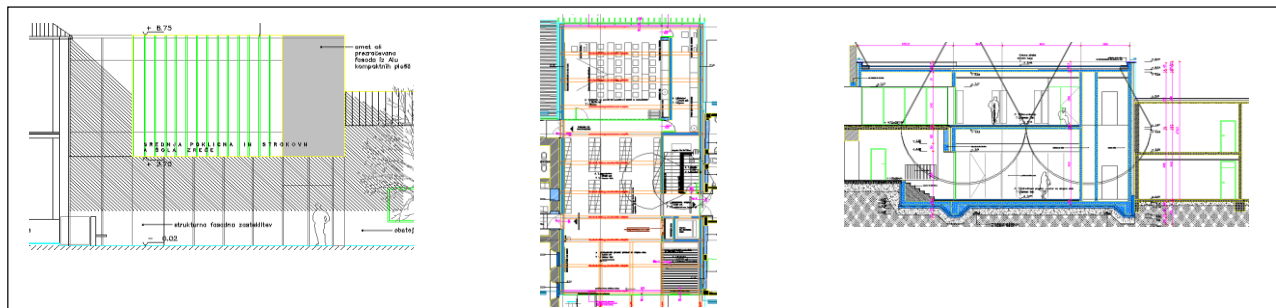


Passive House Verification



Building:	Srednja poklicna in strokovna šola Zreče		
Location and Climate:	Zreče	Ljubljana T1996-2005/J1981-2000	
Street:			
Postcode/City:			
Country:	Slovenija		
Building Type:	Javna stavba		
Home Owner(s) / Client(s):	Občina ZREČE		
Street:			
Postcode/City:			
Architect:	MODULAR arhitekti d.o.o.		
Street:	Gruberjevo nabrežje 33		
Postcode/City:	1000 Ljubljana		
Mechanical System:			
Street:			
Postcode/City:			
Year of Construction:	2018		
Number of Dwelling Units:	1		
Enclosed Volume V_e :	1800,0	m ³	
Number of Occupants:	100,0		
Interior Temperature:	20,0	°C	
Internal Heat Gains:	3,1	W/m ²	

Specific Demands with Reference to the Treated Floor Area					
Treated Floor Area:	472,6	m ²			
Applied:	Monthly Method	kWh/m3a	PH Certificate:		Fulfilled?
Specific Space Heat Demand:	19,6	kWh/(m²a)	5,48	15 kWh/(m²a)	No
Pressurization Test Result:	0,6	h⁻¹		0,6 h ⁻¹	Yes
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	90	kWh/(m²a)		120 kWh/(m ² a)	Yes
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	77	kWh/(m ² a)			
Specific Primary Energy Demand Energy Conservation by Solar Electricity:		kWh/(m ² a)			
Heating Load:	17	W/m ²			
Frequency of Overheating:	0	%	over	25 °C	
Specific Useful Cooling Energy Demand:		kWh/(m ² a)		15 kWh/(m ² a)	
Cooling Load:	5	W/m ²			

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

Issued on:

sep.17

signed:

Simon BRLEK

Passive House Planning

AREAS DETERMINATION

Building: **Srednja poklicna in strokovna šola Zreče**

Heat Demand **20** kWh/(m²a)

Summary						Building Element Overview	Average U-Value [W/(m²K)]
Group Nr.	Area Group	Temp Zone	Area	Unit	Comments		
1	Treated Floor Area		472,60	m²	Living area or useful area within the thermal envelope		
2	North Windows	A	67,00	m²	Results are from the Windows worksheet.	North Windows	0,878
3	East Windows	A	6,00	m²		East Windows	0,848
4	South Windows	A	55,29	m²		South Windows	0,912
5	West Windows	A	10,50	m²		West Windows	0,866
6	Horizontal Windows	A	0,00	m²		Horizontal Windows	
7	Exterior Door	A	4,50	m²	Please subtract area of door from respective building element	Exterior Door	0,900
8	Exterior Wall - Ambient	A	294,85	m²	Window areas are subtracted from the individual areas specified in the "Windows" worksheet.	Exterior Wall - Ambient	0,143
9	Exterior Wall - Ground	B	0,00	m²	Temperature Zone "A" is ambient air.	Exterior Wall - Ground	
10	Roof/Ceiling - Ambient	A	277,58	m²	Temperature zone "B" is the ground.	Roof/Ceiling - Ambient	0,094
11	Floor Slab	B	266,84	m²		Floor Slab	0,144
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"		
14		X	0,00	m²	Temperature zone "X": Please provide user-defined reduction factor (0 < f _r < 1):	Factor for X	
						75%	
						Thermal Bridge Overview	Ψ [W/(mK)]
15	Thermal Bridges Ambient	A	0,00	m	Units in m	Thermal Bridges Ambient	
16	Perimeter Thermal Bridges	P	42,00	m	Units in m; temperature zone "P" is perimeter (see Ground worksheet).	Perimeter Thermal Bridges	0,010
17	Thermal Bridges Floor Slab	B	0,00	m	Units in m	Thermal Bridges Floor Slab	
18	Partition Wall to Neighbour	I	153,12	m²	No heat losses, only considered for the heat load calculation.	Partition Wall to Neighbour	0,170
Total Thermal Envelope			982,56	m²		Average Therm. Envelope	0,239

Area Input																	Selection of the Corresponding Building Element Assembly	Nr.	U-Value [W/(m²K)]	
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]				
	Treated Floor Area	1	Treated Floor Area	1	x (		x		+	472,60	-		-		) =	472,6	From Windows sheet From Windows sheet From Windows sheet From Windows sheet From Windows sheet U-Value Exterior Door		0,878	
	North Windows	2	North Windows													67,0			0,848	
	East Windows	3	East Windows													6,0			0,912	
	South Windows	4	South Windows													55,3			0,866	
	West Windows	5	West Windows													10,5			0,000	
	Horizontal Windows	6	Horizontal Windows													0,0			0,90	
	Exterior Door	7	Exterior Door	1	x (	1,50	x	3,00	+		-		-		) =	4,5				
1	SV-zunanja stena	8	Exterior Wall - Ambient	1	x (	10,60	x	9,00	+		-		-	67,0	) =	28,4	Z1.2 AB nosilna zunanja stena	▼	2	0,143
2	JV-Zunanja stena	8	Exterior Wall - Ambient	1	x (	7,36	x	9,00	+		-		-	0,0	) =	66,2	Z1.2 AB nosilna zunanja stena	▼	2	0,143
3	JV-Stena proti delavnicam	18	Partition Wall to Neighbour	1	x (	15,20	x	5,35	+		-		-	0,0	) =	81,3	Z1.1 AB zunanja stena proti	▼	1	0,170
4	JVn-Zunanja stena nad del	8	Exterior Wall - Ambient	1	x (	15,20	x	2,06	+		-		-	0,0	) =	31,3	Z1.2 AB nosilna zunanja stena	▼	2	0,143
5	JVn-Zunanja stena nadstro	8	Exterior Wall - Ambient	1	x (	4,51	x	4,25	+		-		-	6,0	) =	13,2	Z1.2 AB nosilna zunanja stena	▼	2	0,143
6	JZp-Zunanja stena-vhod	8	Exterior Wall - Ambient	1	x (	7,93	x	4,75	+		-	4,50	-	32,2	) =	1,0	Z1.2 AB nosilna zunanja stena	▼	2	0,143
7	JZn1-Zunanja stena nad vh	8	Exterior Wall - Ambient	1	x (	7,93	x	4,25	+		-		-	15,6	) =	18,1	Z1.3 AB zunanja stena z ALU	▼	3	0,144
8	SZn-Zunanja stena nadstro	8	Exterior Wall - Ambient	1	x (	4,51	x	4,25	+		-		-	0,0	) =	19,2	Z1.2 AB nosilna zunanja stena	▼	2	0,143
9	JZn2-Zunanja stena ob obs	8	Exterior Wall - Ambient	1	x (	2,70	x	9,00	+		-		-	7,5	) =	16,8	Z1.2 AB nosilna zunanja stena	▼	2	0,143
10	SZp-Stena proti obst. šol	18	Partition Wall to Neighbour	1	x (	12,85	x	4,00	+		-		-	0,0	) =	51,4	Z1.1 AB zunanja stena proti	▼	1	0,170
11	SZn-Stena proti obst. šol	18	Partition Wall to Neighbour	1	x (	6,58	x	3,10	+		-		-	0,0	) =	20,4	Z1.1 AB zunanja stena proti	▼	1	0,170
12	SZn1-Zunanja stena	8	Exterior Wall - Ambient	1	x (	6,68	x	1,50	+		-		-	0,0	) =	10,0	Z1.2 AB nosilna zunanja stena	▼	2	0,143
13	SZn2-Zunanja stena	8	Exterior Wall - Ambient	1	x (	7,92	x	4,00	+		-		-	10,5	) =	21,2	Z1.2 AB nosilna zunanja stena	▼	2	0,143
14	SZ-Zunanja stena	8	Exterior Wall - Ambient	1	x (	7,72	x	9,00	+		-		-	0,0	) =	69,5	Z1.2 AB nosilna zunanja stena	▼	2	0,143
15					x (		x		+		-		-	0,0	) =			▼	0	
16	Streha	10	Roof/Ceiling - Ambient	1	x (	26,50	x	10,95	+		-	12,60	-	0,0	) =	277,6	S Streha	▼	4	0,094
17	T1a proti zemlji	11	Floor Slab	1	x (	21,80	x	10,60	+		-		-	0,0	) =	231,1	T 1.1 Tlak v pritličju	▼	5	0,147
18	T1a nadstropja-previs	11	Floor Slab	1	x (	7,93	x	4,51	+		-		-	0,0	) =	35,8	T 2.2a Tlak v mansardi-previs	▼	6	0,120
19					x (		x		+		-		-	0,0	) =			▼	0	
20					x (		x		+		-		-	0,0	) =			▼	0	
21	Pritličje				x (		x		+	224,70	-		-	0,0	) =			▼	0	
22	Nadstropje				x (		x		+	247,90	-		-	0,0	) =			▼	0	
23					x (		x		+		-		-	0,0	) =			▼	0	

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Building: Srednja poklicna in strokovna šola Zreče Wedge Shaped Building Element Layers and Still Air Spaces -> Secondary Calculation to the Right

1	Z1.1 AB zunanja stena proti sosednjim objektom						
Assembly No. Building Assembly Description							
Heat Transfer Resistance [m²K/W] interior R _{si} : 0,13							
exterior R _{se} : 0,13							
Area Section 1		λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width
1.	cementna gladilna malta	0,050					Thickness [mm]
2.	AB zid	2,040					10
3.	mineralna volna (Smartwall)	0,034					250
4.	obstoječa fasada	0,700					160
5.	obstoječa stena	0,600					30
6.	obstoječi omet	0,800					300
7.							30
8.							
			Percentage of Sec. 2		Percentage of Sec. 3		Total
							78,0 cm
U-Value: 0,170 W/(m²K)							

2	Z1.2 AB nosilna zunanja stena						
Assembly No. Building Assembly Description							
Heat Transfer Resistance [m²K/W] interior R _{si} : 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)]	Total Width
1.	cementna gladilna malta	0,050					Thickness [mm]
2.	AB zid	2,040					10
3.	mineralna volna (Smartwall)	0,034					250
4.	fasadni omet	0,800					220
5.							15
6.							
7.							
8.							
			Percentage of Sec. 2		Percentage of Sec. 3		Total
							49,5 cm
U-Value: 0,143 W/(m²K)							

3	Z1.3 AB zunanja stena z ALU fasadno ploščo						
Assembly No. Building Assembly Description							
Heat Transfer Resistance [m²K/W] interior R _{si} : 0,13							
exterior R _{se} : 0,00							
Area Section 1		λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width
1.	cementna gladilna malta	0,050					Thickness [mm]
2.	AB zid	2,040					10
3.	mineralna volna (Smartwall)	0,034					250
4.	protivetrna folija	0,200					220
5.	zračni sloj						1
6.	fasada na podkonstrukciji						
7.							
8.							
			Percentage of Sec. 2		Percentage of Sec. 3		Total
							48,1 cm
U-Value: 0,144 W/(m²K)							

Passive House Planning

Building: Srednja poklicna in strokovna šola Zreče

Still Air Spaces -> Secondary Calculation to the Right

4	S Streha
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Assembly No.	Building Assembly Description
1	Roof Assembly
2	Wall Assembly
3	Floor Assembly
4	Foundation Assembly
5	Window Assembly
6	Door Assembly
7	Roof Assembly
8	Wall Assembly
9	Floor Assembly
10	Foundation Assembly
11	Window Assembly
12	Door Assembly
13	Roof Assembly
14	Wall Assembly
15	Floor Assembly
16	Foundation Assembly
17	Window Assembly
18	Door Assembly
19	Roof Assembly
20	Wall Assembly
21	Floor Assembly
22	Foundation Assembly
23	Window Assembly
24	Door Assembly
25	Roof Assembly
26	Wall Assembly
27	Floor Assembly
28	Foundation Assembly
29	Window Assembly
30	Door Assembly
31	Roof Assembly
32	Wall Assembly
33	Floor Assembly
34	Foundation Assembly
35	Window Assembly
36	Door Assembly
37	Roof Assembly
38	Wall Assembly
39	Floor Assembly
40	Foundation Assembly
41	Window Assembly
42	Door Assembly
43	Roof Assembly
44	Wall Assembly
45	Floor Assembly
46	Foundation Assembly
47	Window Assembly
48	Door Assembly
49	Roof Assembly
50	Wall Assembly
51	Floor Assembly
52	Foundation Assembly
53	Window Assembly
54	Door Assembly
55	Roof Assembly
56	Wall Assembly
57	Floor Assembly
58	Foundation Assembly
59	Window Assembly
60	Door Assembly
61	Roof Assembly
62	Wall Assembly
63	Floor Assembly
64	Foundation Assembly
65	Window Assembly
66	Door Assembly
67	Roof Assembly
68	Wall Assembly
69	Floor Assembly
70	Foundation Assembly
71	Window Assembly
72	Door Assembly
73	Roof Assembly
74	Wall Assembly
75	Floor Assembly
76	Foundation Assembly
77	Window Assembly
78	Door Assembly
79	Roof Assembly
80	Wall Assembly
81	Floor Assembly
82	Foundation Assembly
83	Window Assembly
84	Door Assembly
85	Roof Assembly
86	Wall Assembly
87	Floor Assembly
88	Foundation Assembly
89	Window Assembly
90	Door Assembly
91	Roof Assembly
92	Wall Assembly
93	Floor Assembly
94	Foundation Assembly
95	Window Assembly
96	Door Assembly
97	Roof Assembly
98	Wall Assembly
99	Floor Assembly
100	Foundation Assembly
101	Window Assembly
102	Door Assembly
103	Roof Assembly
104	Wall Assembly
105	Floor Assembly
106	Foundation Assembly
107	Window Assembly
108	Door Assembly
109	Roof Assembly
110	Wall Assembly
111	Floor Assembly
112	Foundation Assembly
113	Window Assembly
114	Door Assembly
115	Roof Assembly
116	Wall Assembly
117	Floor Assembly
118	Foundation Assembly
119	Window Assembly
120	Door Assembly
121	Roof Assembly
122	Wall Assembly
123	Floor Assembly
124	Foundation Assembly
125	Window Assembly
126	Door Assembly
127	Roof Assembly
128	Wall Assembly
129	Floor Assembly
130	Foundation Assembly
131	Window Assembly
132	Door Assembly
133	Roof Assembly
134	Wall Assembly
135	Floor Assembly
136	Foundation Assembly
137	Window Assembly
138	Door Assembly
139	Roof Assembly
140	Wall Assembly
141	Floor Assembly
142	Foundation Assembly
143	Window Assembly
144	Door Assembly
145	Roof Assembly
146	Wall Assembly
147	Floor Assembly
148	Foundation Assembly
149	Window Assembly
150	Door Assembly
151	Roof Assembly
152	Wall Assembly
153	Floor Assembly
154	Foundation Assembly
155	Window Assembly
156	Door Assembly
157	Roof Assembly
158	Wall Assembly
159	Floor Assembly
160	Foundation Assembly
161	Window Assembly
162	Door Assembly
163	Roof Assembly
164	Wall Assembly
165	Floor Assembly
166	Foundation Assembly
167	Window Assembly
168	Door Assembly
169	Roof Assembly
170	Wall Assembly
171	Floor Assembly
172	Foundation Assembly
17	

Heat Transfer Resistance [m²K/W]

interior R₀ : 0.10

exterior R _{so} :	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.	akustičen spuščen strop	0,500					25
2.	Min volna (DP 5)	0,035					40
3.	zračni kanal	1,500					260
4.	AB plošča	2,040					140
5.	parna zapora	0,200					100
6.	TI (Knauf DDP-RT)	0,035					150
7.	TI (Knauf DDP-RT)	0,035					150
8.	Stekleni voal	0,100					1
9.	FPO hidroizolacija	0,200					2
10.							

Percentage of Sec. 2

Percentage of Sec. 3

Total

U-Value: **0.094** W/(m²K)

5	T 1.1 Tlak v pritličaju
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Assembly No.

Heat Transfer Resistance [m²K/W]

interior R₀: 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)]	Total Width
													Thickness [mm]
1.	teraco, brušen					1,800							2
2.	sistemska plošča					0,036							30
3.	EPS T					0,040							40
4.	AB plošča					2,040							200
5.	XPS (Fibran XPS 500)					0,035							160
6.	hidroizolacija					0,200							10
7.	podložni beton					1,500							100
8.	utrjeno nasutje												

Percentage of Sec. 2

Percentage of Sec. 3

Total

U-Value: **0.147** W/(m²K)

6	T 2.2a Tlak v mansardi-previs
---	-------------------------------

0.17

0,04

1.	samorazlicni poliuretanski tlak	0,400				2
2.	cementni estrih	1,600				78
3.	sistemska plošča	0,036				30
4.	mineralna volna (TPS)	0,037				40
5.	AB plošča	2,040				140
6.	mineralna volna (FPL-035)	0,035				200
7.	zračni kanal	0,250				60
8.	fermacell	0,230				30

Percentage of Sec. 2

Percentage of Sec. 3

Total

U-Value: **0.120** W/(m²K)

Passive House Planning

REDUCTION FACTOR SOLAR RADIATION, WINDOW U-VALUE

Building: Srednja poklicna in strokovna šola Zreče

Annual Heat Demand: 20 kWh/(m²a)

Heating Degree Hou

Climate:	Ljubljana T1996-2005/J1981-2000					
Window Area Orientation	Global Radiation (Cardinal Points)	Shading	Dirt	Non-Perpendicular Incident Radiation	Glazing Fraction	
maximum:	kWh/(m²a)	0,75	0,95	0,85		
North	108	0,62	0,95	0,85	0,866	0,50
East	228	0,62	0,95	0,85	0,896	0,50
South	431	0,67	0,95	0,85	0,806	0,50
West	248	0,90	0,95	0,85	0,850	0,50
Horizontal	369	0,75	0,95	0,85	0,000	0,00
Total or Average Value for All Windows.						0,50
						0,45
						138,79
						0,89
						116,9

73,7	
Transmission Losses	Heat Gains Solar Radiation
kWh/a	kWh/a
4333	1831
375	467
3713	4689
670	502
0	0
9091	7489

					Window Rough Openings		Installed		Glazing		Frame		g-Value		U-Value		Window Frame Dimensions				Installation				Ψ-Value		Results			
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	Width - Left	Width - Right	Width - Below	Width - Above	Left 1/0	Right 1/0	Sill 1/0	Head 1/0	Ψ _{Spacer}	Ψ _{Installation}	Window Area	Glazing Area	U-Value Window	Glazed Fraction per Window	
		Degrees	Degrees		m	m	Select:		Select:		Select:		-	W/(m²K)	W/(m²K)	m	m	m	m					W/(mK)	W/(mK)	m²	m²	W/(m²K)	%	
8	SVp Ss-02	40	90	North	1,250	3,700	SV-zunanja stena	▼ 1	Steklo 0,5/0,7	▼ 3	Okno 1,2 fix	▼ 2	0,50	0,70	1,20	0,06	0,06	0,08	0,06	1	0	1	1	0,040	0,020	37,0	32,18	0,87	0,87	
6	JZp Ss-01	220	90	South	1,200	3,700	JZp-Zunanja stena	▼ 6	Steklo 0,5/0,7	▼ 3	Okno 1,2	▼ 1	0,50	0,70	1,20	0,12	0,12	0,13	0,12	1	0	1	1	0,040	0,020	26,6	20,11	0,93	0,75	
2	JZp Ss-01	220	90	South	0,750	3,700	JZp-Zunanja stena	▼ 6	Steklo 0,5/0,7	▼ 3	Okno 1,2 fix	▼ 2	0,50	0,70	1,20	0,06	0,06	0,08	0,06	1	0	1	1	0,040	0,020	5,6	4,49	0,95	0,81	
8	SVp Ss-04	40	90	North	1,250	3,000	SV-zunanja stena	▼ 1	Steklo 0,5/0,7	▼ 3	Okno 1,2 fix	▼ 2	0,50	0,70	1,20	0,06	0,06	0,08	0,06	1	0	1	1	0,040	0,020	30,0	25,85	0,88	0,86	
1	JVn O1	130	90	East	2,000	3,000	JVn-Zunanja stena	▼ 5	Steklo 0,5/0,7	▼ 3	Okno 1,2 fix	▼ 2	0,50	0,70	1,20	0,06	0,06	0,08	0,06	1	1	1	1	0,040	0,020	6,0	5,38	0,85	0,90	
4	JZn Ss-03	220	90	South	1,300	3,000	JZn1-Zunanja stena	▼ 7	Steklo 0,5/0,7	▼ 3	Okno 1,2 fix	▼ 2	0,50	0,70	1,20	0,06	0,06	0,08	0,06	1	0	1	1	0,040	0,020	15,6	13,50	0,88	0,87	
2	JZn2 Ns-07	220	90	South	1,250	3,000	JZn2-Zunanja stena	▼ 9	Steklo 0,5/0,7	▼ 3	Okno 1,2 fix	▼ 2	0,50	0,70	1,20	0,06	0,06	0,08	0,06	1	0	1	1	0,040	0,020	7,5	6,46	0,88	0,86	
1	SZn O2a	310	90	West	2,500	3,000	SZn2-Zunanja stena	▼ 13	Steklo 0,5/0,7	▼ 3	Okno 1,2 fix	▼ 2	0,50	0,70	1,20	0,06	0,06	0,08	0,06	1	0	1	1	0,040	0,020	7,5	6,81	0,82	0,91	
1	SZn O2b	310	90	West	1,000	3,000	SZn2-Zunanja stena	▼ 13	Steklo 0,5/0,7	▼ 3	Okno 1,2	▼ 1	0,50	0,70	1,20	0,12	0,12	0,13	0,12	0	1	1	1	0,040	0,020	3,0	2,12	0,97	0,71	
								▼ 0		▼ 0		▼ 0																		
								▼ 0		▼ 0		▼ 0																		
								▼ 0		▼ 0		▼ 0																		
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								▼ 0		▼ 0		▼ 0																		

Passive House Planning

Climate: **Ljubljana T1996-2005/J1981-2000**

Building: Srednja poklicna in strokovna šola Zreče

Latitude:	46,07	°
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Orientation	Glazing Area m ²	Reduction Factor r _s
North	58,04	62%
East	5,38	62%
South	44,56	67%
West	8,93	90%
Horizontal	0,00	100%

[illegible]

Passive House Planning

VENTILATION DATA

Building: **Srednja poklicna in strokovna šola Zreče**

Treated Floor Area A_{TFA}	m ²	473	(Areas worksheet)
Room Height h	m	3,6	(Annual Heat Demand worksheet)
Room Ventilation Volume ($A_{TFA} \cdot h$) = V_V	m ³	1701	(Annual Heat Demand worksheet)

Ventilation System Design - Standard Operation

Occupancy	m ² /P	5				
Number of Occupants	P	100,0				
Supply Air per Person	m ³ /(P*h)	20				
Supply Air Requirement	m ³ /h	2000				
Extract Air Rooms			Kitchen	Bathroom	Shower	WC
Quantity						
Extract Air Requirement per Room	m ³ /h	60	40	20	20	
Total Extract Air Requirement	m ³ /h	0				

Design Air Flow Rate (Maximum) m³/h **2100**

Average Air Change Rate Calculation

Type of Operation	Daily Operation Duration h/d	Factors Referenced to Maximum	Air Flow Rate m ³ /h	Air Change Rate 1/h
Maximum		1,00	2100	1,23
Standard	12,0	0,77	1615	0,95
Basic	12,0	0,54	1131	0,66
Minimum		0,40	840	0,49
Average value		0,65	1373	0,81

Average Air Flow Rate (m³/h)

Average Air Change Rate (1/h)

The air change rate is probably too low (20 m³/h per person)

Infiltration Air Change Rate according to EN 13790

Wind Protection Coefficients According to EN 13790		
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

Wind Protection Coefficient, e

for Annual Demand:

for Heat Load:

Wind Protection Coefficient, f

for Annual Demand:

for Heat Load:

Air Change Rate at Press. Test

n_{50}

1/h

Net Air Volume for Press. Test V_{n50}

Air Permeability q_{50}

m³/t

Type of Ventilation System

<input checked="" type="checkbox"/> Balanced PH Ventilation	Please Check	for Annual Demand:	for Heat Load:
<input type="checkbox"/> Pure Extract Air			
Excess Extract Air		1/h	1/h
Infiltration Air Change Rate	$n_{V,Res}$	1/h	1/h

Effective Heat Recovery Efficiency of the Ventilation System with Heat Recovery

- ☒ Central unit within the thermal envelope.
- ☐ Central unit outside of the thermal envelope.

Efficiency of Heat Recovery η_{HR}	0,85	Rekuperator	
Transmittance Ambient Air Duct Ψ	W/(mK)	0,677	Calculation see Secondary Calculation
Length Ambient Air Duct	m	5	
Transmittance Exhaust Air Duct Ψ	W/(mK)	0,677	Calculation see Secondary Calculation
Length Exhaust Air Duct	m	5	
Temperature of Mechanical Services Room	°C		Room Temperature (°C) 20
(Enter only if the central unit is outside of the thermal envelope.)			Av. Ambient Temp. Heating P. (°C) 5,0
			Av. Ground Temp (°C) 11,9

Effective Heat Recovery Efficiency

$\eta_{HR,eff}$

83,7%

Effective Heat Recovery Efficiency Subsoil Heat Exchanger

SHX Efficiency	η_{SHX}	0%
Heat Recovery Efficiency SHX	η_{SHX}	0%

CERTIFIED HEAT RECOVERY UNITS

No.	Heat Recovery Unit	Heat Recovery Efficiency %	Electric Efficiency Wh/m ³
1	Rekuperator	85%	0,40
2			

Passive House Planning

SPECIFIC ANNUAL HEAT DEMAND

Climate: **Ljubljana T1996-2005/J1981-2000**
 Building: **Srednja poklicna in strokovna šola Zreče**
 Location: **Zreče**

Interior Temperature: **20,0** °C
 Building Type/Use: **Javna stavba**
 Treated Floor Area A_{TFA}: **472,6** m²

Building Element	Temperature Zone	Area m ²	U-Value W/(m ² K)	Temp. Factor f _t	G _i kKv/a	kWh/a	per m ² Treated Floor Area
1. Exterior Wall - Ambient	A	294,8	0,143	1,00	73,7	3113	
2. Exterior Wall - Ground	B			0,45			
3. Roof/Ceiling - Ambient	A	277,6	0,094	1,00	73,7	1919	
4. Floor Slab	B	266,8	0,144	0,45	73,7	1280	
5.	A			1,00			
6.	A			1,00			
7.	X			0,75			
8. Windows	A	138,8	0,889	1,00	73,7	9091	
9. Exterior Door	A	4,5	0,900	1,00	73,7	298	
10. Exterior TB (length/m)	A			1,00			
11. Perimeter TB (length/m)	P	42,0	0,010	0,45	73,7	14	
12. Ground TB (length/m)	B			0,45			
Total of All Building Envelope Areas		982,6					

Transmission Heat Losses Q_T

Total **15716** kWh/(m²a) **33,3**

Ventilation System:

Effective Heat Recovery Efficiency
 of Heat Recovery
 Efficiency of Subsoil Heat Exchanger

Effective Air Volume, V_V

η_{eff} **84%**

η_{SubX} **0%**

Energetically Effective Air Exchange n_V

n_{V,system}

1/h

Φ_{HR}

1/h

n_{V,Res}

1/h

0,807

0,84

0,054

0,186

V_V

m³

n_V

1/h

C_{Air}

Wh/(m²K)

G_i

kKv/a

kWh/a

kWh/(m²a)

Ventilation Heat Losses Q_V

1701

0,186

0,33

73,7

7702

16,3

Total Heat Losses Q_L

Q_T

kWh/a

15716

Q_V

kWh/a

7702

Reduction Factor

Night/Weekend

Saving

1,0

kWh/a

23418

kWh/(m²a)

49,6

Orientation
of the Area

Reduction Factor
See Windows Sheet

g-Value
(perp. radiation)

Area
m²

Radiation HP
kWh/(m²a)

kWh/a

1. North	0,43	0,50	67,00	126	1831
2. East	0,45	0,50	6,00	347	467
3. South	0,44	0,50	55,29	387	4689
4. West	0,62	0,50	10,50	155	502
5. Horizontal	0,40	0,00	0,00	369	0

Available Solar Heat Gains Q_S

Total **7489** kWh/(m²a) **15,8**

Internal Heat Gains Q_I

kh/d

0,024

Length Heat. Period

d/a

205

Spec. Power q_i

W/m²

3,09

A_{TFA}

m²

472,6

kWh/a

7168

kWh/(m²a)

15,2

Free Heat Q_F

Q_S + Q_I

14657

31,0

Ratio of Free Heat to Losses

Q_F / Q_L

0,63

Utilisation Factor Heat Gains η_G

(1 - (Q_F / Q_L)⁵) / (1 - (Q_F / Q_L)⁶)

96%

Heat Gains Q_G

η_G * Q_F

14097

29,8

Annual Heat Demand Q_H

Q_L - Q_G

9321

20

Limiting Value

kWh/(m²a)

15

Requirement met?

(Yes/No)

No

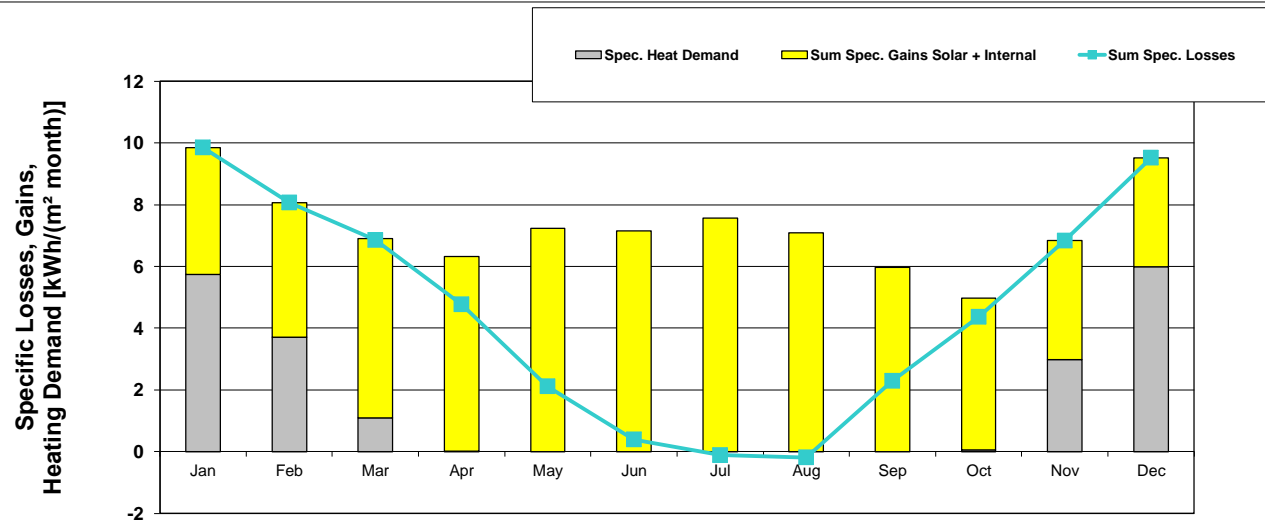
PASSIVE HOUSE PLANNING

SPECIFIC ANNUAL HEAT DEMAND MONTHLY METHOD

Climate: **Ljubljana T1996-2005/J1981-2000**
 Building: **Srednja poklicna in strokovna šola Zreče**
 Location: **Zreče**

Interior Temperature: **20** °C
 Building Type/Use: **Javna stavba**
 Treated Floor Area A_{TFA} : **473** m²

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Heating Degree Hours - E	14,8	12,0	10,0	6,8	2,8	0,2	-0,5	-0,6	3,3	6,4	10,2	14,4	80	kKh
Heating Degree Hours - G	5,5	5,2	5,8	5,2	3,9	3,1	2,6	2,3	2,3	3,6	4,1	4,9	49	kKh
Losses - Exterior	4446	3612	3016	2054	849	65	-156	-179	995	1921	3070	4312	24005	kWh
Losses - Ground	213	203	224	203	151	120	102	90	88	141	159	190	1885	kWh
Sum Spec. Losses	9,9	8,1	6,9	4,8	2,1	0,4	-0,1	-0,2	2,3	4,4	6,8	9,5	54,8	kWh/m ²
Solar Gains - North	145	251	490	630	897	918	975	762	498	279	137	102	6085	kWh
Solar Gains - East	60	69	103	108	128	123	138	127	107	74	49	40	1126	kWh
Solar Gains - South	612	690	944	1028	1099	1059	1151	1170	1025	796	535	417	10527	kWh
Solar Gains - West	39	67	114	172	213	223	228	203	135	91	45	30	1560	kWh
Solar Gains - Horiz.	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Solar Gains - Opaque	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Internal Heat Gains	1086	981	1086	1051	1086	1051	1086	1086	1051	1086	1051	1086	12793	kWh
Sum Spec. Gains Solar +	4,1	4,4	5,8	6,3	7,2	7,1	7,6	7,1	6,0	4,9	3,8	3,5	67,9	kWh/m ²
Utilisation Factor	100%	100%	99%	75%	29%	5%	0%	0%	38%	87%	100%	100%	52%	
Annual Heat Demand	2716	1756	521	3	0	0	0	0	0	27	1411	2828	9261	kWh
Spec. Heat Demand	5,7	3,7	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,1	3,0	6,0	19,6	kWh/m ²



Annual Heat Demand: Comparison

EN 13790 Monthly Method

PHPP, Heating Period Method

9261	kWh/a
9321	kWh/a

19,6	kWh/(m²a) Reference to habitable area
19,7	kWh/(m²a) Reference to habitable area

Passive House Planning

SPECIFIC SPACE HEATING LOAD

Building: **Srednja poklicna in strokovna šola Zreče**

Location: **Zreče**

Building Type/Use: **Javna stavba**

Treated Floor Area A_{TFA} : **472,6** m² Interior Temperature: **20** °C

Climate (HL): **Ljubljana T1996-2005/J1981-2000**

Design Temperature		Radiation: North East South West Horizontal												
Weather Condition 1:	-6,8 °C	11	29	88	32	41	W/m ²							
Weather Condition 2:	-5,9 °C	8	9	39	29	23	W/m ²							
Ground Design Temp.	12,2 °C													
Building Element	Temperature Zone	Area m ²	U-Value W/(m ² K)	Factor Always 1 (except "X")	TempDiff 1 K	TempDiff 2 K		P _T 1 W		P _T 2 W				
1. Exterior Wall - Ambient	A	294,8	0,143	1,00	26,8	25,9	=	1132		1094				
2. Exterior Wall - Ground	B			1,00	7,8	7,8	=							
3. Roof/Ceiling - Ambient	A	277,6	0,094	1,00	26,8	25,9	=	698		675				
4. Floor Slab	B	266,8	0,144	1,00	7,8	7,8	=	299		299				
5.	A			1,00	26,8	25,9	=							
6.	A			1,00	26,8	25,9	=							
7.	X			0,75	26,8	25,9	=							
8. Windows	A	138,8	0,889	1,00	26,8	25,9	=	3307		3196				
9. Exterior Door	A	4,5	0,900	1,00	26,8	25,9	=	109		105				
10. Exterior TB (length/m)	A			1,00	26,8	25,9	=							
11. Perimeter TB (length/m)	P	42,0	0,010	1,00	7,8	7,8	=	3		3				
12. Ground TB (length/m)	B			1,00	7,8	7,8	=							
13. House/DU Partition Wall	I	153,1	0,170	1,00	3,0	3,0	=	78		78				

Transmission Heat Losses P_T

Total = **5626** or **5450**

Ventilation System:

Effective Air Volume, V_v **472,6** m³ * Clear Room Height **3,60** m = **1701** m³

Efficiency of Heat Recovery of the Heat Exchanger η_{HR} **84%** Heat Recovery Efficiency SHX **0%** Efficiency SHX **0%** or **0%**

Energy Effective Air Exchange n_v **0,136** 1/h + **0,807** 1/h * (1 - **0,84** or **0,84**) = **0,268** 1/h or **0,268** 1/h

Ventilation Heating Load P_V

V_L m ³	η_L 1/h	η_L 1/h	c_{Air} Wh/(m ³ K)	TempDiff 1 K	TempDiff 2 K	P _V 1 W	P _V 2 W
1701,4	0,268	0,268	0,33	26,8	25,9	4027	3892

Total Heating Load P_L

P_T + P_V = **9654** or **9342**

Orientation the Area	Area m ²	g-Value (perp. radiation)	Reduction Factor (see Windows worksheet)	Radiation 1 W/m ²	Radiation 2 W/m ²	P _S 1 W	P _S 2 W
1. North	67,0	0,5	0,4	11	3	162	48
2. East	6,0	0,5	0,4	62	23	83	31
3. South	55,3	0,5	0,4	72	40	875	485
4. West	10,5	0,5	0,6	15	19	48	60
5. Horizontal	0,0	0,0	0,4	41	23	0	0

Solar Heat Gain, P_S

Total = **1168** or **624**

Internal Heat Gains P_I

Spec. Power W/m² **1,6** * A_{TFA} m² **473** = **756** or **756**

Heat Gains P_G

P_S + P_I = **1925** or **1381**

P_L - P_G = **7729** or **7962**

Heating Load P_H

= **7962** W

Specific Heating Load P_H / A_{TFA}

= **16,8** W/m²

Input Max. Supply Air Temperature **52** °C

Max. Supply Air Temperature $\vartheta_{Supply,Max}$ **52** °C

Supply Air Temperature Without Heating $\vartheta_{Supply,Min}$ **15,6** °C or **15,8** °C

For Comparison: Heating Load Transportable by Supply Air. P_{Supply Air,Max}

= **16417** W specific: **34,7** W/m²

Supply Air Heating Sufficient? **Yes**

Passive House Planning

COOLING LOAD

Building:	Srednja poklicna in strokovna šola Zreče			Building Type/Use:	Javna stavba	Interior Temperature:	25 °C
Location:	Zreče			Treated Floor Area A _{TFA} :	472,6 m²		
Spec. Capacity:	204	Wh/(m²K) (Enter in "Summer" worksheet.)			Climate (Cooling Load):	Ljubljana T1996-2005/J1981-2000	
Design Temperature:	Ambient Air 25,9 °C	Sky 17,0 °C	Ground 16,9 °C	Radiation:	North 47	East 114	South 131
					West 124	Horizontal 203	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	294,8	0,143	1,00	0,9	38
2. Exterior Wall - Ground	B			1,00	-8,1	
3. Roof/Ceiling - Ambient	A	277,6	0,094	1,00	0,9	23
4. Floor Slab	B	266,8	0,144	1,00	-8,1	-311
5.	A			1,00	0,9	
6.	A			1,00	0,9	
7.	X			0,75	0,9	
8. Windows	A	138,8	0,889	1,00	0,9	111
9. Exterior Door	A	4,5	0,900	1,00	0,9	4
10. Exterior TB (length/m)	A			1,00	0,9	
11. Perimeter TB (length/m)	P	42,0	0,010	1,00	-8,1	-3
12. Ground TB (length/m)	B			1,00	-8,1	
13. House/DU Partition Wall	I	153,1	0,170	1,00	3,0	78
14. Radiation Correction	L _{Ambient} W/K	0,0	TempDiff K	0,9	L _{Sky} W/K	TempDiff K

Transmission Heat Losses P_T

Total	=	-60
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Ventilation System:

Effective Air Volume, V _v	A _{TFA} m²	Clear Room Height m	m³
	472,6	3,60	1701
Exterior	Vent. Transm. W/K	TempDiff K	W
	336,9	0,9	303
Ground	0,0	-8,1	0

Additional Summer Ventilation:

Window Night Ventilation, Manual	Corresponding Air Change Rate	0,30 1/h
Mechanical, Automatically Controlled Ventilation	Minimum Indoor Temperature	22,0 °C
Heat Removal Cooling Design Day (from Cooling worksheet)	Window Ventilation	0,0 kWh/d
	Automatic Night Ventilation	-9,9 kWh/d
		0,024
		0,024
		0
		-414

Ventilation Heat Load P_V

Total	=	-110
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Orientation of the Area	Area m²	g-Value (perp. radiation)	Reduction Factor	Radiation W/m²	P _S W
1. North	67,0	0,5	0,07	66	153
2. East	6,0	0,5	0,03	130	12
3. South	55,3	0,5	0,05	137	170
4. West	10,5	0,5	0,07	83	30
5. Horizontal	0,0	0,0	0,40	203	0
6. Sum Opaque Areas					0

Heat Gain - Solar Heat Load, P_S

Total	=	367
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Internal Heat Load P_I

Spec. Power W/m²	A _{TFA} m²	P _I W
4,1	473	1933

Cooling Load P_C

P _T + P _V + P _S + P _I	=	2129	W
---	---	------	---

Specific Maximum Cooling Load P_C / A_{EB}

	=	4,5	W/m²
--	---	-----	------

Solar Load W	Time h/d	Spec. Capacity Wh/(m²K)	A _{TFA} m²	Daily Temperature Swing due to Solar Load
366,6	24	204	473	0,1 K

Passive House Planning

HEAT DISTRIBUTION AND DHW SYSTEM

Building:	Srednja poklicna in strokovna šola Zreče
Location:	Zreče
Interior Temperature:	20 °C
Building Type/Use:	Javna stavba
Treated Floor Area A_{TFA} :	473 m ²
Occupancy:	100,0 Pers
Number of Residences:	1
Annual Heat Demand $q_{heating}$:	9261 kWh/a
Length of Heating Period:	205 d
Average Heat Load P_{avg} :	1,9 kW
Marginal Utilisability of Additional Heat Gains:	82%

Space Heat Distribution

			Parts		Total	
Length of Distribution Pipes	L_H (Project)		Warm Region	Cold Region		m
Heat Loss Coefficient per m Pipe	Ψ (Project)		1	2	3	W/(mK)
Temperature of the Room Through Which the Pipe	$\theta_{R, Mechanical Room}$		20,00			°C
Design Flow Temperature	$\theta_{DST, Flow, Design Value}$		20			°C
Design System Heat Load	$P_{heating} (exist./calc.)$		25,0			kW
Flow Temperature Control (check)			3,0			
Design Return Temperature	θ_R	= 0,714 * ($\theta_{DST} - 20$) + 20	23,6			°C
Annual Heat Emission per m of Plumbing	q_{HL}	= $\Psi \cdot (\theta_{in} - \theta_R) \cdot t_{heating} \cdot 0,02$	3			Total 1,2,3 kWh/(m ² a)
Possible Utilization Factor of Released Heat	η_{IG}		82%			-
Annual Losses	Q_{HL}	= $L_H \cdot q_{HL} \cdot (1 - \eta_{IG})$	11	0	0	kWh/a
Specif. Losses	q_{HL}	= $\Sigma Q_{HL} / A_{TFA}$				kWh/(m ² a)
Utilisation Factor of Space Heat Distribution	$\eta_{a,HL}$	= $q_H / (q_H + q_{HL})$				-

DHW: Standard Useful Heat

DHW Consumption per Person and Day (60 °C)	V_{DHW} (Project or Average Value 25 Litres/Person/d)		3,0			Litre/Person/d
Average Cold Water Temperature of the Supply	θ_{CW} Temperature of Drinking Water (10°)		10,0			°C
DHW Non-Electric Wash and Dish			0			kWh/a
Useful Heat - DHW	Q_{DHW}		6351			kWh/a
Specif. Useful Heat - DHW	q_{DHW}	= Q_{DHW} / A_{TFA}				kWh/(m ² a)

DHW Distribution and Storage

			Parts		Total	
Length of Circulation Pipes (Flow + Return)	L_{HS} (Project)		Warm Region	Cold Region		m
Heat Loss Coefficient per m Pipe	Ψ (Project)		200,0			W/m/K
Temperature of the Room Through Which the Pipe	$\theta_{R, Mechanical Room}$		0,150			°C
Design Flow Temperature	$\theta_{DST, Flow, Design Value}$		20			°C
Daily circulation period of operation.	$t_{DST, (Project)}$		45,0			h/d
Design Return Temperature	θ_R	= 0,875 * ($\theta_{DST} - 20$) + 20	10,0			°C
Circulation period of operation per year	t_{Circ}	= 365 t_{DST}	42			h/a
Annual Heat Released per m of Pipe	q_{Z}	= $\Psi \cdot (\theta_{in} - \theta_R) \cdot t_{Circ}$	3650			kWh/m/a
Possible Utilization Factor of Released Heat	η_{GDHW}	= $t_{heating} / 365d \cdot \eta_{IG}$	12,8			-
Annual Heat Loss from Circulation Lines	Q_Z	= $L_{HS} \cdot q_{Z} \cdot (1 - \eta_{GDHW})$	45,9%			kWh/a
Total Length of Individual Pipes	L_{IJ} (Project)		1387			kWh/a
Exterior Pipe Diameter	$d_{IJ, Pipe}$ (Project)		25,00			m
Heat Loss Per Tap Opening	$q_{Individual}$	= $(C_{p, H_2O} \cdot V_{DST} + C_{p, H_2O} \cdot V_{tap}) \cdot (\theta_{DST} - \theta_R)$	0,015			m
Occupancy Coefficient	η_{Tap}	= $\eta_{DHW} \cdot 3 \cdot 365 / \eta_{IJ}$	0,0940			kWh/tap opening
Annual Heat Loss	Q_U	= $\eta_{Tap} \cdot q_{Individual}$	109500			Tap openings per year
Possible Utilization Factor of Released Heat	$\eta_{G,U}$	= $t_{heating} / 8760 \cdot \eta_{IG}$	10297,4			kWh/a
Annual Heat Loss of Individual Pipes	Q_U	= $Q_U \cdot (1 - \eta_{G,U})$	45,9%			-
Average Heat Released From Storage	P_S		5566,7			kWh/a
Possible Utilization Factor of Released Heat	$\eta_{G,S}$	= $t_{heating} / 8760 \cdot \eta_{IG}$	50,0			W
Annual Heat Losses from Storage	Q_S	= $P_S \cdot 8.760 \text{ h} \cdot (1 - \eta_{G,S})$	45,9%			kWh/a
Total Heat Losses of the DHW System	Q_{WL}	= $Q_Z + Q_U + Q_S$	236,8			kWh/a
Specif. Losses of the DHW System	q_{WL}	= Q_{WL} / A_{TFA}				kWh/(m ² a)
Utilisation Factor DHW Distrib and Storage	$\eta_{a, WL}$	= $q_{DHW} / (q_{DHW} + q_{WL})$				-
Total Heat Demand of DHW system	Q_{GDHW}	= $Q_{DHW} + Q_{WL}$				kWh/a
Total Spec. Heat Demand of DHW System	q_{GDHW}	= Q_{GDHW} / A_{TFA}				kWh/(m ² a)