2	=	750	or	668
2.	Exterior Wall - Ground	B		*		*	1.00	*	11.9	or	11.9	=		or	
3.	Roof/Ceiling - Ambient	A	142.0	*	0.097	*	1.00	*	21.6	or	19.2	=	298	or	265
4.	Floor slab / basement ceiling	B	84.6	*	0.048	*	1.00	*	11.9	or	11.9	=	48	or	48
5.		A		*		*	1.00	*	21.6	or	19.2	=		or	
6.		A		*		*	1.00	*	21.6	or	19.2	=		or	
7.		X		*		*	0.75	*	21.6	or	19.2	=		or	
8.	Windows	A	79.9	*	0.942	*	1.00	*	21.6	or	19.2	=	1626	or	1448
9.	Exterior Door	A		*		*	1.00	*	21.6	or	19.2	=		or	
10.	Exterior TB (length/m)	A	138.7	*	-0.053	*	1.00	*	21.6	or	19.2	=	-158	or	-141
11.	Perimeter TB (length/m)	P	40.0	*	0.038	*	1.00	*	11.9	or	11.9	=	18	or	18
12.	Ground TB (length/m)	B		*		*	1.00	*	11.9	or	11.9	=		or	
13.	House/DU Partition Wall	I		*		*	1.00	*	3.0	or	3.0	=		or	

Transmission Heat Losses P_T

Total = 2581 or 2306

Ventilation System:

	A_{TFA} m²		Clear Room Height m		m³		η_{SHX} 1		η_{SHX} 2
Effective Air Volume, V_V	181.7	*	2.50	=	454				
Efficiency of Heat Recovery of the Heat Exchanger η_{HR} 81%	Heat Recovery Efficiency SHX		0%		Efficiency SHX		0%	or	0%

	n_V,Res (Heating Load) 1/h		$n_{V,system}$ 1/h		Φ_{HR}		Φ_{HR}		1/h		1/h
Energetically Effective Air Exchange n_v	0.124	+	0.305	*(1-	0.81	or	0.81	) =	0.182	or	0.182

Ventilation Heating Load P_V

V_L m³		n_L 1/h		n_L 1/h		c_{Air} Wh/(m³K)		TempDiff 1 K		TempDiff 2 K		P_V 1 W		P_V 2 W
454.1	*	0.182	or	0.182	*	0.33	*	21.6	or	19.2	=	590	or	525

Total Heating Load P_L

$P_T + P_V$ = 3172 or 2831

	Orientation the Area	Area m²		g-Value (perp. radiation)		Reduction Factor (see Windows worksheet)		Radiation 1 W/m²		Radiation 2 W/m²		P_S 1 W		P_S 2 W
1.	North	24.2	*	0.5	*	0.4	*	25	or	10	=	130	or	52
2.	East	17.3	*	0.6	*	0.3	*	50	or	10	=	158	or	32
3.	South	19.3	*	0.6	*	0.4	*	76	or	16	=	326	or	67
4.	West	17.5	*	0.6	*	0.3	*	35	or	10	=	121	or	35
5.	Horizontal	1.6	*	0.4	*	0.6	*	68	or	18	=	28	or	7

Solar heating power P_S

Total = 763 or 192

Internal heating power P_I

Spec. Power W/m²		A_{TFA} m²		P_I 1 W		P_I 2 W
1.6	*	182	=	291	or	291

Heating power (gains) P_G

	P_G 1 W		P_G 2 W
$P_S + P_I$ =	1054	or	483
$P_L - P_G$ =	2118	or	2348

Heating Load P_H = 2348 W

Specific Heating Load P_H / A_{TFA} = 12.9 W/m²

Input Max. Supply Air Temperature		°C		°C		°C
Max. Supply Air Temperature $\vartheta_{Supply,Max}$	52	°C	Supply Air Temperature Without Heating $\vartheta_{Supply,Min}$	15.9		16.3

For Comparison: Heating Load Transportable by Supply Air. $P_{Supply\ Air,Max}$ = 1631 W specific: 9.0 W/m²

Supply Air Heating Sufficient? (Yes/No) No

Passive House verification

S U M M E R

Climate: Seattle
Building: Park Passive

Interior Temperature: 20 °C
Building Type/Use: Single Family Residential
Treated Floor Area A_{TFA}: 181.7 m²

Spec. Capacity: 132 Wh/K pro m² TFA
Overheating limit: 25 °C

	Building Element	Temperature Zone	Area m²		U-Value W/(m²K)		Red. Factor $f_{T,Summer}$		H_{Summer} Heat Conductance
1.	Exterior Wall - Ambier	A	334.5	*	0.104	*	1.00	=	34.7
2.	Exterior Wall - Ground	B		*		*	1.00	=	
3.	Roof/Ceiling - Ambient	A	142.0	*	0.097	*	1.00	=	13.8
4.	Floor slab / basement	B	84.6	*	0.048	*	1.00	=	4.0
5.		A		*		*	1.00	=	
6.		A		*		*	1.00	=	
7.		X		*		*	0.75	=	
8.	Windows	A	79.9	*	0.942	*	1.00	=	75.3
9.	Exterior Door	A		*		*	1.00	=	
10.	Exterior TB (length/m)	A	138.7	*	-0.053	*	1.00	=	-7.3
11.	Perimeter TB (length/m	P	40.0	*	0.038	*	1.00	=	1.5
12.	Ground TB (length/m)	B		*		*	1.00	=	

Exterior Thermal Transmittance, $H_{T,e}$ 116.5 W/K
Ground Thermal Transmittance, $H_{T,g}$ 5.6 W/K

			A_{TFA} m²		Clear Room Height m		m³
Heat Recovery Efficiency	η_{HR}	81%	Effective Air Volume V_v	181.7	*	2.50	= 454
SHX Efficiency	η^*_{SHX}	0%					

Summer Ventilation

continuous ventilation to provide sufficient indoor air quality

Air Change Rate by Natural (Windows & Leakages) or Exhaust-Only Mechanical Ventilation, Summer: 0.10 1/h

Mechanical Ventilation Summer: 0.31 1/h [ ] with HR (check if applicable)

	$n_{L,nat}$ 1/h		$n_{V,system}$ 1/h		Φ_{HR}		$n_{V,Rest}$ 1/h		1/h
Energetically Effective Airchange Rate n_V	0.101	+	0.305	* (1 -	0.000	) +	0.000	=	0.406

	V_V m³		$n_{V,equi,fraction}$ 1/h		c_{Air} Wh/(m³K)			
Ventilation Transm. Ambient $H_{V,e}$	454	*	0.406	*	0.33	=	60.9	W/K
Ventilation Transm. Ground $H_{V,g}$	454	*	0.000	*	0.33	=	0.0	W/K

Additional Summer Ventilation for Cooling Temperature amplitude summer 10.4 K

Select: [ ] Window Night Ventilation, Manual
[x] Mechanical, Automatically Controlled Ventilation

Corresponding Air Change Rate [ ] 1/h
(for window ventilation: at 1 K temperature difference indoor - outdoor)

Minimum Acceptable Indoor Temperature 22.0 °C

	Orientation of the Area	Angle Factor Summer		Shading Factor Summer		Dirt		g-Value (perp. radiation)		Area m²		Portion of Glazing		Aperture m²
1.	North	0.9	*	0.78	*	0.95	*	0.53	*	24.2	*	67%	=	5.8
2.	East	0.9	*	0.63	*	0.95	*	0.57	*	17.3	*	74%	=	3.9
3.	South	0.9	*	0.71	*	0.95	*	0.60	*	19.3	*	75%	=	5.2
4.	West	0.9	*	0.41	*	0.95	*	0.59	*	17.5	*	76%	=	2.7
5.	Horizontal	0.9	*	0.98	*	0.95	*	0.44	*	1.6	*	74%	=	0.4
6	Sum Opaque Areas													0.0

Solar Aperture Total 18.1 m² | 0.10 m²/m²

	Specif. Power q_{I} W/m²		A_{TFA} m²		W	W/m²
Internal Heat Gains Q_I	2.10	*	182	=	381	2.1

Frequency of Overheating $h_{\vartheta \geq \vartheta max}$ **36.3%** **at the overheating limit ϑ_{max} = 25 °C**

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

Caution: Large daily temperature swing. Calculation of overheating frequency is not reliable.

	Solar Load kWh/d		1/k		Spec. Capacity Wh/(m²K)		A_{TFA} m²		K
Daily Temperature Swing due to Solar Load	76.6	*	1000	/ (	132	*	182	) =	3.2

Passive House verification

CALCULATING SUMMER SHADING FACTORS

Climate: Seattle

Building: Park Passive

Latitude: 47.58

Summer

Orientation	Glazing area m^2	Summer shading factor r_s
North	16.33	78%
East	12.91	63%
South	14.47	71%
West	13.32	41%
Horizontal	1.18	98%

Results from the Summer worksheet:

Frequency of Overheating $h_{\vartheta \geq \vartheta max}$ **36.3%**

															Input Field Summer	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 Shading Reduction Factor (Summer)	Reduction factor z for temporary sun protection	Horizontal Shading Reduction Factor	Reveal Shading Reduction Factor	Overhang Shading Reduction Factor	Total Summer Shading Reduction Factor
		Degrees	Degrees			m		m	m	m	m	m	m	%	%	%	%	%	%
					w_G	h_G	A_G	h_{Hori}	d_{Hori}	o_{Reveal}	d_{Reveal}	o_{over}	d_{over}	r_{other}	z	r_H	r_R	r_O	r_S
1	wi-n-1	0	90	North	1.28	0.70	0.9	15.00	15.08	0.11	0.01	0.60	0.04	100%		57%	95%	67%	36%
1	wi-n-2	0	90	North	0.70	2.18	1.5	15.00	15.08	0.39	1.62	0.69	0.14	100%		57%	94%	91%	49%
1	wi-n-3	0	90	North	0.80	2.28	1.8			0.39	1.60	0.69	0.14	100%		100%	95%	91%	86%
1	wi-n-4	0	90	North	0.80	2.28	1.8			0.39	1.60	0.69	0.14	100%		100%	95%	91%	86%
1	wi-n-5	0	90	North	0.70	2.18	1.5			0.39	1.62	0.69	0.14	100%		100%	94%	91%	86%
1	wi-n-6	0	90	North	0.30	2.09	0.6			0.35	0.57	0.69	0.05	100%		100%	88%	89%	78%
1	wi-n-7	0	90	North	0.70	1.88	1.3			0.35	0.27	0.69	0.14	100%		100%	86%	89%	76%
1	wi-n-8	0	90	North	0.57	1.15	0.7			0.37	0.18	0.37	0.14	62%		100%	81%	92%	47%
1	wi-n-9	0	90	North	0.67	1.02	0.7			0.15	0.10	0.15	0.10	100%		100%	91%	98%	89%
1	wi-n-10	0	90	North	1.57	1.15	1.8			0.15	0.44	0.15	0.01	100%		100%	96%	98%	94%
1	wi-n-11	0	90	North	0.66	1.06	0.7			0.15	0.88	0.15	0.10	100%		100%	96%	98%	94%
1	wi-n-12	0	90	North	0.98	1.84	1.8			0.37	0.16	0.37	0.14	100%		100%	86%	96%	82%
1	wi-n-13	0	90	North	0.67	1.02	0.7			0.15	0.10	0.15	0.10	100%		100%	91%	98%	89%
1	wi-n-14	0	90	North	0.57	0.70	0.4			0.37	0.18	0.37	0.14	100%		100%	81%	85%	70%
1	wi-e-1	90	90	East	0.74	1.93	1.4	13.68	20.83	0.35	0.18	0.35	0.18	100%		65%	91%	96%	57%
1	wi-e-2	90	90	East	3.19	0.70	2.2	12.09	18.81	0.11	0.01	0.60	0.04	100%		65%	99%	60%	39%
1	wi-e-3	90	90	East	1.08	0.70	0.8	10.53	20.77	0.35	0.01	0.35	0.01	100%		71%	91%	76%	49%
1	wi-e-4	90	90	East	0.66	1.06	0.7	9.71	18.33	0.15	1.58	0.15	0.10	100%		70%	99%	98%	68%
1	wi-e-5	90	90	East	2.16	1.15	2.5	9.76	18.33	0.15	0.87	0.15	0.01	100%		70%	99%	97%	67%
1	wi-e-6	90	90	East	0.66	1.06	0.7	9.71	18.33	0.15	1.58	0.15	0.10	100%		70%	99%	98%	68%
1	wi-e-7	90	90	East	0.66	1.06	0.7	6.74	20.77	0.15	1.58	0.15	0.10	100%		80%	99%	98%	77%
1	wi-e-8	90	90	East	2.09	1.15	2.4	6.74	20.77	0.15	0.90	0.15	0.01	100%		80%	99%	97%	77%
1	wi-e-9	90	90	East	0.73	2.05	1.5	7.68	20.77	0.15	1.58	0.15	0.10	100%		78%	99%	99%	76%
1	wi-s-1	180	90	South	0.67	1.02	0.7	8.10	2.44	0.35	0.10	0.35	0.10	100%		39%	79%	74%	23%
1	wi-s-2	180	90	South	1.13	0.47	0.5	6.07	5.64	0.35	0.10	0.35	0.10	100%		70%	86%	48%	29%
1	wi-s-3	180	90	South	1.28	0.70	0.9	5.86	8.56	0.11	0.01	0.60	0.04	100%		80%	95%	32%	24%
1	wi-s-4	180	90	South	1.90	1.15	2.2	2.34	4.96	0.15	0.44	0.15	0.01	100%		85%	97%	93%	77%
1	wi-s-5	180	90	South	0.66	1.06	0.7	2.29	4.96	0.15	1.05	0.15	0.10	100%		86%	97%	94%	78%
1	wi-s-6	180	90	South	1.59	1.15	1.8	2.34	4.96	0.15	0.01	0.15	0.01	100%		85%	94%	93%	75%
1	wi-s-7	180	90	South	2.76	1.15	3.2	2.34	4.96	0.15	0.01	0.15	0.01	100%		85%	97%	93%	77%
1	wi-s-8	180	90	South	0.66	1.06	0.7	2.29	4.96	0.15	1.05	0.15	0.10	100%		86%	97%	94%	78%
1	wi-s-9	180	90	South	1.90	1.15	2.2	0.51	8.16	0.15	0.44	0.15	0.01	100%		98%	97%	93%	88%
1	wi-rf-s-10	180	40	South	0.48	0.81	0.4	3.87	3.43	0.03	0.03	0.03	0.03	100%		76%	97%	99%	73%
1	wi-rf-s-11	180	40	South	0.48	0.81	0.4	3.87	3.43	0.03	0.03	0.03	0.03	100%		76%	97%	99%	73%
1	wi-rf-s-12	180	40	South	0.48	0.81	0.4	3.87	3.43	0.03	0.03	0.03	0.03	100%		76%	97%	99%	73%
1	wi-rf-s-13	180	40	South	0.48	0.81	0.4	3.87	3.43	0.03	0.03	0.03	0.03	100%		76%	97%	99%	73%
1	wi-rf-s-14	180	16	Horizontal	0.96	1.23	1.2			0.03	0.03	0.03	0.03	100%		100%	98%	100%	98%
1	wi-w-1	270	90	West	1.08	0.70	0.8	4.90	8.59	0.35	0.01	0.35	0.01	100%		68%	91%	76%	47%
1	wi-w-2	270	90	West	0.66	1.06	0.7	4.09	4.93	0.15	1.59	0.15	0.10	47%		58%	99%	98%	27%
1	wi-w-3	270	90	West	2.16	1.15	2.5	4.14	4.93	0.15	0.88	0.15	0.01	47%		58%	99%	97%	26%
1	wi-w-4	270	90	West	0.66	1.06	0.7	4.09	4.93	0.15	1.59	0.15	0.10	47%		58%	99%	98%	27%
1	wi-w-5	270	90	West	0.77	0.93	0.7	2.11	4.93	0.15	1.52	0.15	1.25	49%		75%	99%	100%	36%
1	wi-w-6	270	90	West	2.16	0.96	2.1	2.11	4.93	0.15	0.88	0.15	1.25	49%		75%	99%	100%	36%
1	wi-w-7	270	90	West	0.77	0.93	0.7	2.11	4.93	0.15	1.52	0.15	1.25	49%		75%	99%	100%	36%
1	wi-w-8	270	90	West	0.66	1.04	0.7	1.07	4.93	0.15	1.59	0.15	0.10	53%		86%	99%	98%	44%
1	wi-w-9	270	90	West	2.16	1.11	2.4	1.12	4.93	0.15	0.88	0.15	0.01	53%		85%	99%	97%	44%
1	wi-w-10	270	90	West	0.66	1.04	0.7	1.07	4.93	0.15	1.59	0.15	0.10	53%		86%	99%	98%	44%
1	wi-w-11	270	90	West	0.74	1.88	1.4			0.35	0.18	0.35	0.18	100%		100%	91%	96%	88%

Passive House verification

SUMMER VENTILATION

Building: Park Passive

Building Type/Use: Single Family Residential

Building Volume: 454 m³

Description		Wi-s-5	Wi-s-8	Wi-e-4,6	wi-e-7,9	wi-w-2,4	wi-w-8,10	
	Fraction of Opening Duration	30%	30%	30%	30%	30%	30%	
Climate Boundary Conditions								
	Temperature Diff Interior - Exterior	4	4	4	4	4	4	K
	Wind Velocity	2	2	2	2	2	2	m/s
Window Group 1								
	Quantity	1	1	2	2	2	2	
	Clear Width	0.838	0.838	0.838	0.84	0.838	0.84	m
	Clear Height	1.295	1.295	1.295	1.30	1.295	1.22	m
	Tilting Windows?	x	x	x	x	x	x	
	Opening Width (for tilting windows)	0.150	0.150	0.150	0.150	0.150	0.150	m
Window Group 2 (Cross Ventilation)								
	Quantity							
	Clear Width							m
	Clear Height							m
	Tilting Windows?							
	Opening Width (for Tilting Windows)							m
	Difference in Height to Window 1							m
Single-Sided Ventilation 1 - Airflow Volume		77	77	153	153	153	144	m³/h
Single-Sided Ventilation 2 - Airflow Volume		0	0	0	0	0	0	m³/h
Cross Ventilation Airflow Volume		77	77	153	153	153	144	m³/h
Contribution to Air Change Rate		0.05	0.05	0.10	0.10	0.10	0.10	1/h

Note: for summer night ventilation please set a temperature difference of 1 K and a wind velocity of 0 m/s otherwise the cooling effects of the night ventilation will be overestimated!

Summary of Summer Ventilation Distribution

Description Ventilation Type	Daily Average Air Change Rate	
Whole day Ventialtion	0.10	1/h
		1/h
		1/h

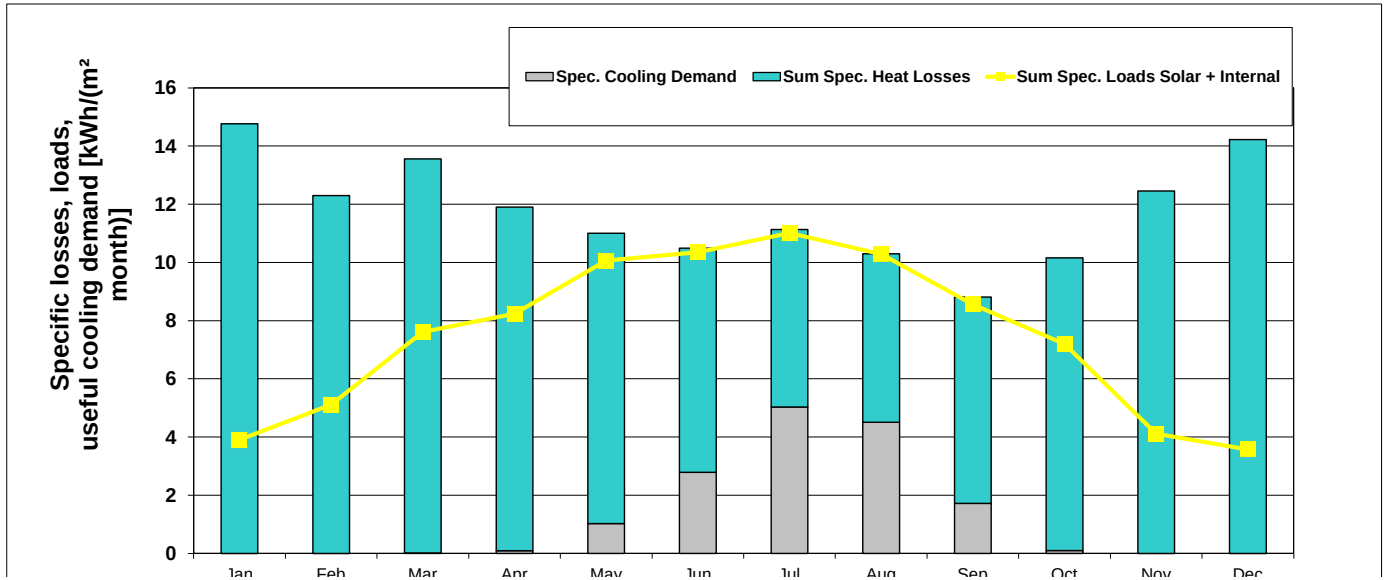
Passive House verification

SPECIFIC USEFUL COOLING DEMAND
MONTHLY METHOD

Climate: Seattle
Building: Park Passive

Interior Temperature: 25 °C
Building Type/Use: Single Family Residential
Treated Floor Area A_{TFA}: 182 m²

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Heating Degree Hours - E	14.7	12.2	13.5	11.7	9.9	7.6	6.0	5.7	7.1	10.0	12.5	14.2	125	kKh
Heating Degree Hours - G	11.8	11.4	12.6	11.4	10.4	8.6	7.4	6.7	6.5	7.6	8.7	10.5	114	kKh
Losses - Exterior	2635	2188	2409	2099	1770	1365	1078	1025	1262	1797	2228	2542	22397	kWh
Losses - Ground	48	46	51	46	42	35	30	27	26	31	35	42	459	kWh
Losses Summer Ventilatio	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Sum Spec. Heat Losses	14.8	12.3	13.5	11.8	10.0	7.7	6.1	5.8	7.1	10.1	12.5	14.2	125.8	kWh/m²
Solar Load North	46	81	139	173	272	290	284	214	156	110	64	41	1871	kWh
Solar Load East	75	122	225	260	381	409	433	398	288	194	83	63	2931	kWh
Solar Load South	245	360	529	511	551	536	602	639	584	542	254	209	5561	kWh
Solar Load West	43	83	159	219	263	290	309	254	194	137	54	40	2046	kWh
Solar Load Horiz.	15	26	47	59	77	83	89	79	58	41	18	13	605	kWh
Solar Load Opaque	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Internal Heat Gains	284	256	284	275	284	275	284	284	275	284	275	284	3342	kWh
Sum Spec. Loads Solar +	3.9	5.1	7.6	8.2	10.1	10.4	11.0	10.3	8.6	7.2	4.1	3.6	90.0	kWh/m²
Utilisation Factor Losses	26%	42%	56%	69%	91%	98%	98%	100%	96%	71%	33%	25%	59%	
Useful Cooling Energy De	0	0	3	17	187	506	915	819	313	18	0	0	2777	kWh
Spec. Cooling Demand	**0.0**	**0.0**	**0.0**	**0.1**	**1.0**	**2.8**	**5.0**	**4.5**	**1.7**	**0.1**	**0.0**	**0.0**	**15.3**	kWh/m²



Passive House verification

COMPRESSOR COOLING UNITS

Climate: Seattle
Building: Park Passive

Interior Temperature Summer: 25 °C
Building Type/Use: Single Family Residential
Treated Floor Area A_{TFA}: 181.7 m²

		A_{TFA} m²		Clear Room Height m		m³
Effective Air Volume V_V		182	*	2.50	=	454

	$n_{V,system}$ 1/h		Φ_{HR} Efficiency Humidity Rec.		1/h
Hygrically Effective Mech. Air Change Rate Summer	0.305	* (1 -		)	= 0.305

	$n_{V,nat}$ 1/h		$n_{V,Res}$ 1/h		$n_{Night,Windows}$ 1/h		$n_{Night,mechanical}$ 1/h		
Direct Ambient Air Change Rate Summer	0.101	+	0.000	+	0.000	+	0.000	=	0.101

Ambient Air Change Rate Summer — Total 0.41 1/h

☐ **Supply Air Cooling**

check as appropriate

On/Off Mode (check as appropriate)		
Minimum Temperature of Cooling Coil Surface		°C

☒ **Recirculation Cooling**

check as appropriate

On/Off Mode (check as appropriate)		
Minimum Temperature of Cooling Coil Surface	10	°C
Volume Flow Rate	500	m³/h

☐ **Additional Dehumidification**

check as appropriate

Max. Humidity Ratio	12	g/kg
Humidity Sources	2	g/(m²h)
Humidity Capacity Building	700	g/(g/kg)/m²
Humidity at Beginning of Cooling Period	8	g/kg

☐ **Panel Cooling**

check as appropriate

	sensible	latent		Sensible Fraction
Useful Cooling Demand	15.3	0.0		
of which				
Supply Air Cooling			kWh/(m²a)	
Recirculation Cooling	15.3	0.0	kWh/(m²a)	100.0%
Dehumidification			kWh/(m²a)	
Remaining for Panel Cooling			kWh/(m²a)	
Total	**15.3**	**0.0**	kWh/(m²a)	100.0%
Unsatisfied Demand	0.0	0.0	kWh/(m²a)	

Passive House verification

COOLING LOAD

Building: Park Passive | Building Type/Use: Single Family Resid | Interior Temperature: 25 °C

Spec. Capacity: 132 Wh/(m²K) (Enter in "Summer" worksheet.) | Treated Floor Area A_{TFA}: 181.7 m²

Climate (Cooling Load): Seattle

	Ambient Air	Sky	Ground	Radiation:	North	East	South	West	Horizontal
Design Temperature:	23.0 °C	12.8 °C	16.0 °C		90	210	200	200	350 W/m²

	Building Elements	Temperature Zone	Area m²		U-Value W/(m²K)		Factor Always 1 (except "X")		TempDiff K		W
1.	Exterior Wall - Ambient	A	334.5	*	0.104	*	1.00	*	-2.0	=	-69
2.	Exterior Wall - Ground	B		*		*	1.00	*	-9.0	=	
3.	Roof/Ceiling - Ambient	A	142.0	*	0.097	*	1.00	*	-2.0	=	-28
4.	Floor slab / basement c	B	84.6	*	0.048	*	1.00	*	-9.0	=	-36
5.		A		*		*	1.00	*	-2.0	=	
6.		A		*		*	1.00	*	-2.0	=	
7.		X		*		*	0.75	*	-2.0	=	
8.	Windows	A	79.9	*	0.942	*	1.00	*	-2.0	=	-151
9.	Exterior Door	A		*		*	1.00	*	-2.0	=	
10.	Exterior TB (length/m)	A	138.7	*	-0.053	*	1.00	*	-2.0	=	15
11.	Perimeter TB (length/m)	P	40.0	*	0.038	*	1.00	*	-9.0	=	-14
12.	Ground TB (length/m)	B		*		*	1.00	*	-9.0	=	
13.	House/DU Partition Wall	I		*		*	1.00	*	3.0	=	
			$L_{ambient}$ W/K		TempDiff K		L_{Sky} W/K		TempDiff K		
14.	Radiation Correction		0.0	*	-2.0	+	0.0	*	-12.2	=	0

Transmission Heat Losses P_T Total = **-283**

Ventilation System:

	A_{TFA} m²		Clear Room Height m		m³
Effective Air Volume, V_V	181.7	*	2.50	=	454

	Vent. Transm. W/K		TempDiff K		W
Exterior	60.9	*	-2.0	=	-122
Ground	0.0	*	-9.0	=	0

Additional Summer Ventilation:

	Window Night Ventilation, Manual	Corresponding Air Change Rate	0.00	1/h
X	Mechanical, Automatically Controlled Ventilation	Minimum Indoor Temperature	22.0	°C

		kWh/d		kh/d		W
Heat Removal Cooling Design Day	Window Ventilation	0.0	/	0.024	=	0
(from Cooling worksheet)	Automatic Night Ventilation	0.0	/	0.024	=	0

Ventilation Heat Load P_V Total = **-122** W

	Orientation of the Area	Area m²		g-Value (perp. radiation)		Reduction Factor		Radiation W/m²		P_S W
1.	North	24.2	*	0.5	*	0.45	*	90	=	522
2.	East	17.3	*	0.6	*	0.40	*	210	=	826
3.	South	19.3	*	0.6	*	0.45	*	218	=	1141
4.	West	17.5	*	0.6	*	0.26	*	200	=	541
5.	Horizontal	1.6	*	0.4	*	0.62	*	374	=	163
6.	Sum Opaque Areas									0

Heat Gain - Solar Heat Load, P_S Total = **3193**

	Spec. Power W/m²		A_{TFA} m²		P_I W
Internal Heat Load P_I	3.1	*	182	=	**563**

Cooling Load P_C $P_T + P_V + P_S + P_I$ = **3351** W

Specific Maximum Cooling Load P_C / A_{EB} = **18.4** W/m²

Caution: Large daily temperature swing. Consideration of daily average cooling load is not sufficient. Reduce solar load!

Minimal supply air temperature 4 °C | Supply air temperature without cooling $\vartheta_{Supply,Min}$ = 23.0 °C

Cooling capacity that is transportable through the supply air $P_{SupplyAir;Max}$ = **866** W

specific = 4.8 W/m²

Air conditioning over the supply air possible? (yes/no) **no**

	Solar Load W		Time h/d	/ (	Spec. Capacity Wh/(m²K)		A_{TFA} m²	) =	
Daily Temperature Swing due to Solar Load	3192.8	*	24	/ (	132	*	182	) =	**3.2** K

Passive House verification

HEAT DISTRIBUTION AND DHW SYSTEM

Building:	Park Passive	
Interior Temperature:	20	°C
Building Type/Use:	Single Family Residential	
Treated Floor Area A_{TFA}:	182	m²
Occupancy:	5.2	Pers
Number of Residences:	1	
Annual Heating Demand qHeating	2720	kWh/a
Length of Heating Period:	208	d
Average heating load Pave:	0.5	kW
Marginal Utilisability of Additional Heat Gains:	72%	

				Parts				
				Warm Region	Cold Region		Total	
Space Heat Distribution				1	2	3		
Length of Distribution Pipes	L_H	*(Project)*		0.00				m
Heat Loss Coefficient per m Pipe	Ψ	*(Project)*		0.169				W/(mK)
Temperature of the Room Through Which the Pipes l	ϑ_X	*Mechanical Room*		20				°C
Design Flow Temperature	ϑ_{dist}	*Flow, Design Value*		55.0				°C
Design System heating load	$P_{heating}$	*(exist./calc.)*		2.3				kW
Flow Temperature Control (check)				x				
Design Return Temperature	ϑ_R		=0.714*(ϑ_{dist}-20)+20	45.0				°C
Annual Heat Emission per m of Plumbing	q^*_{HL}		= Ψ (ϑ_m−ϑ_X) $t_{Heating}$*0.024	8			Total 1,2,3	kWh/(m·a)
Possible Utilization Factor of Released Heat	η_G			72%				-
Annual Losses	Q_{HL}		= L_H · q^*_{HL} · (1-η_G)	0	0	0	0	kWh/a
Specif. Losses	q_{HL}		= ΣQ_{HL} / A_{TFA}					kWh/(m²a) 0.0
'Performance ratio of heat distribution	$e_{a,HL}$		= (q_H + q_{HL}) / q_H				100%	-
DHW: Standard Useful Heat								
DHW Consumption per Person and Day (60 °C)	V_{DHW}	*(Project or Average Value 25 Litres/P/d)*					25.0	Litre/Person/d
Average Cold Water Temperature of the Supply	ϑ_{DW}	*Temperature of Drinking Water (10°)*					11.7	°C
DHW Non-Electric Wash and Dish		*(Electricity worksheet)*					0	kWh/a
Useful Heat - DHW	Q_{DHW}						2653	kWh/a
Specif. Useful Heat - DHW	q_{DHW}		= Q_{DHW} / A_{TFA}					kWh/(m²a) 14.6
DHW Distribution and Storage				Warm Region	Cold Region		Total	
Length of Circulation Pipes (Flow + Return)	L_{HS}	*(Project)*		0.0				m
Heat Loss Coefficient per m Pipe	Ψ	*(Project)*		0.169				W/m/K
Temperature of the Room Through Which the Pipes l	ϑ_X	*Mechanical Room*		20				°C
Design Flow Temperature	ϑ_{dist}	*Flow, Design Value*		60.0				°C
Daily circulation period of operation.	td_{Circ}	*(Project)*		0.0				h/d
Design Return Temperature	ϑ_R		=0.875*(ϑ_{dist}-20)+20	55				°C
Circulation period of operation per year	t_{Circ}		= 365 td_{Circ}	0				h/a
Annual Heat Released per m of Pipe	q^*_Z		= Ψ (ϑ_m−ϑ_X) t_{Circ}	0				kWh/m/a
Possible Utilization Factor of Released Heat	η_{GDHW}		=$t_{heating}$/365d * η_G	41%				-
Annual Heat Loss from Circulation Lines	Q_Z		= L_{HS} · q^*_Z ·(1-η_{GDHW})	0			0	kWh/a
Total Length of Individual Pipes	L_U	*(Project)*		15.00				m
Exterior Pipe Diameter	d_{U_Pipe}	*(Project)*		0.044				m
Heat loss per tap opening	$q_{Individual}$		=($c_{pH2O}$$V_{H2O}$+$c_{pMat}$$V_{Mat}$)($\vartheta_{dist}$-$\vartheta_X$)	0.9695				kWh/tap opening
Amount of tap openings per year	n_{Tap}		= n_{Pers} . 3 . 365 / n_{LU}	5683				Tap openings per year
Annual Heat Loss	q_U		= n_{Tap} · $q_{Individual}$	5510				kWh/a
Possible Utilization Factor of Released Heat	η_{G_U}		=$t_{heating}$/8760*η_G	41%				-
Annual Heat Loss of Individual Pipes	Q_U		= q_U ·(1-η_{G_U})	3259			3259	kWh/a
							Total 1,2,3	
Average Heat Released From Storage	P_S			34				W
Possible Utilization Factor of Released Heat	η_{G_S}		=$t_{heating}$/8760*η_G	41%				
Annual Heat Losses from Storage	Q_S		= P_S·8.760 kh·(1-η_{G_S})	174			174	kWh/a
							Total 1,2,3	
Total Heat Losses of the DHW System	Q_{WL}		= Q_Z+Q_U+Q_S				3433	kWh/a
Specif. Losses of the DHW System	q_{WL}		= Q_{WL} / A_{TFA}					kWh/(m²a) 18.9
Performance ratio DHW-distribution + storage	$e_{a,WL}$		= (q_{TWW} + q_{WV}) / q_{TWW}				229.4%	-
Total Heating Demand of DHW system	Q_{gDHW}		= Q_{DHW}+Q_{WL}				6086	kWh/a
Total Spec. Heating Demand of DHW System	q_{gDHW}		= Q_{gDHW} / A_{TFA}					kWh/(m²a) 33.5

Secondary Calculation: Ψ-Values of Plumbing

Nominal Width	19	mm
Insulation Thickness:	25.4	mm
Reflective? Please mark with an "x"!		
Yes		
x No		
Thermal Conductivity	0.037	W/(mK)
$\Delta\vartheta$	30	K
Interior Pipe Diameter:	0.01900	m
Exterior Pipe Diameter	0.02125	m
Exterior Pipe Diameter	0.07205	m
α–Surface	6.52	W/(m²K)
Ψ-Value	**0.169**	**W/(mK)**
Surface Temperature Difference	3.427	K

Passive House verification

SOLAR HOT WATER GENERATION

Building: Park Passive

Building Type/Use: Single Family Residential

Treated Floor Area A_{TFA}: 181.7 m²

Solar Fraction with DHW demand including washing and dish-washing

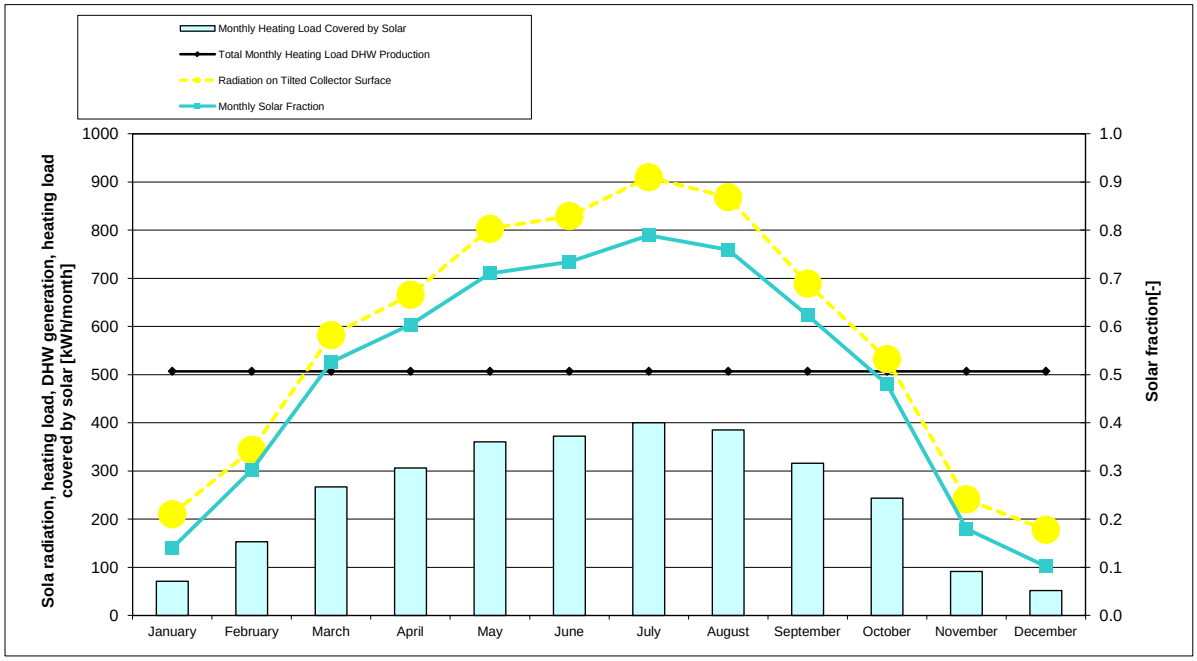
Heating Demand DHW	q_{gDHW}	6086	kWh/a	from DHW+Distribution worksheet
Latitude:		47.6	°	from Climate Data worksheet
Selection of collector from list (see below):		7	Selection:	7 Improved Flat Plate Collector
Solar Collector Area		4.65	m²	
Deviation from North		180	°	
Angle of Inclination from the Horizontal		40	°	
Height of the Collector Field		2.039	m	
Height of Horizon	h_{Hori}		m	
Horizontal Distance	a_{Hori}		m	
Additional Reduction Factor Shading	r_{other}	100%	%	

Occupancy	5.2	Persons
Specific Collector Area	0.9	m²/Pers

Estimated Solar Fraction of DHW Production	**50%**		
Solar Contribution to Useful Heat	**3019**	kWh/a	**17** kWh/(m²a)

Secondary Calculation of Storage Losses

Selection of DHW storage from list (see below):	12	Selection:	12 Stratified Solar Storage
Total Storage Volume	490	litre	
Volume Standby Part (above)	147	litre	
Volume Solar Part (below)	343	litre	
Specific Heat Losses Storage (total)	3.3	W/K	
Typical Temperature DHW	60	°C	
Room Temperature	20	°C	
Storage Heat Losses (Standby Part Only)	34	W	
Total Storage Heat Losses	132	W	



Passive House verification

ELECTRICITY DEMAND

Building: Park Passive

# Households	1	HH
Persons	5.2	P
Living Area	182	m²
Annual Heating Demand	15	kWh/(m²a)

Solar Fraction of DHW Laundry&Dish	
Marginal Performance Ratio DHW	100%
Marginal Performance Ratio Heating	27%

Prim. Energy Factors:		
Electricity	2.6	kWh/kWh
Natural Gas	1.1	kWh/kWh
Energy Carrier for Space Heating/DHW:	2.6	2.6

Column Nr.	1	2	3		4		5		6		7		8	8a		9		10		11		12		13		14
Application	Used ? (1/0)	Within the Thermal Envelope? (1/0)	Norm Demand			Utilization 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)		Primary Energy-Demand (kWh/a)
Dishwashing	1	1	1.10	kWh/Use		* 1.00	*	65	/(P*a)	*	5.2	P	= 371	*	100%	=	371									965
Cold Water Connection														*	0%			* (1+	0.30	) *	1.00	*(1-		) =		
Clothes washing	1	1	1.10	kWh/Use		* 1.00	*	57	/(P*a)	*	5.2	P	= 325	*	100%	=	325									846
Cold Water Connection														*	0%			* (1+	0.05	) *	1.00	*(1-		) =		
Clothes drying with:	1	1	3.50	kWh/Use	Residual dampness	0.75	*	57	/(P*a)	*	5.2	P	= 777		100%	=	777									2019
Condensation Dryer					0.50							=	0		0%						1.00	*			0	0
Energy consumed by evaporation	0	1	3.13	kWh/Use		* 0.50	*	57	/(P*a)	*	5.2	P	= 0	*	100%			* (1+	0.00	) *	0.27	*(1-	0.71	) =	0	0
Refrigerating	0	1	0.78	kWh/d		* 1.00	*	365	d/a	*	1	HH	= 0	*	100%	=	0									0
Freezing	0	0	0.88	kWh/d		* 0.90	*	365	d/a	*	1	HH	= 0	*	100%	=	0									0
or combined unit	1	1	1.00	kWh/d		* 1.00	*	365	d/a	*	1	HH	= 365	*	100%	=	365									949
Cooking with:	1	1	0.25	kWh/Use		* 1.00	*	500	/(P*a)	*	5.2	P	= 649	*	100%	=	649									1687
Electricity					Percentage CFLs									*	0%										0	0
Lighting	1	1	21	W	80%	* 1.00	*	2.90	kh/(P*a)	*	5.2	P	= 313	*	100%	=	313									814
Consumer electronics	1	1	80	W		* 1.00	*	0.55	kh/(P*a)	*	5.2	P	= 228	*	100%	=	228									594
Small appliances, etc.	1	1	50	kWh		* 1.00	*	1.00	/(P*a)	*	5.2	P	= 260	*	100%	=	260									675
Total aux. electricity													271				271									704
Other:																										
				kWh/a									0				0									0
				kWh/a									0				0									0
				kWh/a									0				0									0
Total													**3558** kWh				3558	kWh		DHW Non-Electric - Wash&Dish 0		kWh		0		9252
Specific Demand																	**19.6**	kWh/(m²a)		Non-Renewable Non-Electric DHW Wash&Dish 0.0		kWh/(m²a)		**0.0**		**50.9**
Recommended Maximum Value																	18									50

Passive House verification

AUXILIARY ELECTRICITY

Building: Park Passive

1	Living Area	182	m²
2	Heating Period	208	d
3	Air Volume	454	m³
4	Dwelling Units	1	HH
5	Enclosed Volume	616	m³

Operation Vent. System Winter	5.00	kh/a
Operation Vent. System Summer	3.76	kh/a
Air Change Rate	0.31	h^{-1}
Defrosting HX from		°C

Primary Energy Factor - Electricity	2.6	kWh/kWh
Annual Space Heating Demand	15	kWh/(m²a)
Boiler Rated Power	15	kW
DHW System Heating Demand	6086	kWh/a
Design Flow Temperature	55	°C

Column Nr.	1	2	3		4		5		6		7	8		9	10	11
Application	Used ? (1/0)	Within the Thermal Envelope? (1/0)	Norm Demand		Utilization Factor		Period of Operation		Reference Size		Electricity Demand (kWh/a)	Available as Interior Heat		Used During Time Period (kh/a)	Internal Heat Source (W)	Primary Energy Demand (kWh/a)
Ventilation System																
Winter Ventilation	1	1	0.29	Wh/m³ *	0.31	h^{-1} *	5.0	kh/a *	454.137005	m³ =	201	considered in heat recovery efficiency				522
Summer Ventilation	0	1	0.29	Wh/m³ *	0.31	h^{-1} *	3.8	kh/a *	454.137005	m³ =	0	no summer contribution to IHG				0
Defroster HX	0	0	0	W *	1.00	*	0.2	kh/a *	1	=	0	* 1.0	/	5.00	= 0	0
Heating System				Controlled/Uncontrolled (1/0)												
Enter the Rated Power of the Pump				W	0											
Circulation Pump	0	0	62	W *	1.0	*	5.0	kh/a *	1	=	0	* 1.0	/	5.00	= 0	0
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	/	5.00	= 0	0
Aux. Energy - Wood fired/pellet boiler	0	0	Data entries in worksheet Boiler. Auxiliary energy demand including possible drinking water produc								0	* 1.0	/	5.00	= 0	0
DHW system																
Enter Average Power Consumption of Pump				W												
Circulation Pump	0	0	29	W *	1.00	*	4.8	kh/a *	1	=	0	* 0.6	/	8.76	= 0	0
Enter the Rated Power of the Pump				W												
Storage Load Pump DHW	0	0	56	W *	1.00	*	0.0	kh/a *	1	=	0	* 1.0	/	5.00	= 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	/	5.00	= 0	0
Enter the Rated Power of the Solar DHW Pump				W												
Solar Aux Electricity	1	1	40	W *	1.00	*	1.8	kh/a *	1	=	70	* 0.6	/	8.76	= 5	181
Misc. Aux. Electricity																
Misc. Aux. Electricity	0	0		kWh/a *	1.00	*	1.0	*	1	HH =	0	* 1.0	/	8.76	= 0	0
Total											271				5	704
Specific Demand	kWh/(m²a)		Divide by Living Area:								1.5					3.9

Passive House verification

PRIMARY ENERGY VALUE

Building: Park Passive

Building Type/Use: Single Family Residential

Treated Floor Area A_{TFA}: 182 m²

Space Heating Demand incl. Distribution: 15 kWh/(m²a)

Useful Cooling Demand: 15 kWh/(m²a)

			Final Energy kWh/(m²a)	Primary Energy kWh/(m²a)	Emissions CO_2-Equivalent kg/(m²a)
Electricity Demand (without Heat Pump)				PE Value	CO_2-Emissions Factor (CO_2-Equivalent)
Covered Fraction of Space Heating Demand		*(Project)*		kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*	100%	2.6	680
Direct Electric Heating	$Q_{H,de}$		0.0	0.0	0.0
DHW Production, Direct Electric (without Wash&Dish)	$Q_{DHW,de}$	*(DHW+Distribution, SolarDHW)*	16.9	43.9	11.5
Electric Post heating DHW Wash&Dish		*(Electricity, SolarDHW)*	0.0	0.0	0.0
Strombedarf Haushaltsgeräte	Q_{EHH}	*(Electricity worksheet)*	18.1	47.1	12.3
Electricity Demand - Auxiliary Electricity			1.5	3.9	1.0
Total Electricity Demand (without Heat Pump)			**36.5**	**94.8**	**24.8**
Heat Pump				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
Covered Fraction of Space Heating Demand		*(Project)*	100%	kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*		2.6	680
Energy Carrier - Supplementary Heating			Electricity	2.6	680
Annual Coefficient of Performance - Heat Pump		*Separate Calculation*	3.72		
Total System Performance Ratio of Heat Generator		*Separate Calculation*	0.27		
Electricity Demand Heat Pump (without DHW Wash&Dish)	Q_{HP}		4.0	10.5	2.7
Non-Electric Demand, DHW Wash&Dish		*(Electricity worksheet)*	0.0	0.0	0.0
Total Electricity Demand Heat Pump			**4.0**	**10.5**	**2.7**
Compact Heat Pump Unit				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
Covered Fraction of Space Heating Demand		*(Project)*		kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*		2.6	680
Energy Carrier - Supplementary Heating			Electricity	2.6	680
COP Heat Pump Heating		*(Compact worksheet)*	0.0		
COP Heat Pump DHW		*(Compact worksheet)*	0.0		
Performance Ratio of Heat Generator (Verification)		*(Compact worksheet)*			
Performance Ratio of Heat Generator (Planning)		*(Compact worksheet)*			
Electricity Demand Heat Pump (without DHW Wash&Dish)	Q_{HP}	*(Compact worksheet)*	0.0	0.0	0.0
Non-Electric Demand, DHW Wash&Dish			0.0	0.0	0.0
Total Compact Unit		*(Compact worksheet)*	**0.0**	**0.0**	**0.0**
HP Combination: 2 independent HP for heating and WW see "HP Combi" worksheet				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
Covered Fraction of Space Heating Demand		*(Project)*		kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*		2.6	680
Energy Carrier - Supplementary Heating			Electricity	2.6	680
COP Heat Pump for Heating		*(Compact worksheet)*	0.0		
COP Heat Pump for DHW		*(Compact worksheet)*	0.0		
Performance Ratio of Heat Generator (Verification)		*(Compact worksheet)*			
Performance Ratio of Heat Generator (Planning)		*(Compact worksheet)*			
Electricity Demand Heat Pump (without DHW Wash&Dish)	Q_{HP}	*(Compact worksheet)*	0.0	0.0	0.0
Non-Electric Demand, DHW Wash&Dish			0.0	0.0	0.0
Total Combined HP		*(Compact worksheet)*	**0.0**	**0.0**	**0.0**
Boiler				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
Covered Fraction of Space Heating Demand		*(Project)*		kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*			
Boiler Type		*(Boiler worksheet)*			
Performance Ratio of Heat Generator		*(Boiler worksheet)*	0%		
Annual Energy Demand (without DHW Wash&Dish)		*(Boiler worksheet)*	0.0	0.0	0.0
Non-Electric Demand, DHW Wash&Dish		*(Electricity worksheet)*	0.0	0.0	0.0
Total Heating Oil/Gas/Wood			**0.0**	**0.0**	**0.0**
District Heat				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
Covered Fraction of Space Heating Demand		*(Project)*		kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*		0.0	0
Heat Source		*(District Heat worksheet)*			
Performance Ratio of Heat Generator		*(District Heat worksheet)*	0%		
Heating Demand District Heat (without DHW Wash&Dish)		*(District Heat worksheet)*	0.0	0.0	0.0
Non-Electric Demand, DHW Wash&Dish		*(Blatt Strom)*	0.0	0.0	0.0
Total District Heat			**0.0**	**0.0**	**0.0**
Other				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
Covered Fraction of Space Heating Demand		*(Project)*		kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*		0.2	55
Heat Source		*(Project)*	Wood		
Performance Ratio of Heat Generator		*(Project)*			
Annual Energy Demand, Space Heating			0.0	0.0	0.0
Annual Energy Demand, DHW (without DHW Wash&Dish)			0.0	0.0	0.0
Non-Electric Demand, DHW Wash&Dish		*(Blatt Strom)*	0.0	0.0	0.0
Non-Electric Demand Cooking/Drying (Gas)		*(Blatt Strom)*	0.0	0.0	0.0
Total - Other			**0.0**	**0.0**	**0.0**
Cooling with Electric Heat Pump				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
				kWh/kWh	g/kWh
Covered Fraction of Cooling Demand		*(Project)*	100%	2.6	680
Heat Source			Electricity		
Annual coefficient of performance cooling			3.651851191		
Energy Demand Space Cooling			**4.2**	**10.9**	**2.8**
Heating, Cooling, DHW, Auxiliary and Household Electricity			**44.7**	**116.2**	**30.4**
Total PE Value			**116.2** kWh/(m²a)		
Total Emissions CO_2-Equivalent			**30.4** kg/(m²a)		
Primary Energy Requirement			**120** kWh/(m²a)		**yes** (Yes/No)
Heating, DHW, Auxiliary Electricity (No Household Applications)			**22.4**	**58.2**	**15.2**
Specific PE Demand - Mechanical System			**58.2** kWh/(m²a)		
Total Emissions CO_2-Equivalent			**15.2** kg/(m²a)		

Solar Electricity		kWh/a	PE Value (Savings)	CO_2-Emission Factor
Planned Annual Electricity Generation	*Separate Calculation*		kWh/kWh	g/kWh
			0.7	250
Specific Demand				
PE Value: Conservation by Solar Electricity		kWh/(m²a)		
Saved CO_2 emissions through solar electricity		kg/(m²a)		

Passive House verification

CLIMATE DATA

Standard/Regional Climate: Select here.

Regional climate data

Select region here

USA NE & NC & NW

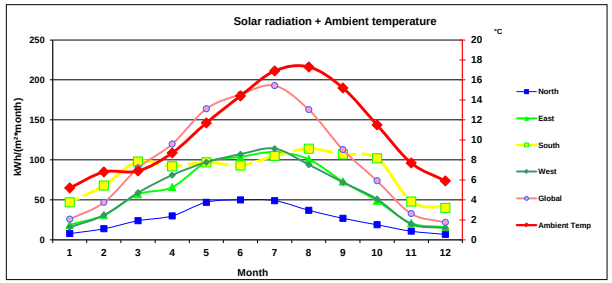
Select regional climate here:

Seattle

Building:	Park Passive	
Use Regional Data?	Yes	
Climate Building	Seattle	
Chosen Method for Heating Demand:	Monthly method	
Monthly Data:	Seattle	
Annual Data:		
Use Annual Climate Data Set	No	
Results:		
Annual Heating Demand	15.0	kWh/(m²a)
Heating Load	12.9	W/m²

Transfer to Annual Method

H_T	208	d/a
G_t	65	kKh/a
North	115	kWh/(m²a)
East	256	kWh/(m²a)
South	456	kWh/(m²a)
West	265	kWh/(m²a)
Horizontal	410	kWh/(m²a)



Month	1	2	3	4	5	6	7	8	9	10	11	12	Heating Load		Cooling Load
Days	31	28	31	30	31	30	31	31	30	31	30	31	Weather 1	Weather 2	Radiation
Seattle	Latitude:	47.6	Longitude ° East	-122.3	Altitude m	0		Daily Temperature Swing Summer (K)		10.4	Radiation Data:	kWh/(m²*month)	Radiation: W/m²		W/m²
Ambient Temp	5.2	6.8	6.9	8.7	11.7	14.4	16.9	17.3	15.2	11.5	7.7	5.9	-1.6	0.8	23.0
North	8	14	24	30	47	50	49	37	27	19	11	7	25	10	90
East	19	31	57	66	97	104	110	101	73	49	21	16	50	10	210
South	47	68	98	92	97	93	105	114	107	102	48	40	75	15	200
West	16	31	59	81	97	107	114	94	72	51	20	15	35	10	200
Global	26	47	90	120	164	182	193	163	113	74	33	22	55	15	350
Dew Point	2.5	2.3	3.4	4.9	7.4	9.6	11.8	12.2	11.0	7.7	4.8	2.2			
Sky Temp	-7.1	-7.5	-4.8	-0.7	2.8	5.6	8.2	8.2	5.4	-2.0	-3.9	-8.1			12.8
Ground Temp	9.1	8.1	8.1	9.2	11.0	13.1	15.0	16.0	16.0	14.8	12.9	10.9	8.1	8.1	16.0

Parameters for PHPP Calculated Ground Temperatures:

Phase Shift Months	
2.00	
Damping	
-1.05	
Depth m	
3.32	
Shift of Average Temperature K	
1.60	

Certification Documentation