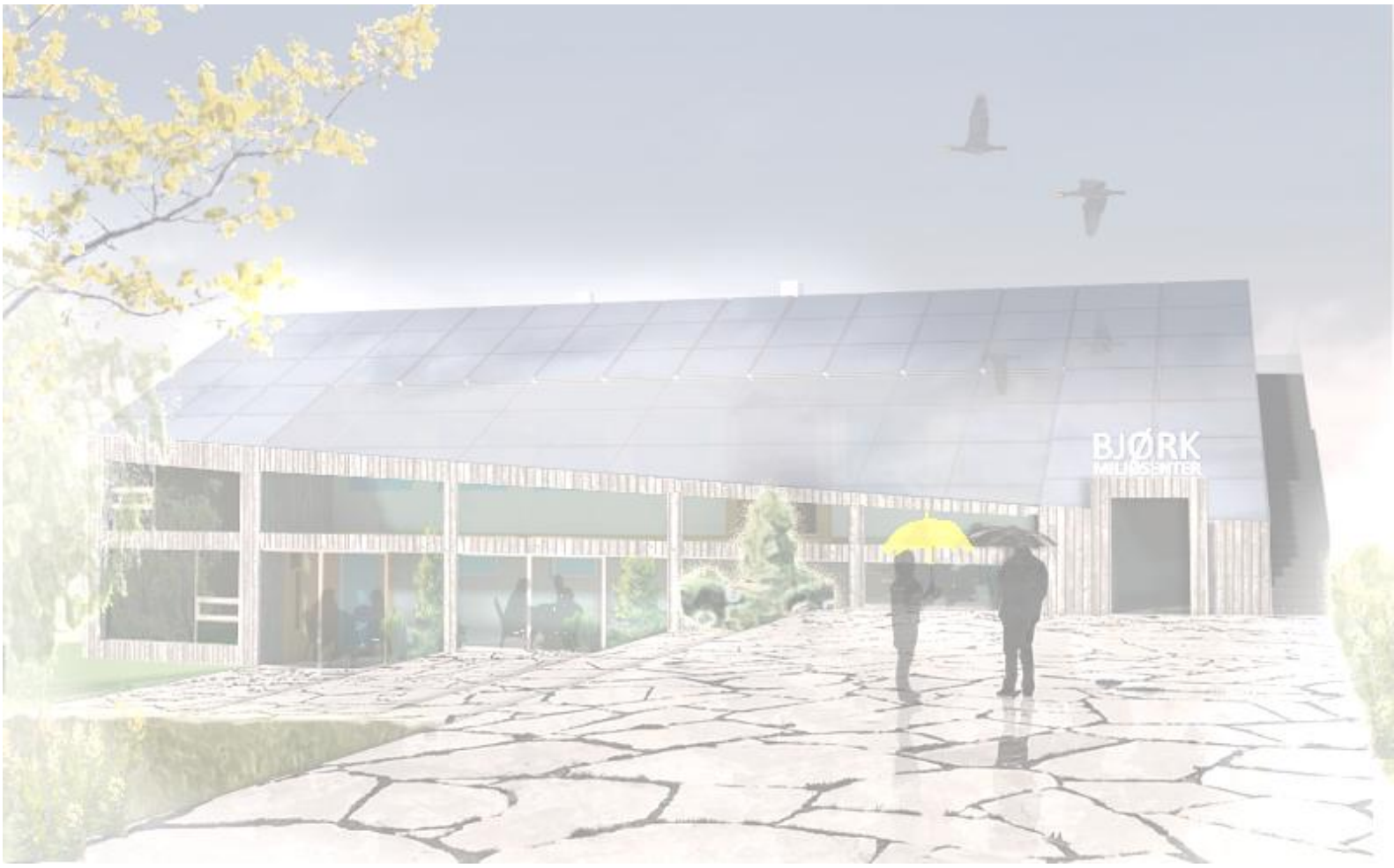
INTEGRATED ENERGY DESIGN – assignment 3



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1. INTRODUCTION

The core of the Linesøya project is to generate a showcase project for sustainable architecture and environmental measures. It aims to complete Scandinavia's first retrofit of a single unit building to zero-energy standard. The existing school building from the 1950 will be renovated to passive house standard to develop energy-efficient retrofitting and on-site energy production. In this context, we have just completed our design studio. For the energy calculation of this project, we have divided the building into three zones which are residential (106.5m^2), culture/office (198m^2) and sports area (159.5m^2). So the total heated floor area is 464m^2.

2. METHODOLOGY

In this assignment, we have basically used the PHPP to to work out more updated energy budgets and quality control related to the project. In this regards, we will somewhat compare the calculations that we have made earlier in the 2nd assignment and the design project. In the earlier assignments, we basically calculated manually and also used Ecotect to some extent.

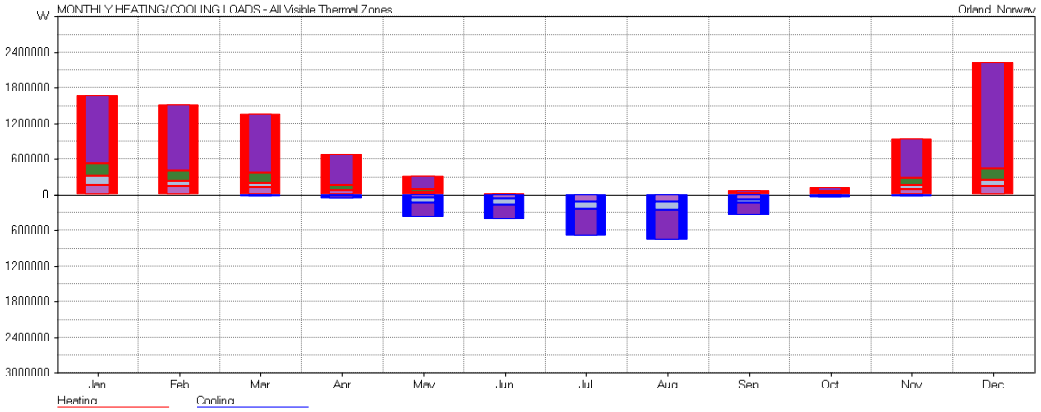
3. CALCULATION RESULTS

Comparative study of calculations made during the design project with PHPP

Heating

	heat		electricity		total
	Net energy demand [kwh/a]	Specific energy demand [kwh/(m^{2}a) (464.4m^2)]	Net energy demand [kwh/a]	Specific energy demand [kwh/(m^{2}a) (464.4m^2)]	
heating	10093.768	21.74			
domestic hot water(DHW)	12119.0918	26.10			
fans			4820.724	10.38	
pumps			1441.44	3.10	
lighting			6430.144	13.85	
technical equipment			4876.782	10.50	
cooling					
sum	22212.8598		17569.09		39781.95
		47.83		37.83	85.66

Figure 1: Energy demand of the building (calculation during the design project)



MONTH	HEATING (Wh)	COOLING (Wh)	TOTAL (Wh)
Jan	1667302	0	1667302
Feb	1505826	0	1505826
Mar	1358103	25953	1384056
Apr	684460	70939	755398
May	317166	375289	692455
Jun	13253	425503	438756
Jul	6498	695363	701862
Aug	5775	760896	766671
Sep	66788	348524	415312
Oct	117361	60807	178168
Nov	946406	24155	970561
Dec	2226450	3524	2229974
TOTAL	**8915389**	**2790952**	**11706342**
PER M	**19197.6507**	**6009.80189**	**41.3386105**
Floor Area:	**464.4**	m2	

Figure 2: Heating demand of the building from the Ecotect

From fig1, we see that the maximum heating demand of the building is 21.74kwh/(m^2a). This number is calculated according to the Norwegian Passive House Standard. However, the simulation result of the heating requirement from the Ecotect is 19.2kwh/(m^2a)(Fig 2). It seems that this result doesn't meet the passive house requirement of no more than 15 kwh/(m^2a). The reasons behind this are, first the limitation of the Ecotect, for example, we were not able to find all materials which we choose in our project, so the deviation exists during simulation. Second one is because this house is not only serves for a residential purpose, but is also a multipurpose space with office, a gym and a conference . In this case, the heating demand for the office as per the standard is no more than 25 kwh/(m^2a). Therefore, our design meets the Passive House Standard.

Specific Demands with Reference to the Treated Floor Area

Treated Floor Area: 472.0 m^2

	Applied:	Monthly Method		PH Certificate:	Fulfilled?
Specific Space Heat Demand:	**8**	**kWh/(m^2a)**	**15**	**kWh/(m^2a)**	**Yes**
Pressurization Test Result:	**0.1**	**h^{-1}**	0.6	h^{-1}	**Yes**
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	**93**	**kWh/(m^2a)**	120	kWh/(m^2a)	**Yes**
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	**34**	**kWh/(m^2a)**			
Specific Primary Energy Demand Energy Conservation by Solar Electricity:	**37**	**kWh/(m^2a)**			
Heating Load:	**8**	**W/m^2**			

Frequency of Overheating:	**0**	**%**	over	25	°C
Specific Useful Cooling Energy Demand:		**kWh/(m²a)**		15	kWh/(m²a)
Cooling Load:	**8**	**W/m²**			

Figure 3: Simulation results from PHPP

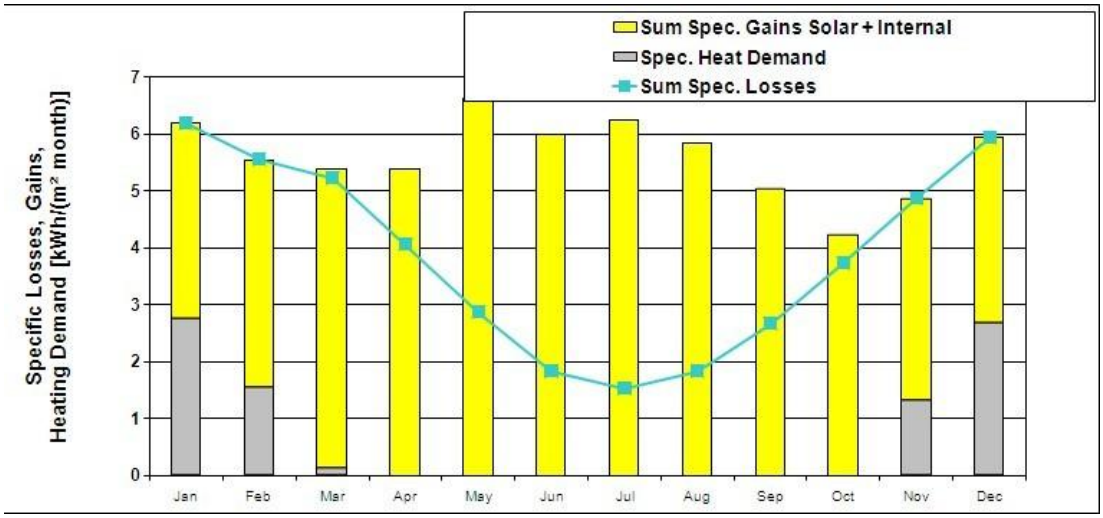


Figure 4: Heating demand of the building from PHPP

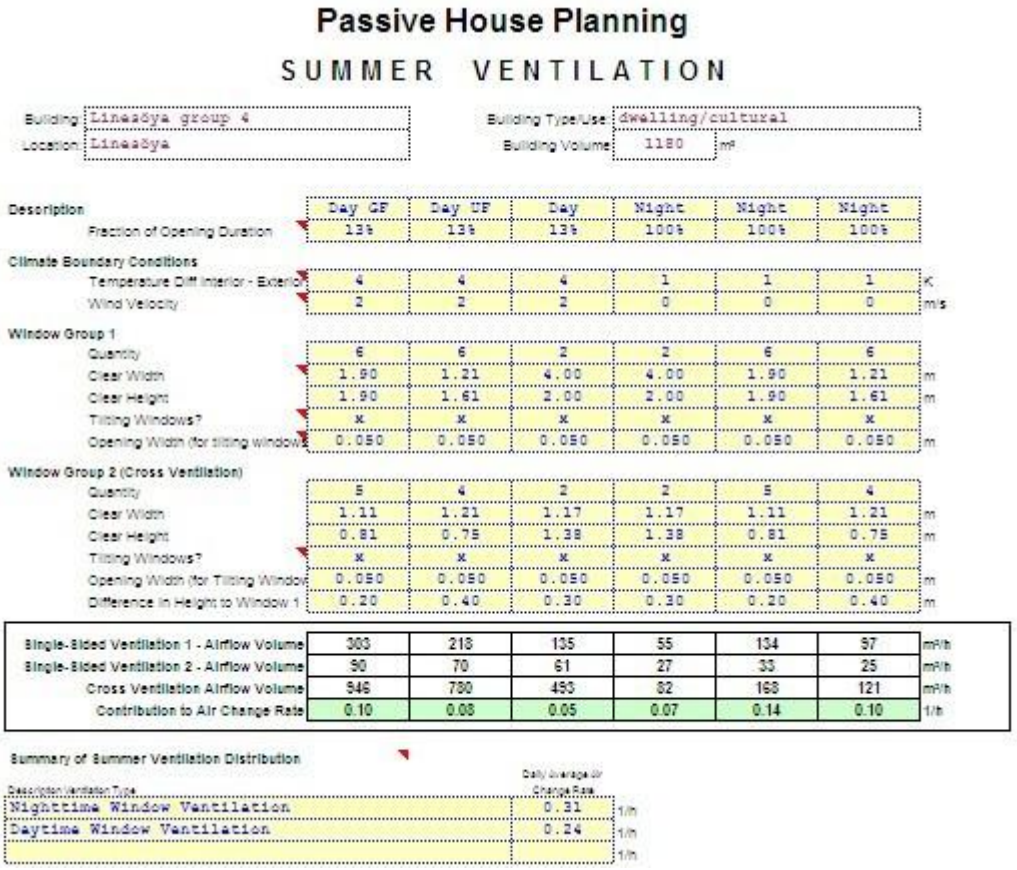
Fig3 and 4 show that the specific space heat demand of the building is 8kwh/(m^{2}a). This is because we choose an excellent insulation in the real situation, which helps reduce the heating demand of the building. And also, we can notice that the treated floor area is 472m^2, which is bigger than the heated floor area(464 m^2) which we used in the energy calculation manually during the design process. This 472m^2 also contains about the partition wall area and elevator. The primary energy demand is 93 kwh/(m^{2}a), which also meets the passive house standard.

Electricity

For reference see attached PHPP (appendix)

In PHPP we have calculated the electricity demand for lighting. This depends on the category, the geometry and orientation of the room, and of course the window sizes. This gives us the lightning demand of 8083 kWh/a. Here we also can see that even though the gym does not demand high illuminance level it is still the biggest consumer of electricity for lighting. This is because it takes 26% of the floor area and has small windows compared to its size. This lighting demand is about 1600 kWh higher then calculated in the energy budget in previous phase.

When it comes to office equipment we have calculated with 2 PCs with monitors, 1 copier, 2 printers, 1 server and 1 telephone system. The telephone system is the largest consumer in this chart mainly because it runs for 8769 hours a year. In the café kitchen we have a gas stove, dishwasher, refrigerator and a coffee machine. Since we have chosen to treat the building as non-domestic in PHPP the household appliances are not taken into account. But we have manually calculated them to 4587 kWh/a. This contains dishwasher, washing machine, refrigerator, freezer, consumer electronics and other small appliances. The office equipment and the kitchen cafè demands are 2114 kWh compared to 4875 kWh calculated in previous phase. The difference is because we earlier calculated this with a standard value for technical equipment in offices, while in PHPP we have specified the type and number of equipment.



Passive House Planning

SUMMER VENTILATION

Building	Linaa3ya group 4		Building Type/use	dwelling/cultural		
Location	Linaa3ya		Building Volume	1180	m³	

Description	Day GF	Day UF	Day	Night	Night	Night	
Fraction of Opening Duration	13%	13%	13%	100%	100%	100%	
Climate Boundary Conditions							
Temperature Diff Interior - Exterior	4	4	4	1	1	1	K
Wind Velocity	2	2	2	0	0	0	m/s
Window Group 1							
Quantity	6	6	2	2	6	6	
Clear Width	1.90	1.21	4.00	4.00	1.90	1.21	m
Clear Height	1.90	1.61	2.00	2.00	1.90	1.61	m
Tilting Windows?	x	x	x	x	x	x	
Opening Width (for tilting windows)	0.050	0.050	0.050	0.050	0.050	0.050	m
Window Group 2 (Cross Ventilation)							
Quantity	5	4	2	2	5	4	
Clear Width	1.11	1.21	1.17	1.17	1.11	1.21	m
Clear Height	0.81	0.75	1.38	1.38	0.81	0.75	m
Tilting Windows?	x	x	x	x	x	x	
Opening Width (for Tilting Windows)	0.050	0.050	0.050	0.050	0.050	0.050	m
Difference in Height to Window 1	0.20	0.40	0.20	0.20	0.20	0.40	m

Single-Sided Ventilation 1 - Airflow Volume	303	218	135	55	134	97	m³/h
Single-Sided Ventilation 2 - Airflow Volume	90	70	61	27	33	25	m³/h
Cross Ventilation Airflow Volume	546	780	450	82	160	121	m³/h
Contribution to Air Change Rate	0.10	0.08	0.05	0.07	0.14	0.10	1/h

Summary of Summer Ventilation Distribution

Description Ventilation Type	Daily Average Air Change Rate	
Nighttime Window Ventilation	0.31	1/h
Daytime Window Ventilation	0.24	1/h
		1/h

Figure 5: Summer ventilation

We decide to use cross ventilation in the summer, figure 5 shows that the air change rate of the night time widow ventilation is 0.31 1/h and the day time widow ventilation is 0.24 1/h.

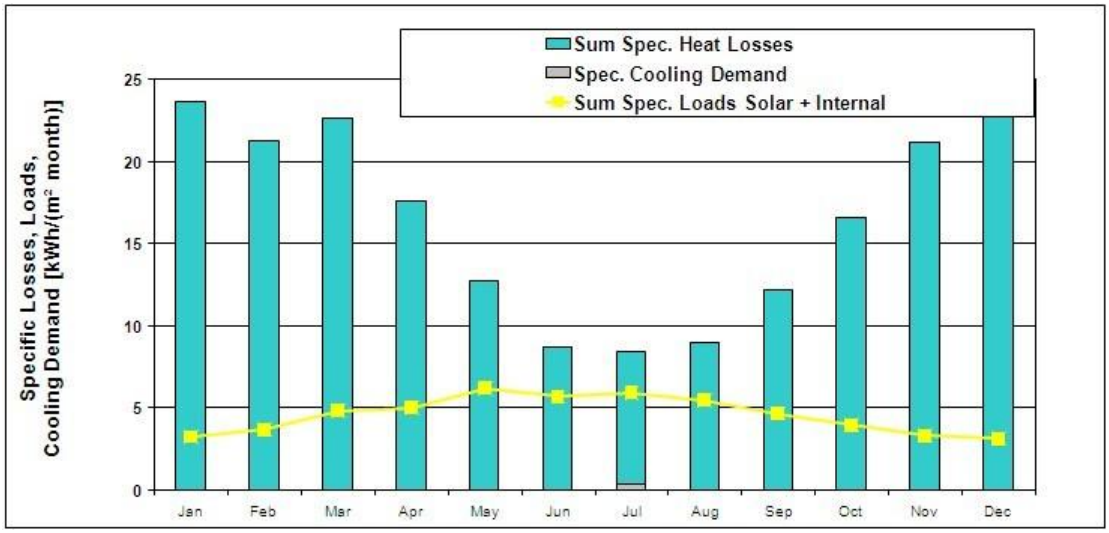


Figure 6: Cooling demand of the building

Figure 6 shows that the cooling demand of the building in Oslo is not too much, which is just 0.4 kwh/(m^2a) in July.

Secondary Calculation: Ψ-Values of Plumbing

Nominal Width		240	mm
Insulation Thickness:		100	mm
Reflective? Please mark with an "x"!			
x	Yes		
	No		
Thermal Conductivity		0.035	W/(mK)
	ΔϑΔ	30	K
	Interior Pipe Diameter:	0.24000	m
	Exterior Pipe Diameter	0.24225	m
	Exterior Pipe Diameter	0.44225	m
	α–Surface	2.72	W/(m²K)
	Ψ-Value	**0.333**	**W/(mK)**
Surface Temperature Difference		0.000	K

Figure 7 : The dimension of the plumbing of the solar thermal system

Secondary Calculation:

Ψ-value Supply or Ambient Air Duct

Nominal Width	100	mm
Insul. Thickness:	150	mm
Reflective? Please mark with an "x"!		
x	Yes	
	No	
Thermal Conductivity	0.04	W/(mK)
Nominal Air Flow Rate	354	m³/h
Δϑ	21	K
Interior Duct Diameter	0.100	m
Interior Diameter	0.100	m
Exterior Diameter	0.400	m
α-Interior	46.12	W/(m²K)
α–Surface	2.32	W/(m²K)
Ψ-value	**0.169**	**W/(mK)**
Surface Temperature Difference	1.467	K

Figure 8: The dimension of the supply air duct of the heat recovery system

Secondary Calculation:

Ψ-value Extract or Exhaust Air Duct

Nominal Width	125	mm
Insul. Thickness:	100	mm
Reflective? Please mark with an "x"!		
x	Yes	
	No	
Thermal Conductivity	0.04	W/(mK)
Nominal Air Flow Rate	354	m³/h
Δϑ	21	K
Interior Duct Diameter	0.12500	m
Exterior Duct Diameter	0.12500	m
Exterior Diameter	0.32500	m
α-Interior	30.86	W/(m²K)
α–Surface	2.61	W/(m²K)
Ψ-value	**0.235**	**W/(mK)**
Surface Temperature Difference	2.269	K

Figure 9: The dimension of the exhaust air duct of the heat recovery system

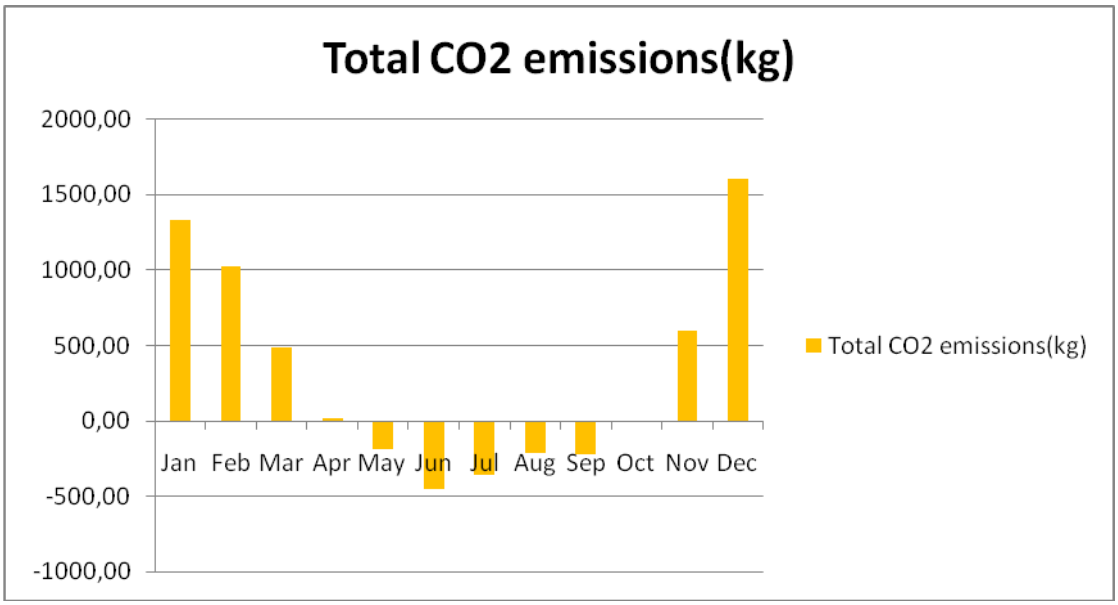


Figure 10: Total CO2 emissions

Heating, Cooling, DHW, Auxiliary and Household Electricity			44.7	119.7	30.0
Total PE Value	119.7	kWh/(m²a)			
Total Emissions CO_2-Equivalent	30.0	kg/(m²a)			(Yes/No)
Primary Energy Requirement		120	kWh/(m²a)		Yes
Heating, DHW, Auxiliary Electricity (No Household Applications)			12.7	34.3	8.6
Specific PE Demand - Mechanical System	34.3	kWh/(m²a)			
Total Emissions CO_2-Equivalent	8.6	kg/(m²a)			
Solar Electricity			kWh/a	PE Value (Savings)	CO_2-Emission Factor
Planned Annual Electricity Generation		*Separate Calculation*	8628	kWh/kWh	g/kWh
				0.7	250
Specific Demand			18.3	12.8	4.6
PE Value: Conservation by Solar Electricity	36.6	kWh/(m²a)			
CO_2-Emissions Avoided Due to Solar Electricity	7.9	kg/(m²a)			

Figure 11: PE value and CO_2 emissions

Fig10 shows that the total $C0_2$ emissions for the whole year of the building is 6849.32kg which is 14.7 kg/(m^2a). But the result from PHPP(Fig11) shows that the CO2- Equivalent is 8.6 kg/(m^2a). This is because the design from PHPP doesn't contain the wind turbine system which we decide to use in our primary design.

Strategies used in the design:

Passive

- Orientation of the sunspace
- Thermal mass
- Insulation
- Natural ventilation

Active

- PV
- Solar thermal collector
- Heat pump
- Wind turbine
- Heat recovery system

Strategy in PHPP:

- Insulation
- Cross ventilation

Active

- PV
- Solar thermal collector
- Compact heat pump
- Heat recovery system

According to PHPP the U-values of the building elements are; wall 0,103 W(m³K), roof 0,080 W(m³K), and ground floor 0,124 W(m³K). This corresponds with other information we found about the construction chosen. This construction is also used In Oslo's first passive house on Ladeveien.

5. Conclusions

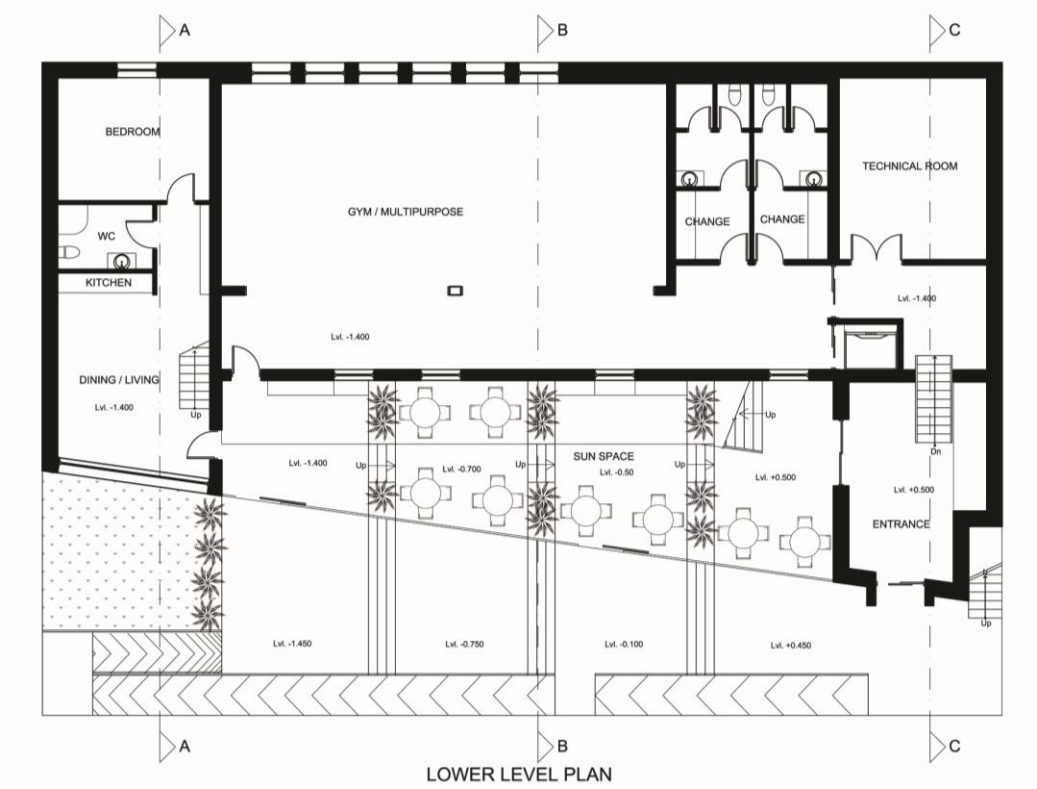
We have tried to use PHPP for our calculations even though our knowledge in this package is limited. In the process, we have realised that there are some differences in the parameters that we used in the calculations manually or using Ecotect to that used in PHPP. Hence, the calculations have to be viewed based on these realities.

From the calculations by PHPP, we see that the results are better in terms of use of energy. One of the reason is we used the exact windows with relevant U-values that is recommened by PHPP. In the earlier calculations, we had not detailed out the electricity used in lighting as PHPP has helped us to do it now. So, the values for energy seems to be higher than that we have calculated earlier.

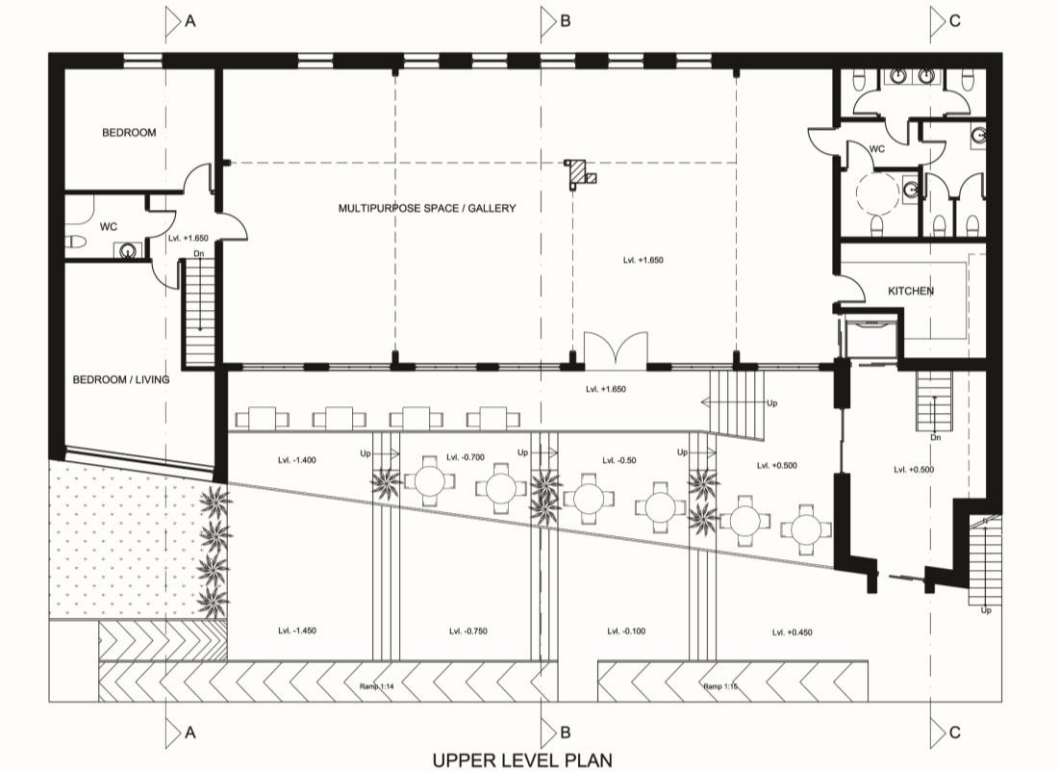
5. Limitations

Due to limitations with the knowledge on the package PHPP,unable to understand all the topics raised in the assignments and time limitations, wemay not have been able solve all the issues stated in the assignments. We wished there was some guidance, however this was not possible due to time restriction. Inspite of all these, we have tried our best.

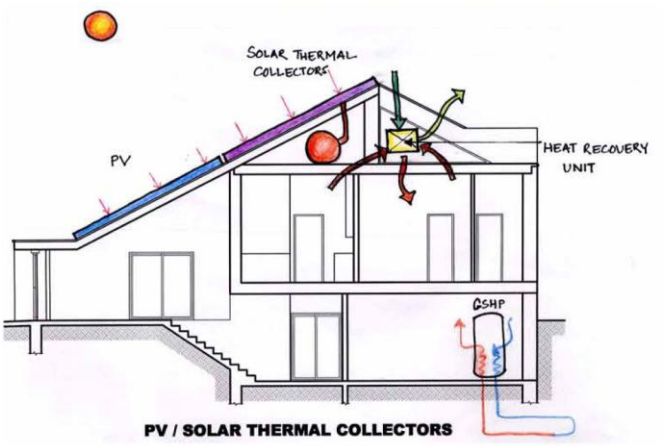
Plans



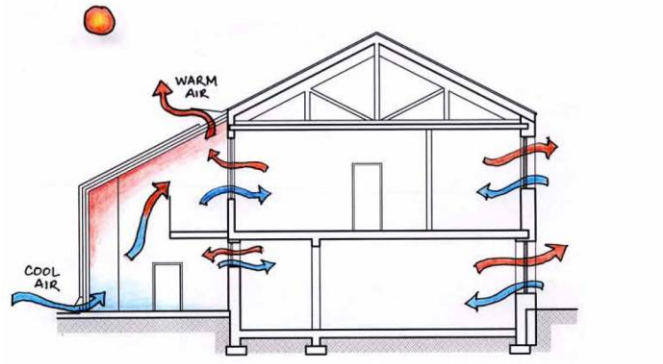
LOWER LEVEL PLAN



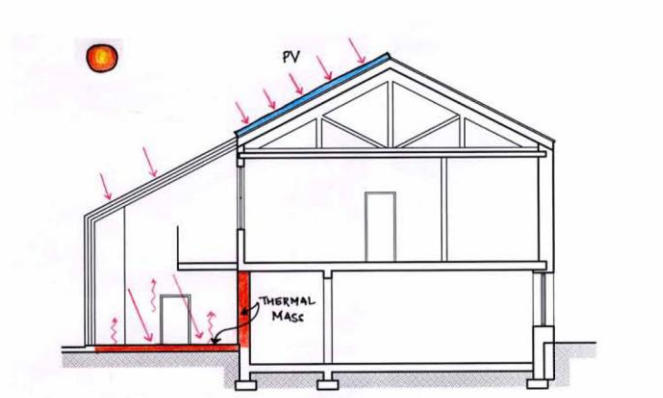
UPPER LEVEL PLAN



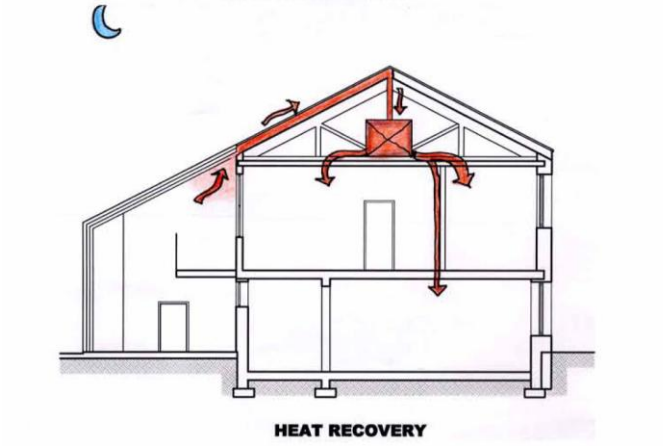
PV / SOLAR THERMAL COLLECTORS



Natural Ventilation



PV & THERMAL MASS



HEAT RECOVERY

Reference

[1] M. Haase, V. Novakovic, Renewable energy application in zero emission buildings- a case study, NTNU, Norway.

[2] M. Haase, Energy calculations and documentations lectures, NTNU, Norway.

[3] Norwegian Passive house standard (NS3700, 2010)

[4] Dr. Wolfgang Feist, Passiv Haus Institut. Passive House Planning Package 2007.

Appendix

Passive House Verification

Building:	Linesöya group 4	
Location and Climate:	Linesöya	N - Oslo
Street:		
Postcode/City:		
Country:		
Building Type:	dwelling/cultural	
Home Owner(s) / Client(s):		
Street:		
Postcode/City:		
Architect:		
Street:		
Postcode/City:		
Mechanical System:		
Street:		
Postcode/City:		
Year of Construction:		
Number of Dwelling Units:	1	
Enclosed Volume V_e:	1180.0	m^3
Number of Occupants:	12.0	
Interior Temperature:	20.0	°C
Internal Heat Gains:	3.5	W/m^2

Specific Demands with Reference to the Treated Floor Area

Treated Floor Area: 472.0 m^2

	Applied:	Monthly Method	PH Certificate:		Fulfilled?
Specific Space Heat Demand:	**8**	**kWh/(m^2a)**	**15**	**kWh/(m^2a)**	**Yes**
Pressurization Test Result:	**0.1**	**h^{-1}**	0.6	h^{-1}	**Yes**
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	**93**	**kWh/(m^2a)**	120	kWh/(m^2a)	**Yes**
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	**34**	**kWh/(m^2a)**			
Specific Primary Energy Demand Energy Conservation by Solar Electricity:	**37**	**kWh/(m^2a)**			
Heating Load:	**8**	**W/m^2**			
Frequency of Overheating:	**0**	**%**	over 25 °C		
Specific Useful Cooling Energy Demand:		**kWh/(m^2a)**	15	kWh/(m^2a)	
Cooling Load:	**8**	**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:

signed:

Passive House Planning

AREAS DETERMINATION

Building: Linesöya group 4 Heat Demand 8 kWh/(m²a)

Summary							
Group Nr.	Area Group	Temp Zone	Area	Unit	Comments	Building Element Overview	Average U-Value [W/(m²K)]
1	Treated Floor Area		472.00	m²	*Living area or useful area within the thermal envelope*		
2	North Windows	A	21.42	m²	Results are from the Windows worksheet.	North Windows	0.786
3	East Windows	A	5.29	m²		East Windows	0.787
4	South Windows	A	43.66	m²		South Windows	0.762
5	West Windows	A	0.00	m²		West Windows	
6	Horizontal Windows	A	0.00	m²		Horizontal Windows	
7	Exterior Door	A	0.00	m²	*Please subtract area of door from respective building element*	Exterior Door	
8	Exterior Wall - Ambient	A	416.63	m²	*Window areas are subtracted from the individual areas specified in the "Windows" worksheet.*	Exterior Wall - Ambient	0.103
9	Exterior Wall - Ground	B	0.00	m²	*Temperature Zone "A" is ambient air.*	Exterior Wall - Ground	
10	Roof/Ceiling - Ambient	A	314.00	m²	*Temperature zone "B" is the ground.*	Roof/Ceiling - Ambient	0.080
11	Floor Slab	B	214.00	m²		Floor Slab	0.124
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	0.00	m	*Units in m*	Thermal Bridges Ambient	
16	Perimeter Thermal Bridges	P	0.00	m	*Units in m; temperature zone "P" is perimeter (see Ground worksheet).*	Perimeter Thermal Bridges	
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 heat load calculation.*	Partition Wall to Neighbour	
Total Thermal Envelope			1015.00	m²		Average Therm. Envelope	0.146

Area Input

Area Nr.	Building Element Description	Group Nr.	Assigned to Group	Quan-tity	x (	a [m]	x	b [m]	+	User-Deter-mined [m²]	-	User Sub-traction [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		+	472.00	-				) =	472.0			
	North Windows	2	North Windows	Please complete in Windows worksheet only!												21.4	From Windows sheet		0.786
	East Windows	3	East Windows													5.3	From Windows sheet		0.787
	South Windows	4	South Windows													43.7	From Windows sheet		0.762
	West Windows	5	West Windows													0.0	From Windows sheet		0.000
	Horizontal Windows	6	Horizontal Windows													0.0	From Windows sheet		0.000
	Exterior Door	7	Exterior Door		x (		x		+	16.00	-		) -		=		U-Value Exterior Door		
1	Exterior wall south	8	Exterior Wall - Ambient	1	x (		x		+	162.00	-	11.00	) -	40.0	=	111.0	Exterior wall	1	0.103
2	Exterior wall north	8	Exterior Wall - Ambient	1	x (		x		+	165.00	-		) -	25.1	=	139.9	Exterior wall	1	0.103
3	Exterior wall west	8	Exterior Wall - Ambient	1	x (		x		+	93.00	-		) -	0.0	=	93.0	Exterior wall	1	0.103
4	Roof	10	Roof/Ceiling - Ambient	1	x (		x		+	162.00	-		) -	0.0	=	162.0	Roof	2	0.080
5	Basement floor	11	Floor Slab	1	x (		x		+	214.00	-		) -	0.0	=	214.0	Ground Floor	3	0.124
6	EXTERIOR WALL EAST	8	Exterior Wall - Ambient	1	x (		x		+	83.00	-	5.00	) -	5.3	=	72.7	Exterior wall	1	0.103
7					x (		x		+		-		) -	0.0	=			4	
8	ROOF 2	10	Roof/Ceiling - Ambient	1	x (		x		+	152.00	-		) -	0.0	=	152.0	Roof	2	0.080
9					x (		x		+		-		) -	0.0	=			0	
10					x (		x		+		-		) -	0.0	=			0	
11					x (		x		+		-		) -	0.0	=			0	
12					x (		x		+		-		) -	0.0	=			0	
13					x (		x		+		-		) -	0.0	=			0	
14					x (		x		+		-		) -	0.0	=			0	
15					x (		x		+		-		) -	0.0	=			0	
16					x (		x		+		-		) -	0.0	=			0	
17					x (		x		+		-		) -	0.0	=			0	
18					x (		x		+		-		) -	0.0	=			0	
19					x (		x		+		-		) -	0.0	=			0	
20					x (		x		+		-		) -	0.0	=			0	
21					x (		x		+		-		) -	0.0	=			0	
22					x (		x		+		-		) -	0.0	=			0	
23					x (		x		+		-		) -	0.0	=			0	
24					x (		x		+		-		) -	0.0	=			0	
25					x (		x		+		-		) -	0.0	=			0	
26					x (		x		+		-		) -	0.0	=			0	
27					x (		x		+		-		) -	0.0	=			0	
28					x (		x		+		-		) -	0.0	=			0	
29					x (		x		+		-		) -	0.0	=			0	
30					x (		x		+		-		) -	0.0	=			0	
31					x (		x		+		-		) -	0.0	=			0	
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	
FLend																			

Passive House Planning

AREAS DETERMINATION

Building: Linesöya group 4 Heat Demand 8 kWh/(m²a)

Summary							Building Element Overview	Average U-Value [W/(m²K)]
Group Nr.	Area Group	Temp Zone	Area	Unit	Comments			
1	Treated Floor Area		472.00	m²	*Living area or useful area within the thermal envelope*			
2	North Windows	A	21.42	m²	Results are from the Windows worksheet.		North Windows	0.786
3	East Windows	A	5.29	m²			East Windows	0.787
4	South Windows	A	43.66	m²			South Windows	0.762
5	West Windows	A	0.00	m²			West Windows	
6	Horizontal Windows	A	0.00	m²			Horizontal Windows	
7	Exterior Door	A	0.00	m²	*Please subtract area of door from respective building element*		Exterior Door	
8	Exterior Wall - Ambient	A	416.63	m²	*Window areas are subtracted from the individual areas specified in the "Windows" worksheet.*		Exterior Wall - Ambient	0.103
9	Exterior Wall - Ground	B	0.00	m²	*Temperature Zone "A" is ambient air.*		Exterior Wall - Ground	
10	Roof/Ceiling - Ambient	A	314.00	m²	*Temperature zone "B" is the ground.*		Roof/Ceiling - Ambient	0.080
11	Floor Slab	B	214.00	m²			Floor Slab	0.124
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	0.00	m	*Units in m*		Thermal Bridges Ambient	
16	Perimeter Thermal Bridges	P	0.00	m	*Units in m; temperature zone "P" is perimeter (see Ground worksheet).*		Perimeter Thermal Bridges	
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 heat load calculation.*		Partition Wall to Neighbour	
Total Thermal Envelope			1015.00	m²			Average Therm. Envelope	0.146

Thermal Bridge Inputs

Nr. of Thermal Bridge	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	Ext. wall-basement	15	Thermal Bridges Ambient	1	x (	0.00	-		) =	0.00	Ext. wall-basement	-0.039
2	Int. wall-basement	17	Thermal Bridges Floor Slab	1	x (	0.00	-		) =	0.00	Int. wall-basement	0.061
3	Partition walls	15	Thermal Bridges Ambient	1	x (	0.00	-		) =	0.00	Partition walls	0.000
4	Interior ceilings	15	Thermal Bridges Ambient	1	x (	0.00	-		) =	0.00	Interior ceilings	0.002
5	Partition wall-roof	15	Thermal Bridges Ambient	1	x (	0.00	-		) =	0.00	Partition wall-roof	0.005
6	Ext. wall-roof	15	Thermal Bridges Ambient	1	x (	0.00	-		) =	0.00	Ext. wall-roof	-0.061
7	Ext. wall edge	15	Thermal Bridges Ambient	1	x (	0.00	-		) =	0.00	Ext. wall edge	-0.062
8					x (		-		) =			
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 (		-		) =			
TBend												

Additional Inputs for Radiation Balance

Exterior Absorptivity	Exterior Emissivity	Deviation from North	Angle of Inclination from the Horizontal	Reduction Factor Shading
These columns serve for considering the radiation balance of exterior, opaque surfaces. Inputs only for those surfaces which are adjacent to ambient air! For consideration of heating in Central European climates no input is required.				
0.60	0.90	164	90	0.90
0.60	0.90	344	90	0.90
0.60	0.90	254	90	0.90
0.90	0.90	164	27	
0.60	0.90	74	90	0.90
0.90	0.90	344	27	

A Tool for Thermal Bridge Conversion To Exterior Dimensions

Description		Units	Example			
	Ψ Interior Dimensions	W/(mK)	0.027			
	Temperature Diff. TB	K	30			
Adjacent Area I	Temperature Diff. ∆ϑ I	K	30			
	Exterior - Interior Dim. I	m	0.40			
	U-Value Building Element I	W/(m²K)	0.138			
Adjacent Area II	Temperature Diff. ∆ϑ II	K	30			
	Exterior - Interior Dim. II	m	0.30			
	U-Value Building Element II	W/(m²K)	0.110			
	Ψ Exterior Dimensions	W/(mK)	-0.061			

Passive House Planning

AREAS DETERMINATION

Building: Linesöya group 4 Heat Demand 8 kWh/(m²a)

Summary							
Group Nr.	Area Group	Temp Zone	Area	Unit	Comments	Building Element Overview	Average U-Value [W/(m²K)]
1	Treated Floor Area		472.00	m²	*Living area or useful area within the thermal envelope*		
2	North Windows	A	21.42	m²	Results are from the Windows worksheet.	North Windows	0.786
3	East Windows	A	5.29	m²		East Windows	0.787
4	South Windows	A	43.66	m²		South Windows	0.762
5	West Windows	A	0.00	m²		West Windows	
6	Horizontal Windows	A	0.00	m²		Horizontal Windows	
7	Exterior Door	A	0.00	m²	*Please subtract area of door from respective building element*	Exterior Door	
8	Exterior Wall - Ambient	A	416.63	m²	*Window areas are subtracted from the individual areas specified in the "Windows" worksheet.*	Exterior Wall - Ambient	0.103
9	Exterior Wall - Ground	B	0.00	m²	*Temperature Zone "A" is ambient air.*	Exterior Wall - Ground	
10	Roof/Ceiling - Ambient	A	314.00	m²	*Temperature zone "B" is the ground.*	Roof/Ceiling - Ambient	0.080
11	Floor Slab	B	214.00	m²		Floor Slab	0.124
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	0.00	m	*Units in m*	Thermal Bridges Ambient	
16	Perimeter Thermal Bridges	P	0.00	m	*Units in m; temperature zone "P" is perimeter (see Ground worksheet).*	Perimeter Thermal Bridges	
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 heat load calculation.*	Partition Wall to Neighbour	
Total Thermal Envelope			1015.00	m²		Average Therm. Envelope	0.146

Area Input

Area Nr.	Building Element Description	Group Nr.	Assigned to Group	Quan-tity	x (	a [m]	x	b [m]	+	User-Deter-mined [m²]	-	User Sub-traction [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		+	472.00	-				) =	472.0			
	North Windows	2	North Windows	Please complete in Windows worksheet only!												21.4	From Windows sheet		0.786
	East Windows	3	East Windows													5.3	From Windows sheet		0.787
	South Windows	4	South Windows													43.7	From Windows sheet		0.762
	West Windows	5	West Windows													0.0	From Windows sheet		0.000
	Horizontal Windows	6	Horizontal Windows													0.0	From Windows sheet		0.000
	Exterior Door	7	Exterior Door		x (		x		+	16.00	-		) -		=		U-Value Exterior Door		
1	Exterior wall south	8	Exterior Wall - Ambient	1	x (		x		+	162.00	-	11.00	) -	40.0	=	111.0	Exterior wall	1	0.103
2	Exterior wall north	8	Exterior Wall - Ambient	1	x (		x		+	165.00	-		) -	25.1	=	139.9	Exterior wall	1	0.103
3	Exterior wall west	8	Exterior Wall - Ambient	1	x (		x		+	93.00	-		) -	0.0	=	93.0	Exterior wall	1	0.103
4	Roof	10	Roof/Ceiling - Ambient	1	x (		x		+	162.00	-		) -	0.0	=	162.0	Roof	2	0.080
5	Basement floor	11	Floor Slab	1	x (		x		+	214.00	-		) -	0.0	=	214.0	Ground Floor	3	0.124
6	EXTERIOR WALL EAST	8	Exterior Wall - Ambient	1	x (		x		+	83.00	-	5.00	) -	5.3	=	72.7	Exterior wall	1	0.103
7					x (		x		+		-		) -	0.0	=			4	
8	ROOF 2	10	Roof/Ceiling - Ambient	1	x (		x		+	152.00	-		) -	0.0	=	152.0	Roof	2	0.080
9					x (		x		+		-		) -	0.0	=			0	
10					x (		x		+		-		) -	0.0	=			0	
11					x (		x		+		-		) -	0.0	=			0	
12					x (		x		+		-		) -	0.0	=			0	
13					x (		x		+		-		) -	0.0	=			0	
14					x (		x		+		-		) -	0.0	=			0	
15					x (		x		+		-		) -	0.0	=			0	
16					x (		x		+		-		) -	0.0	=			0	
17					x (		x		+		-		) -	0.0	=			0	
18					x (		x		+		-		) -	0.0	=			0	
19					x (		x		+		-		) -	0.0	=			0	
20					x (		x		+		-		) -	0.0	=			0	
21					x (		x		+		-		) -	0.0	=			0	
22					x (		x		+		-		) -	0.0	=			0	
23					x (		x		+		-		) -	0.0	=			0	
24					x (		x		+		-		) -	0.0	=			0	
25					x (		x		+		-		) -	0.0	=			0	
26					x (		x		+		-		) -	0.0	=			0	
27					x (		x		+		-		) -	0.0	=			0	
28					x (		x		+		-		) -	0.0	=			0	
29					x (		x		+		-		) -	0.0	=			0	
30					x (		x		+		-		) -	0.0	=			0	
31					x (		x		+		-		) -	0.0	=			0	
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	
FLend																			

Passive House Planning

AREAS DETERMINATION

Building: Linesöya group 4 Heat Demand 8 kWh/(m²a)

Summary							Building Element Overview	Average U-Value [W/(m²K)]
Group Nr.	Area Group	Temp Zone	Area	Unit	Comments			
1	Treated Floor Area		472.00	m²	*Living area or useful area within the thermal envelope*			
2	North Windows	A	21.42	m²	Results are from the Windows worksheet.		North Windows	0.786
3	East Windows	A	5.29	m²			East Windows	0.787
4	South Windows	A	43.66	m²			South Windows	0.762
5	West Windows	A	0.00	m²			West Windows	
6	Horizontal Windows	A	0.00	m²			Horizontal Windows	
7	Exterior Door	A	0.00	m²	*Please subtract area of door from respective building element*		Exterior Door	
8	Exterior Wall - Ambient	A	416.63	m²	*Window areas are subtracted from the individual areas specified in the "Windows" worksheet.*		Exterior Wall - Ambient	0.103
9	Exterior Wall - Ground	B	0.00	m²	*Temperature Zone "A" is ambient air.*		Exterior Wall - Ground	
10	Roof/Ceiling - Ambient	A	314.00	m²	*Temperature zone "B" is the ground.*		Roof/Ceiling - Ambient	0.080
11	Floor Slab	B	214.00	m²			Floor Slab	0.124
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	0.00	m	*Units in m*		Thermal Bridges Ambient	
16	Perimeter Thermal Bridges	P	0.00	m	*Units in m; temperature zone "P" is perimeter (see Ground worksheet).*		Perimeter Thermal Bridges	
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 heat load calculation.*		Partition Wall to Neighbour	
Total Thermal Envelope			1015.00	m²			Average Therm. Envelope	0.146

Thermal Bridge Inputs

Nr. of Thermal Bridge	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	Ext. wall-basement	15	Thermal Bridges Ambient	1	x (	0.00	-		) =	0.00	Ext. wall-basement	-0.039
2	Int. wall-basement	17	Thermal Bridges Floor Slab	1	x (	0.00	-		) =	0.00	Int. wall-basement	0.061
3	Partition walls	15	Thermal Bridges Ambient	1	x (	0.00	-		) =	0.00	Partition walls	0.000
4	Interior ceilings	15	Thermal Bridges Ambient	1	x (	0.00	-		) =	0.00	Interior ceilings	0.002
5	Partition wall-roof	15	Thermal Bridges Ambient	1	x (	0.00	-		) =	0.00	Partition wall-roof	0.005
6	Ext. wall-roof	15	Thermal Bridges Ambient	1	x (	0.00	-		) =	0.00	Ext. wall-roof	-0.061
7	Ext. wall edge	15	Thermal Bridges Ambient	1	x (	0.00	-		) =	0.00	Ext. wall edge	-0.062
8					x (		-		) =			
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 (		-		) =			
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24					x (		-		) =			
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26					x (		-		) =			
27					x (		-		) =			
28					x (		-		) =			
29					x (		-		) =			
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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 (		-		) =			
TBend												

Additional Inputs for Radiation Balance

Exterior Absorptivity	Exterior Emissivity	Deviation from North	Angle of Inclination from the Horizontal	Reduction Factor Shading
These columns serve for considering the radiation balance of exterior, opaque surfaces. Inputs only for those surfaces which are adjacent to ambient air! For consideration of heating in Central European climates no input is required.				
0.60	0.90	164	90	0.90
0.60	0.90	344	90	0.90
0.60	0.90	254	90	0.90
0.90	0.90	164	27	
0.60	0.90	74	90	0.90
0.90	0.90	344	27	

A Tool for Thermal Bridge Conversion To Exterior Dimensions

Description		Units	Example			
	Ψ Interior Dimensions	W/(mK)	0.027			
	Temperature Diff. TB	K	30			
Adjacent Area I	Temperature Diff. ∆ϑ I	K	30			
	Exterior - Interior Dim. I	m	0.40			
	U-Value Building Element I	W/(m²K)	0.138			
Adjacent Area II	Temperature Diff. ∆ϑ II	K	30			
	Exterior - Interior Dim. II	m	0.30			
	U-Value Building Element II	W/(m²K)	0.110			
	Ψ Exterior Dimensions	W/(mK)	-0.061			

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Building: Linesöya group 4

Wedge Shaped Building Element Layers and
Still Air Spaces -> Secondary Calculation to the Right

1	Exterior wall

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 Thickness [mm]
1.	MASSIVE WOOD	0.130					84
2.	VAPOUR RETARDER						
3.	INSULATION ROCKWOOL	0.040					350
4.	FURRING						53
5.	CLADDING	0.130					22
6.							
7.							
8.							

Percentage of Sec. 2: | Percentage of Sec. 3: | Total: 50.9 cm

U-Value: 0.103 W/(m²K)

2	Roof

Assembly No. Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} : 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)]	Total Width Thickness [mm]
1.	MASSIVE WOOD	0.130					98
2.	WOOD FIBER BOARD	0.070					6
3.	VAPOUR RETARDER						
4.	XPS	0.032					300
5.	ROCKWOOL	0.040					80
6.	FURRING						102
7.	CLADDING	0.130					22
8.							

Percentage of Sec. 2: 2.0% | Percentage of Sec. 3: | Total: 60.8 cm

U-Value: 0.080 W/(m²K)

3	Ground Floor

Assembly No. Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} : 0.17
exterior Rse: 0.17

	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.	Parquet	0.130					22
2.							
3.							
4.	Concrete	2.100					160
5.	Polystyrene Foam	0.040					300

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Building: Linesöya group 4

Wedge Shaped Building Element Layers and
Still Air Spaces -> Secondary Calculation to the Right

6.							
7.							
8.							

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

Total: 48.2 cm

U-Value: 0.124 W/(m²K)

---

4 | 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 Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

cm

U-Value: W/(m²K)

---

5 | Assembly No. Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

cm

U-Value: W/(m²K)

---

6 | Assembly No. Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Building: Linesöya group 4

Wedge Shaped Building Element Layers and
Still Air Spaces -> Secondary Calculation to the Right

	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.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

cm

U-Value: W/(m²K)

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Building: Linesöya group 4

Wedge Shaped Building Element Layers and
Still Air Spaces -> Secondary Calculation to the Right

7	

Assembly No. Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

Total: cm

U-Value: W/(m²K)

8	

Assembly No. Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

Total: cm

U-Value: W/(m²K)

9	

Assembly No. Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Wedge Shaped Building Element Layers and

Building: Linesöya group 4 Still Air Spaces -> Secondary Calculation to the Right

8.

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

U-Value: W/(m²K)

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Building: Linesöya group 4

Wedge Shaped Building Element Layers and
Still Air Spaces -> Secondary Calculation to the Right

10	
Assembly No.	Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

cm

U-Value: W/(m²K)

11	
Assembly No.	Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

cm

U-Value: W/(m²K)

12	
Assembly No.	Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Wedge Shaped Building Element Layers and

Building: Linesöya group 4 Still Air Spaces -> Secondary Calculation to the Right

8.

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

U-Value: W/(m²K)

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Building: Linesöya group 4

Wedge Shaped Building Element Layers and
Still Air Spaces -> Secondary Calculation to the Right

13	

Assembly No. Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :

exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

cm

U-Value: W/(m²K)

14	

Assembly No. Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :

exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

cm

U-Value: W/(m²K)

15	

Assembly No. Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :

exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Wedge Shaped Building Element Layers and

Building: Linesöya group 4 Still Air Spaces -> Secondary Calculation to the Right

8.

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

U-Value: W/(m²K)

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Building: Linesöya group 4

Wedge Shaped Building Element Layers and
Still Air Spaces -> Secondary Calculation to the Right

16	
Assembly No.	Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

cm

U-Value: W/(m²K)

17	
Assembly No.	Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

cm

U-Value: W/(m²K)

18	
Assembly No.	Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Wedge Shaped Building Element Layers and

Building: Linesöya group 4 Still Air Spaces -> Secondary Calculation to the Right

8.

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

U-Value: W/(m²K)

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Building: Linesöya group 4

Wedge Shaped Building Element Layers and
Still Air Spaces -> Secondary Calculation to the Right

19	
Assembly No.	Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

cm

U-Value: W/(m²K)

20	
Assembly No.	Building Assembly Description

Heat Transfer Resistance [m²K/W] interior R_{si} :
exterior R_{se} :

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

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

cm

U-Value: W/(m²K)

Secondary Calculation: Equivalent Thermal Conductivity of Still Air Spaces

Air Layer Thickness	100	mm			λ	
Direction of		Upwards	h_a	1.25 W/(m²K)	**0.542**	W/(mK)
Heat Flow	x	Horizontal	h_r	4.17 W/(m²K)		
(check only one field)		Downwards				

Secondary Calculation: Equivalent Thermal Conductivity of Still Air Spaces

Air Layer Thickness	100	mm			λ	
Direction of		Upwards	h_a	1.25 W/(m²K)	**0.542**	W/(mK)
Heat Flow	x	Horizontal	h_r	4.17 W/(m²K)		
(check only one field)		Downwards				

Wedge-Shaped Layers (at an inclination of max. 5%)

(Calculation following EN 6946 Appendix C)

2.1	Example: Flat roof with sloped insulation

Assembly No. Building Assembly Description

Heat Transfer Resistance [m²K/W]

interior R_{si} : 0.10

exterior R_{se} : 0.04

A Parallel Assemblies Layer

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness d_0 [mm]
1.	Concrete Ceiling	0.000					0
2.	PS Rigid Foam	0.000					0
3.							
4.							
5.							

Percentage of Sec. 2: 0.0%

Percentage of Sec. 3: 0.0%

Total: 0.0 cm

U_0: 7.143 W/(m²K)

R_0: 0.140 (m²K)/W

B Wedge-Shaped Assembly Layer

Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Thickness d_1 [mm]
PS rigid foam insulation	0.040					150

Percentage of Sec. 2: 0.0%

Percentage of Sec. 3:

Thickness d_1 [cm]: 15.0 cm

U_1: 0.267 W/(m²K)

R_1: 3.750 (m²K)/W

Rectangular Area U-Value: 0.887 W/(m²K)

U-value of triangular area with the thickest point at the apex: 1.306 W/(m²K)

U-value of triangular area with the thinnest point at the apex: 0.467 W/(m²K)

Wedge-Shaped Layers (at an inclination of max. 5%)

(Calculation following EN 6946 Appendix C)

3.1	Example: Flat Roof with sloping insulation

Assembly No. Building Assembly Description

Heat Transfer Resistance [m²K/W]

interior R_{si} :	0.10
exterior R_{se} :	0.04

A Parallel Assemblies Layer

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness d_0 [mm]
1.	Concrete Ceiling	2.100					0
2.	PS rigid foam insulation	0.040					0
3.							
4.							
5.							

Percentage of Sec. 2	Percentage of Sec. 3	Total	
0.0%	0.0%	**0.0**	cm

U_0:	7.143	W/(m²K)
R_0:	0.140	(m²K)/W

B Wedge-Shaped Assembly Layer

Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Thickness d_1 [mm]
PS rigid foam insulation	0.040					150

Percentage of Sec. 2	Percentage of Sec. 3	Thickness d_1 [cm]	
0.0%		**15.0**	cm

U_1:	0.267	W/(m²K)
R_1:	3.750	(m²K)/W
Rectangular Area U-Value:	**0.887**	W/(m²K)
U-value of triangular area with the thickest point at the apex:	**1.306**	W/(m²K)
U-value of triangular area with the thinnest point at the apex:	**0.467**	W/(m²K)

Passive House Planning

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 Temperature	$T_{g,ave}$	6.1	°C
Amplitude of $T_{g,ave}$	$T_{g,\wedge}$	10.6	°C
Length of the Heating Period	n	6.7	months
Heating Degree Hours - Exterior	G_t	103.6	kKh/a

Building Data				Floor Slab U-Value	U_f	0.124	W/(m²K)
Floor Slab Area	A	214.0	m²	Thermal Bridges at Floor Slab	Ψ_B*l	0.00	W/K
Floor Slab Perimeter	P	25.0	m	Floor Slab U-Value incl. TB	U_f'	0.124	W/(m²K)
Charact. Dimension of Floor Slab	B'	17.12	m	Eq. Thickness Floor	d_t	16.2	m

Floor Slab Type (select only one)

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

For Basement or Underground Floor Slab				U-Value Belowground Wall	U_{wB}	0.103	W/(m²K)
Basement Depth	z	0.90	m				
Additionally for Unheated Basements				Height Aboveground Wall	h	0.00	m
Air Change Unheated Basement	n	0.00	h^{-1}	U-Value Aboveground Wall	U_W	0.103	W/(m²K)
Basement Volume	V	0	m³	U-Value Basement Floor Slab	U_{fB}	0.645	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
Location of the Perimeter Insulation	horizontal			Wind Velocity at 10 m Height	v	4.0	m/s
(check only one field)	vertical	x		Wind Shield factor	f_W	0.05	-

Additional Thermal Bridge Heat Losses at Perimeter				Steady-State Fraction	$\Psi_{P,stat}$*l	0.000	W/K
Phase Shift	β		months	Harmonic Fraction	$\Psi_{P,harm}$*l	0.000	W/K

Groundwater Correction							
Depth of the Groundwater Table	z_w	3.0	m	Transm. Belowground El. (w/o Ground)	L_{reg}	28.78	W/K
Groundwater Flow Rate	q_w	0.05	m/d	Relative Insulation Standard	d_t/B'	0.96	-
				Relative Groundwater Depth	z_w/B'	0.18	-
Groundwater Correction Factor	G_w	1.1078298	-	Relative Groundwater Velocity	l/B'	0.05	-

Basement or Underground Floor Slab							
Eq. Thickness Floor Slab	d_t	16.2	m	Phase Shift	β	1.42	months
U-Value Floor Slab	U_{bf}	0.08	W/(m²K)	Exterior Periodic Transmittance	L_{pe}	3.87	W/K
Eq. Thickness Basement Wall	d_w	19.42	m				
U-Value Wall	U_{bw}	0.09	W/(m²K)				
Steady-State Transmittance	L_S	21.80	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	W/(m²K)	Phase Shift	β	months
Eq. Ins. Thickness Perimeter Ins.	d'	m	Exterior Periodic Transmittance	L_{pe}	W/K
Perimeter Insulation Correction	ΔΨ	W/(mK)			
Steady-State Transmittance	L_S	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	1.42	months	Steady-State Heat Flow	Φ_{stat}	301.9	W
Steady-State Transmittance	L_S	21.80	W/K	Periodic Heat Flow	Φ_{harm}	16.8	W
Exterior Periodic Transmittance	L_{pe}	3.87	W/K	Heat Losses During Heating Period	Q_{tot}	1565	kWh

Ground Reduction Factor for "Annual Heat Demand" Sheet **0.525**

Monthly Average Ground Temperatures for Monthly Method

Month	1	2	3	4	5	6	7	8	9	10	11	12	Average Val
Winter	8.5	8.1	8.1	8.5	9.2	9.9	10.6	10.9	10.9	10.5	9.8	9.1	9.5
Summer	9.7	9.3	9.4	9.8	10.4	11.1	11.8	12.1	12.1	11.7	11.0	10.3	10.7

Design Ground Temperature for Heat Load Sheet **8.1** **for Cooling Load Sheet** **12.1**

Passive House Planning

G L A Z I N G A C C O R D I N G T O C E R T I F I C A T I O N

for frame types, go to row: 71

	Type		
Assembly No.	Glazing	g-Value	U_g-Value
			W/(m²K)
1	Triple-low-e Kr08	0.500	0.700
2	Triple-low-e Kr12	0.500	0.580
3	28 Low-E 0.51 N 52 - GUARDIAN Flachglas	0.520	0.510
4	37 iPlus 3S - INTERPANE	0.520	0.600
5			
6			
7			
8			
9			
10			
11			

Passive House Planning

F R A M E T Y P E A C C O R D I N G T O C E R T I F I C A T I O N

for glazings, go to row: 2

	Type	U_f-Value	Frame Dimensions				Thermal Bridge	Thermal Bridge
Assembly No.	Frame	Frame	Width - Left	Width - Right	Width - Below	Width - Above	Ψ_{Spacer}	$\Psi_{Installation}$
		W/(m²K)	m	m	m	m	W/(mK)	W/(mK)
1	standard PU on wood	0.59	0.135	0.135	0.175	0.135	0.049	0.005
2	junction PU on wood	0.59	0.070	0.125	0.125	0.125	0.049	0.005
3	wide PU on wood	0.59	0.150	0.150	0.175	0.150	0.049	0.005
4								
5								
6								
7								
8								
9								
10								
11								

Passive House Planning

V E N T I L A T I O N D A T A

Building: Linesöya group 4

Treated Floor Area A_{TFA}	m²	472	*(Areas worksheet)*
Room Height h	m	2.5	*(Annual Heat Demand worksheet)*
Room Ventilation Volume (A_{TFA}*h) = V_V	m³	1180	*(Annual Heat Demand worksheet)*

Ventilation System Design - Standard Operation

Occupancy	m²/P	39				
Number of Occupants	P	12.0				
Supply Air per Person	m³/(P*h)	30				
Supply Air Requirement	m³/h	**360**				
Extract Air Rooms		Kitchen	Bathroom	Shower	WC	
Quantity		2	1	1	3	
Extract Air Requirement per Room	m³/h	60	40	20	20	
Total Extract Air Requirement	m³/h	**240**				
Design Air Flow Rate (Maximum)	m³/h	460				

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	460	0.39
Standard	24.0	0.77	354	0.30
Basic		0.54	248	0.21
Minimum		0.40	184	0.16

x Residential Building — **Average value** 0.77 — Average Air Flow Rate (m³/h): **354** — Average Air Change Rate (1/h): **0.30**

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

		for Annual Demand:	for Heat Load:			
Wind Protection Coefficient, e		0.10	**0.25**			
Wind Protection Coefficient, f		15	**15**	Net Air Volume for Press. Test	V_{n50}	Air Permeability q_{50}
Air Change Rate at Press. Test	n_{50}	*1/h* 0.14	0.14	480	m³	0.07 m³/(h

Type of Ventilation System

			for Annual Demand:	for Heat Load:
x	Balanced PH Ventilation	*Please Check*		
	Pure Extract Air			
	Excess Extract Air	1/h	0.00	0.00
	Infiltration Air Change Rate	$n_{V,Res}$ 1/h	**0.006**	**0.014**

Effective Heat Recovery Efficiency of the Ventilation System with Heat Recovery

x Central unit within the thermal envelope.

Central unit outside of the thermal envelope.

Efficiency of Heat Recovery	η_{HR}		0.83	Heat Recovery Unit
Transmittance Ambient Air Duct	Ψ	W/(mK)	0.169	Calculation see Secondary Calculation
Length Ambient Air Duct		m	1.1	
Transmittance Exhaust Air Duct	Ψ	W/(mK)	0.235	Calculation see Secondary Calculation
Length Exhaust Air Duct		m	1.5	
Temperature of Mechanical Services Room (Enter only if the central unit is outside of the thermal envelope.)		°C	11	

Room Temperature (°C)	20
Av. Ambient Temp. Heating P. (°C)	-1.1
Av. Ground Temp (°C)	6.1

Effective Heat Recovery Efficiency $\eta_{HR,eff}$ — **82.7%**

Effective Heat Recovery Efficiency Subsoil Heat Exchanger

SHX Efficiency	η^*_{SHX}	93%
Heat Recovery Efficiency SHX	η_{SHX}	32%

Secondary Calculation:
Ψ-value Supply or Ambient Air Duct

Nominal Width	100	mm
Insul. Thickness:	150	mm
Reflective? Please mark with an "x"!		
x Yes		
No		
Thermal Conductivity	0.04	W/(mK)
Nominal Air Flow Rate	354	m³/h
$\Delta\vartheta$	21	K
Interior Duct Diameter	0.100	m
Interior Diameter	0.100	m
Exterior Diameter	0.400	m
α-Interior	46.12	W/(m²K)
α–Surface	2.32	W/(m²K)
Ψ-value	**0.169**	**W/(mK)**
Surface Temperature Difference	1.467	K

Secondary Calculation:
Ψ-value Extract or Exhaust Air Duct

Nominal Width	125	mm
Insul. Thickness:	100	mm
Reflective? Please mark with an "x"!		
x Yes		
No		
Thermal Conductivity	0.04	W/(mK)
Nominal Air Flow Rate	354	m³/h
$\Delta\vartheta$	21	K
Interior Duct Diameter	0.12500	m
Exterior Duct Diameter	0.12500	m
Exterior Diameter	0.32500	m
α-Interior	30.86	W/(m²K)
α–Surface	2.61	W/(m²K)
Ψ-value	**0.235**	**W/(mK)**
Surface Temperature Difference	2.269	K

Passive House Planning

SPECIFIC ANNUAL HEAT DEMAND

Climate: N - Oslo
Building: Linesöya group 4
Location: Linesöya

Interior Temperature: 20.0 °C
Building Type/Use: dwelling/cultural
Treated Floor Area A_{TFA}: 472.0 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
1.	Exterior Wall - Ambient	A	416.6	*	0.103	*	1.00	*	103.6	=	4432	
2.	Exterior Wall - Ground	B		*		*	0.52	*		=		
3.	Roof/Ceiling - Ambient	A	314.0	*	0.080	*	1.00	*	103.6	=	2597	
4.	Floor Slab	B	214.0	*	0.124	*	0.52	*	103.6	=	1439	
5.		A		*		*	1.00	*		=		
6.		A		*		*	1.00	*		=		
7.		X		*		*	0.75	*		=		
8.	Windows	A	70.4	*	0.771	*	1.00	*	103.6	=	5620	
9.	Exterior Door	A		*		*	1.00	*		=		
10.	Exterior TB (length/m)	A		*		*	1.00	*		=		
11.	Perimeter TB (length/m)	P		*		*	0.52	*		=		
12.	Ground TB (length/m)	B		*		*	0.52	*		=		
	Total of All Building Envelope Areas		1015.0									kWh/(m²a)

Transmission Heat Losses Q_T — Total: 14088 kWh/a; 29.8 kWh/(m²a)

Ventilation System:

Effective Air Volume, V_V: A_{TFA} 472.0 m² * Clear Room Height 2.50 m = 1180.0 m³

Effective Heat Recovery Efficiency of Heat Recovery η_{eff}: 83%

Efficiency of Subsoil Heat Exchanger η_{SHX}: 32%

Energetically Effective Air Exchange n_v: $n_{V,system}$ 0.300 1/h (1 - 0.88) + $n_{V,Res}$ 0.006 1/h = 0.041 1/h

Ventilation Heat Losses Q_V: V_V 1180 m³ * n_V 0.041 1/h * c_{Air} 0.33 Wh/(m³K) * G_t 103.6 kKh/a = 1658 kWh/a; 3.5 kWh/(m²a)

Total Heat Losses Q_L: (Q_T 14088 kWh/a + Q_V 1658 kWh/a) * Reduction Factor Night/Weekend Saving 1.0 = 15746 kWh/a; 33.4 kWh/(m²a)

	Orientation of the Area	Reduction Factor See Windows Sheet		g-Value (perp. radiation)		Area m²		Radiation HP kWh/(m²a)		kWh/a
1.	North	0.36	*	0.50	*	21.42	*	65	=	248
2.	East	0.36	*	0.50	*	5.29	*	134	=	129
3.	South	0.44	*	0.50	*	43.66	*	420	=	4021
4.	West	0.40	*	0.00	*	0.00	*	182	=	0
5.	Horizontal	0.40	*	0.00	*	0.00	*	233	=	0

Available Solar Heat Gains Q_S — Total: 4399 kWh/a; 9.3 kWh/(m²a)

Internal Heat Gains Q_I: 0.024 kh/d * Length Heat. Period 205 d/a * Spec. Power q_I 3.50 W/m² * A_{TFA} 472.0 m² = 8109 kWh/a; 17.2 kWh/(m²a)

Free Heat Q_F: Q_S + Q_I = 12507 kWh/a; 26.5 kWh/(m²a)

Ratio of Free Heat to Losses: Q_F / Q_L = 0.79

Utilisation Factor Heat Gains η_G: $(1 - (Q_F / Q_L)^5) / (1 - (Q_F / Q_L)^6)$ = 91%

Heat Gains Q_G: η_G * Q_F = 11421 kWh/a; 24.2 kWh/(m²a)

Annual Heat Demand Q_H: Q_L - Q_G = 4325 kWh/a; **9** kWh/(m²a)

Limiting Value: 15 kWh/(m²a)

Requirement met? Yes (Yes/No)

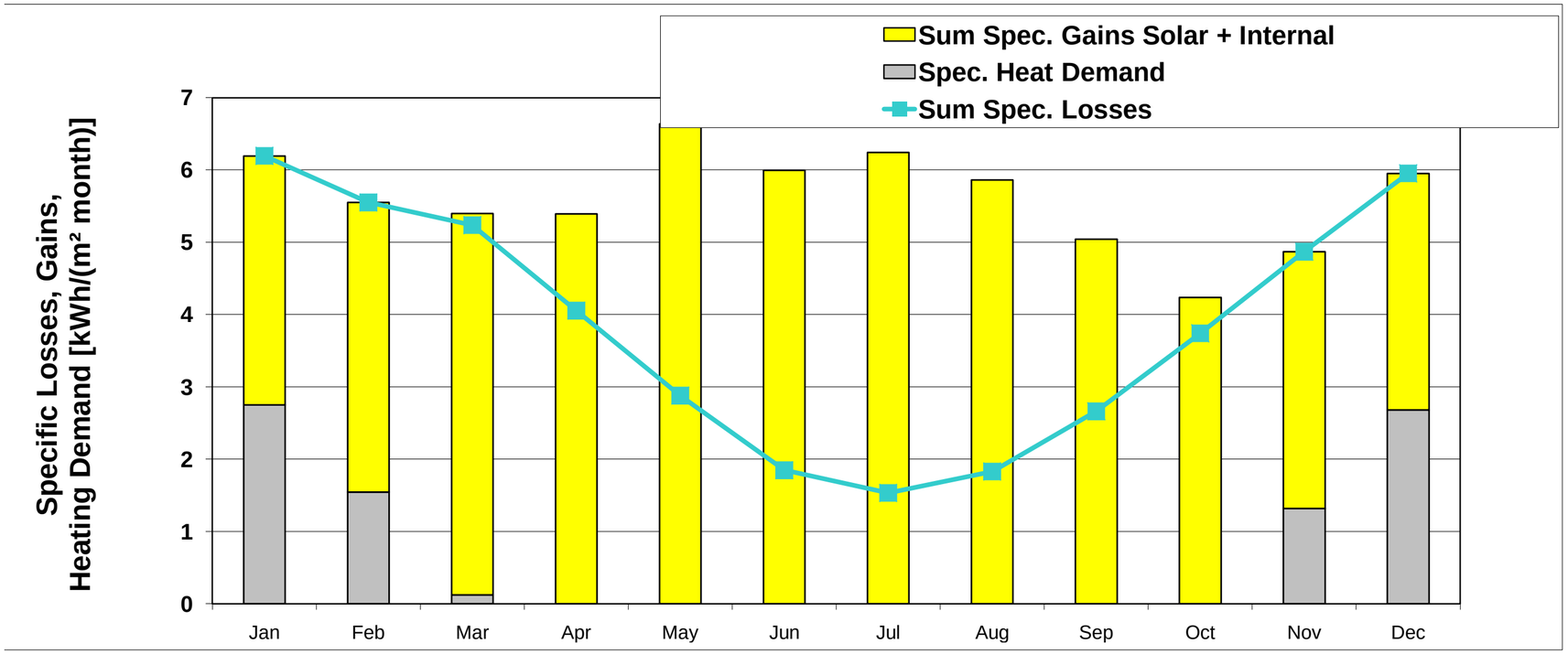
For buildings with a gain-loss-ratio above 0,7 you should use the Monthly Method (cf. manual).

PASSIVE HOUSE PLANNING

SPECIFIC ANNUAL HEAT DEMAND
MONTHLY METHOD

Climate:	N - Oslo	Interior Temperature:	20	°C
Building:	Linesöya group 4	Building Type/Use:	dwelling/cultural	
Location:	Linesöya	Treated Floor Area A_{TFA}:	472	m²

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Heating Degree Hours - E	20.2	18.0	16.5	12.2	7.9	4.3	3.6	4.4	7.6	11.5	15.6	19.4	141	kKh
Heating Degree Hours - G	8.6	8.0	8.8	8.2	8.0	7.2	6.1	6.8	6.6	7.1	7.3	8.1	91	kKh
Losses - Exterior	2535	2258	2072	1540	994	543	446	557	959	1445	1966	2442	17758	kWh
Losses - Ground	389	362	400	374	364	328	277	307	298	321	332	368	4119	kWh
Sum Spec. Losses	6.2	5.6	5.2	4.1	2.9	1.8	1.5	1.8	2.7	3.7	4.9	6.0	46.3	kWh/m²
Solar Gains - North	11	28	70	108	200	207	204	148	84	43	15	9	1127	kWh
Solar Gains - East	5	16	38	59	98	94	89	69	40	20	7	4	538	kWh
Solar Gains - South	349	666	1008	996	1300	1060	1139	1085	915	624	424	278	9844	kWh
Solar Gains - West	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Solar Gains - Horiz.	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Solar Gains - Opaque	31	72	144	193	306	280	286	234	151	81	40	24	1842	kWh
Internal Heat Gains	1229	1110	1229	1189	1229	1189	1229	1229	1189	1229	1189	1229	14472	kWh
Sum Spec. Gains Solar +	3.4	4.0	5.3	5.4	6.6	6.0	6.2	5.9	5.0	4.2	3.5	3.3	58.9	kWh/m²
Utilisation Factor	100%	100%	97%	75%	43%	31%	25%	31%	53%	88%	100%	100%	64%	
Annual Heat Demand	1299	728	59	0	0	0	0	0	0	2	623	1266	3977	kWh
Spec. Heat Demand	**2.8**	**1.5**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1.3**	**2.7**	**8.4**	kWh/m²



Passive House Planning

SPECIFIC SPACE HEATING LOAD

Building: Linesöya group 4

Location: Linesöya

Building Type/Use: dwelling/cultural

Treated Floor Area A_{TFA}: 472.0 m² Interior Temperature: 20 °C

Climate (HL): N - Oslo

	Design Temperature		Radiation:	North	East	South	West	Horizontal	
Weather Condition 1:	-13.5	°C		5	10	30	15	15	W/m²
Weather Condition 2:	-7.6	°C		5	5	10	5	5	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	416.6	*	0.103	*	1.00	*	33.5	or	27.6	=	1435	or	1181
2.	Exterior Wall - Ground	B		*		*	1.00	*	11.9	or	11.9	=		or	
3.	Roof/Ceiling - Ambient	A	314.0	*	0.080	*	1.00	*	33.5	or	27.6	=	841	or	692
4.	Floor Slab	B	214.0	*	0.124	*	1.00	*	11.9	or	11.9	=	314	or	314
5.		A		*		*	1.00	*	33.5	or	27.6	=		or	
6.		A		*		*	1.00	*	33.5	or	27.6	=		or	
7.		X		*		*	0.75	*	33.5	or	27.6	=		or	
8.	Windows	A	70.4	*	0.771	*	1.00	*	33.5	or	27.6	=	1820	or	1497
9.	Exterior Door	A		*		*	1.00	*	33.5	or	27.6	=		or	
10.	Exterior TB (length/m)	A		*		*	1.00	*	33.5	or	27.6	=		or	
11.	Perimeter TB (length/m)	P		*		*	1.00	*	11.9	or	11.9	=		or	
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 = 4411 or 3684

Ventilation System:

Effective Air Volume, V_V: A_{TFA} 472.0 m² * Clear Room Height 2.50 m = 1180 m³

Efficiency of Heat Recovery of the Heat Exchanger η_{HR}: 83%

Heat Recovery Efficiency SHX: 93%

Efficiency SHX: η_{SHX} 1 55% or η_{SHX} 2 46%

Energetically Effective Air Exchange n_v: $n_{V,Res}$ (Heating Load) 1/h 0.014 + $n_{V,system}$ 1/h 0.300 *(1- Φ_{HR} 0.92 or Φ_{HR} 0.91) = 1/h 0.038 or 1/h 0.042

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
1180.0	*	0.038	or	0.042	*	0.33	*	33.5	or	27.6	=	**495**	or	**453**

Total Heating Load P_L

	P_L 1 W		P_L 2 W
$P_T + P_V$ =	**4905**	or	**4137**

	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	21.4	*	0.5	*	0.4	*	6	or	5	=	22	or	19
2.	East	5.3	*	0.5	*	0.4	*	7	or	5	=	7	or	4
3.	South	43.7	*	0.5	*	0.4	*	28	or	10	=	273	or	93
4.	West	0.0	*	0.0	*	0.4	*	15	or	5	=	0	or	0
5.	Horizontal	0.0	*	0.0	*	0.4	*	15	or	5	=	0	or	0

Solar Heat Gain, P_S

Total = **302** or **116**

Internal Heat Gains P_I

Spec. Power W/m²		A_{TFA} m²		P_I 1 W		P_I 2 W
1.6	*	472	=	**755**	or	**755**

Heat Gains P_G

	P_G 1 W		P_G 2 W
$P_S + P_I$ =	**1057**	or	**871**
$P_L - P_G$ =	**3848**	or	**3265**

Heating Load P_H

= **3848** W

Specific Heating Load P_H / A_{TFA}

= **8.2** W/m²

Input Max. Supply Air Temperature: 52 °C

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

Supply Air Temperature Without Heating $\vartheta_{Supply,Min}$: °C 17.4 or °C 17.4

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

= **4047** W specific: 8.6 W/m²

(Yes/No)

Supply Air Heating Sufficient? **Yes**

Passive House Planning

S U M M E R

Climate: N - Oslo
Building: Linesöya group 4
Location: Linesöya
Spec. Capacity: 204 Wh/K pro m² TFA
Overheating Limit: 25 °C

Interior Temperature: 20 °C
Building Type/Use: dwelling/cultural
Treated Floor Area A_{TFA}: 472.0 m²

	Building Element	Temperature Zone	Area m²		U-Value W/(m²K)		Red. Factor $f_{T,Summer}$		H_{Summer} Heat Conductance
1.	Exterior Wall - Ambien	A	416.6	*	0.103	*	1.00	=	42.8
2.	Exterior Wall - Ground	B		*		*	1.00	=	
3.	Roof/Ceiling - Ambient	A	314.0	*	0.080	*	1.00	=	25.1
4.	Floor Slab	B	214.0	*	0.124	*	1.00	=	26.5
5.		A		*		*	1.00	=	
6.		A		*		*	1.00	=	
7.		X		*		*	0.75	=	
8.	Windows	A	70.4	*	0.771	*	1.00	=	54.3
9.	Exterior Door	A		*		*	1.00	=	
10.	Exterior TB (length/m)	A		*		*	1.00	=	
11.	Perimeter TB (length/m	P		*		*	1.00	=	
12.	Ground TB (length/m)	B		*		*	1.00	=	

Exterior Thermal Transmittance, $H_{T,e}$ 122.1 W/K
Ground Thermal Transmittance, $H_{T,g}$ 26.5 W/K

Heat Recovery Efficiency η_{HR} 83%
SHX Efficiency η^*_{SHX} 93%

Effective Air Volume V_v: A_{TFA} 472.0 m² * Clear Room Height 2.50 m = 1180 m³

Summer Ventilation

continuous ventilation to provide sufficient indoor air quality

Air Change Rate by Natural (Windows & Leakages) or Exhaust-Only Mechanical Ventilation, Summer: 0.24 1/h

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

Energetically Effective Airchange Rate n_V: $n_{L,nat}$ 0.235 1/h + $n_{V,system}$ 0.000 1/h * (1 - Φ_{HR} 0.000) + $n_{V,Rest}$ 0.000 1/h = 0.235 1/h

	V_V m³		$n_{V,equi,fraction}$ 1/h		c_{Air} Wh/(m³K)			
Ventilation Transm. Ambient $H_{V,e}$	1180	*	0.235	*	0.33	=	91.5	W/K
Ventilation Transm. Ground $H_{V,g}$	1180	*	0.000	*	0.33	=	0.0	W/K

Additional Summer Ventilation for Cooling

Temperature Amplitude Summer 7.8 K

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

Corresponding Air Change Rate 0.31 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	*	1.00	*	0.95	*	0.50	*	21.4	*	59%	=	5.4
2.	East	0.9	*	1.00	*	0.95	*	0.50	*	5.3	*	60%	=	1.4
3.	South	0.9	*	0.53	*	0.95	*	0.50	*	43.7	*	72%	=	7.2
4.	West	0.9	*	1.00	*	0.95	*	0.00	*	0.0	*	0%	=	0.0
5.	Horizontal	0.9	*	1.00	*	0.95	*	0.00	*	0.0	*	0%	=	0.0
6	Sum Opaque Areas													2.3

Solar Aperture

Total 16.2 m² → 0.03 m²/m²

Internal Heat Gains Q_I

Specif. Power q_I 3.50 W/m² * A_{TFA} 472 m² = 1652 W → 3.5 W/m²

Frequency of Overheating $h_{\vartheta \geq \vartheta max}$ **0.0%** **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.

Daily Temperature Swing due to Solar Load: Solar Load 70.9 kWh/d * 1000 1/k / (Spec. Capacity 204 Wh/(m²K) * A_{TFA} 472 m²) = **0.7** **K**

Passive House Planning

SUMMER VENTILATION

Building:	Linesöya group 4	Building Type/Use:	dwelling/cultural
Location:	Linesöya	Building Volume	1180 m³

Description	Day GF	Day UF	Day	Night	Night	Night	
Fraction of Opening Duration	13%	13%	13%	100%	100%	100%	
Climate Boundary Conditions							
Temperature Diff Interior - Exterior	4	4	4	1	1	1	K
Wind Velocity	2	2	2	0	0	0	m/s
Window Group 1							
Quantity	6	6	2	2	6	6	
Clear Width	1.90	1.21	4.00	4.00	1.90	1.21	m
Clear Height	1.90	1.61	2.00	2.00	1.90	1.61	m
Tilting Windows?	x	x	x	x	x	x	
Opening Width (for tilting windows)	0.050	0.050	0.050	0.050	0.050	0.050	m
Window Group 2 (Cross Ventilation)							
Quantity	5	4	2	2	5	4	
Clear Width	1.11	1.21	1.17	1.17	1.11	1.21	m
Clear Height	0.81	0.75	1.38	1.38	0.81	0.75	m
Tilting Windows?	x	x	x	x	x	x	
Opening Width (for Tilting Windows)	0.050	0.050	0.050	0.050	0.050	0.050	m
Difference in Height to Window 1	0.20	0.40	0.30	0.30	0.20	0.40	m
Single-Sided Ventilation 1 - Airflow Volume	303	218	135	55	134	97	m³/h
Single-Sided Ventilation 2 - Airflow Volume	90	70	61	27	33	25	m³/h
Cross Ventilation Airflow Volume	946	780	493	82	168	121	m³/h
Contribution to Air Change Rate	0.10	0.08	0.05	0.07	0.14	0.10	1/h

Summary of Summer Ventilation Distribution

Description Ventilation Type	Daily Average Air Change Rate	
Nighttime Window Ventilation	0.31	1/h
Daytime Window Ventilation	0.24	1/h
		1/h

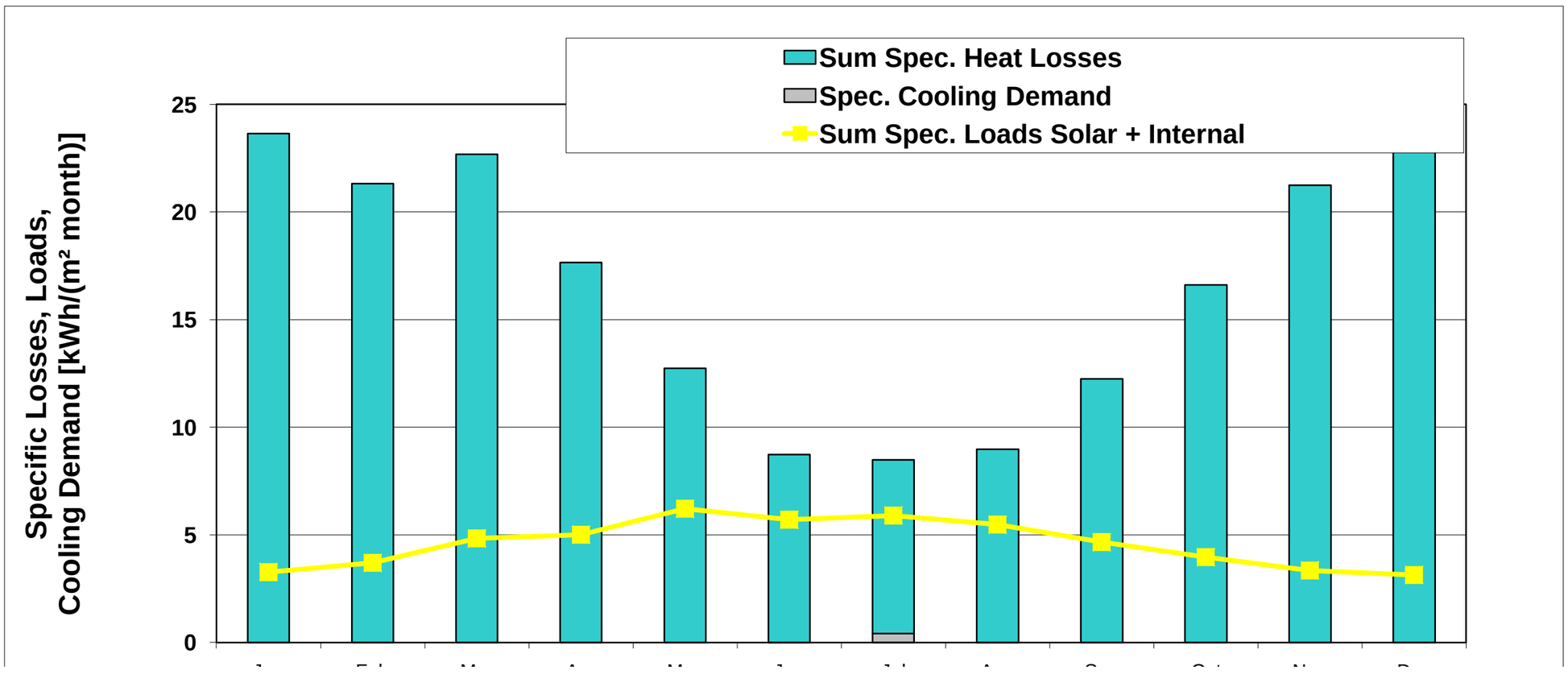
PASSIVE HOUSE PLANNING

SPECIFIC USEFUL COOLING DEMAND
MONTHLY METHOD

Climate:	N - Oslo
Building:	Linesöya group 4
Location:	Linesöya

Interior Temperature:	25	°C
Building Type/Use:	dwelling/cultural	
Treated Floor Area A_{TFA}:	472	m²

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Heating Degree Hours - E	23.3	20.8	19.8	15.5	11.3	7.7	7.0	7.9	11.0	14.8	18.7	22.5	180	kKh
Heating Degree Hours - G	12.3	11.3	12.5	11.8	11.8	10.8	9.8	10.5	10.2	10.8	10.9	11.8	135	kKh
Losses - Exterior	4978	4447	4227	3322	2423	1642	1503	1691	2342	3168	4001	4806	38549	kWh
Losses - Ground	326	300	332	314	311	287	260	278	269	286	289	313	3565	kWh
Losses Summer Ventilatio	5860	5317	6146	4692	3278	2195	2051	2268	3173	4383	5733	5965	51062	kWh
Sum Spec. Heat Losses	23.7	21.3	22.7	17.6	12.7	8.7	8.1	9.0	12.3	16.6	21.2	23.5	197.3	kWh/m²
Solar Load North	15	39	99	153	283	292	288	210	118	61	21	13	1591	kWh
Solar Load East	7	22	53	83	138	133	126	98	56	29	10	5	760	kWh
Solar Load South	262	499	756	747	975	795	854	814	686	468	318	208	7384	kWh
Solar Load West	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Solar Load Horiz.	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Solar Load Opaque	31	72	144	193	306	280	286	234	151	81	40	24	1842	kWh
Internal Heat Gains	1229	1110	1229	1189	1229	1189	1229	1229	1189	1229	1189	1229	14472	kWh
Sum Spec. Loads Solar +	3.3	3.7	4.8	5.0	6.2	5.7	5.9	5.5	4.7	4.0	3.3	3.1	55.2	kWh/m²
Utilisation Factor Losses	14%	17%	21%	28%	49%	65%	68%	61%	38%	24%	16%	13%	28%	
Useful Cooling Energy De	0	0	0	0	0	0	194	0	0	0	0	0	194	kWh
Spec. Cooling Demand	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	kWh/m²



Passive House Planning

C O O L I N G L O A D

Building: Linesöya group 4 | Building Type/Use: dwelling/cultural | Interior Temperature: 25 °C

Location: Linesöya | Treated Floor Area A_{TFA}: 472.0 m²

Spec. Capacity: 204 Wh/(m²K) (Enter in "Summer" worksheet.) | Climate (Cooling Load): Nord- und westdeutsches Tiefland, z.B. Ha

	Ambient Air		Sky		Ground		Radiation:	North	East	South	West	Horizontal	
Design Temperature:	24.0	°C	14.2	°C	12.1	°C		100	220	210	220	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	416.6	*	0.103	*	1.00	*	-1.0	=	-43
2.	Exterior Wall - Ground	B		*		*	1.00	*	-12.9	=	
3.	Roof/Ceiling - Ambient	A	314.0	*	0.080	*	1.00	*	-1.0	=	-25
4.	Floor Slab	B	214.0	*	0.124	*	1.00	*	-12.9	=	-341
5.		A		*		*	1.00	*	-1.0	=	
6.		A		*		*	1.00	*	-1.0	=	
7.		X		*		*	0.75	*	-1.0	=	
8.	Windows	A	70.4	*	0.771	*	1.00	*	-1.0	=	-54
9.	Exterior Door	A		*		*	1.00	*	-1.0	=	
10.	Exterior TB (length/m)	A		*		*	1.00	*	-1.0	=	
11.	Perimeter TB (length/m)	P		*		*	1.00	*	-12.9	=	
12.	Ground TB (length/m)	B		*		*	1.00	*	-12.9	=	
13.	House/DU Partition Wall	I		*		*	1.00	*	3.0	=	

		$L_{ambient}$ W/K		TempDiff K		L_{Sky} W/K		TempDiff K		W
14.	Radiation Correction	-10.0	*	-1.0	+	9.9	*	-10.8	=	-97

Transmission Heat Losses P_T Total = **-560**

Ventilation System:

	A_{TFA} m²		Clear Room Height m		m³
Effective Air Volume, V_V	472.0	*	2.50	=	1180

	Vent. Transm. W/K		TempDiff kKh/a		W
Exterior	91.5	*	-1.0	=	-92
Ground	0.0	*	-12.9	=	0

Additional Summer Ventilation:

x	Window Night Ventilation, Manual	Corresponding Air Change Rate	0.31	1/h
	Mechanical, Automatically Controlled Ventilation	Minimum Indoor Temperature	22.0	°C

		kWh/d		kh/d		W
Heat Removal Cooling Design Day	Window Ventilation	-19.2	/	0.024	=	-799
(from Cooling worksheet)	Automatic Night Ventilation	0.0	/	0.024	=	0

Ventilation Heat Load P_V Total = **-890** W

	Orientation of the Area	Area m²		g-Value (perp. radiation)		Reduction Factor		Radiation W/m²		P_S W
1.	North	21.4	*	0.5	*	0.50	*	107	=	578
2.	East	5.3	*	0.5	*	0.51	*	200	=	271
3.	South	43.7	*	0.5	*	0.33	*	213	=	1530
4.	West	0.0	*	0.0	*	0.40	*	220	=	0
5.	Horizontal	0.0	*	0.0	*	0.40	*	350	=	0
6.	Sum Opaque Areas									577

Heat Gain - Solar Heat Load, P_S Total = **2955**

	Spec. Power W/m²		A_{TFA} m²		P_I W
Internal Heat Load P_I	4.5	*	472	=	**2124**

Cooling Load P_C $P_T + P_V + P_S + P_I$ = **3629** **W**

Specific Maximum Cooling Load P_C / A_{EB} = **7.7** **W/m²**

	Solar Load W		Time h/d		Spec. Capacity Wh/(m²K)		A_{TFA} m²			
Daily Temperature Swing due to Solar Load	2955.5	*	24	/ (	204	*	472	) =	**0.7**	**K**

Passive House Planning

HEAT DISTRIBUTION AND DHW SYSTEM

Building:	Linesöya group 4	
Location:	Linesöya	
Interior Temperature:	20	°C
Building Type/Use:	dwelling/cultural	
Treated Floor Area A_{TFA}:	472	m²
Occupancy:	12.0	Pers
Number of Residences:	1	
Annual Heat Demand $q_{Heating}$	3977	kWh/a
Length of Heating Period:	205	d
Average Heat Load P_{ave}:	0.8	kW
Marginal Utilisability of Additional Heat Gains:	64%	

Space Heat Distribution

			Parts: Warm Region 1	Cold Region 2	Cold Region 3	Total		
Length of Distribution Pipes	L_H *(Project)*		13.50				m	
Heat Loss Coefficient per m Pipe	Ψ *(Project)*		0.140				W/(mK)	
Temperature of the Room Through Which the Pipe	ϑ_X *Mechanical Room*		20				°C	
Design Flow Temperature	ϑ_{dist} *Flow, Design Value*		55.0				°C	
Design System Heat Load	$P_{heating}$ *(exist./calc.)*		2.0				kW	
Flow Temperature Control (check)			x					
Design Return Temperature	ϑ_R	$=0.714*(\vartheta_{dist}-20)+20$	45.0				°C	
Annual Heat Emission per m of Plumbing	q^*_{HL}	$=\Psi\,(\vartheta_m-\vartheta_X)\,t_{Heating}*0.02$	10				Total 1,2,3 kWh/(m·a)	
Possible Utilization Factor of Released Heat	η_G		64%				-	
Annual Losses	Q_{HL}	$= L_H \cdot q^*_{HL} \cdot (1-\eta_G)$	51	0	0	51	kWh/a	
Specif. Losses	q_{HL}	$= \Sigma Q_{HL} / A_{TFA}$					kWh/(m²a)	0.1
Utilisation Factor of Space Heat Distribution	$h_{a,HL}$	$= q_H / (q_H + q_{HL})$				99%	-	

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°)*	10.0	°C	
DHW Non-Electric Wash and Dish	*(Electricity worksheet)*	865	kWh/a	
Useful Heat - DHW	Q_{DHW}	7216	kWh/a	
Specif. Useful Heat - DHW	q_{DHW} $= Q_{DHW} / A_{TFA}$		kWh/(m²a)	15.3

DHW Distribution and Storage

			Warm Region 1	Cold Region 2	Cold Region 3	Total		
Length of Circulation Pipes (Flow + Return)	L_{HS} *(Project)*		13.5	2.0			m	
Heat Loss Coefficient per m Pipe	Ψ *(Project)*		0.140	0.140			W/m/K	
Temperature of the Room Through Which the Pipe	ϑ_X *Mechanical Room*		20	11.0			°C	
Design Flow Temperature	ϑ_{dist} *Flow, Design Value*		60.0	60.0			°C	
Daily circulation period of operation.	td_{Circ} *(Project)*		18.0	18.0			h/d	
Design Return Temperature	ϑ_R	$=0.875*(\vartheta_{dist}-20)+20$	55	55			°C	
Circulation period of operation per year	t_{Circ}	$= 365\ td_{Circ}$	6570	6570			h/a	
Annual Heat Released per m of Pipe	q^*_Z	$=\Psi\,(\vartheta_m-\vartheta_X)\,t_{Circ}$	34.5	42.8			kWh/m/a	
Possible Utilization Factor of Released Heat	η_{GDHW}	$=t_{heating}/365d * \eta_G$	35.8%	0.0%			-	
Annual Heat Loss from Circulation Lines	Q_Z	$= L_{HS} \cdot q^*_Z \cdot (1-\eta_{GDHW})$	299	86		384	kWh/a	
Total Length of Individual Pipes	L_U *(Project)*		9.00				m	
Exterior Pipe Diameter	d_{U_Pipe} *(Project)*		0.012				m	
Heat Loss Per Tap Opening	$q_{Individual}$	$=(c_{pH2O}V_{H2O}+c_{pMat}V_{Mat})(\vartheta_{dist}-\vartheta_X)$	0.0322				kWh/tap opening	
Occupancy Coefficient	n_{Tap}	$= n_{Pers} \cdot 3 \cdot 365 / n_{LU}$	13140				Tap openings per year	
Annual Heat Loss	q_U	$= n_{Tap} \cdot q_{Individual}$	423.4				kWh/a	
Possible Utilization Factor of Released Heat	η_{G_U}	$=t_{heating}/8760*\eta_G$	35.8%				-	
Annual Heat Loss of Individual Pipes	Q_U	$= q_U \cdot (1-\eta_{G\_U})$	271.7			272	kWh/a	
						Total 1,2,3		
Average Heat Released From Storage	P_S			98			W	
Possible Utilization Factor of Released Heat	η_{G_S}	$=t_{heating}/8760*\eta_G$		0.0%				
Annual Heat Losses from Storage	Q_S	$= P_S \cdot 8.760\ kh \cdot (1-\eta_{G\_S})$		857.8		858	kWh/a	
						Total 1,2,3		
Total Heat Losses of the DHW System	Q_{WL}	$= Q_Z+Q_U+Q_S$				1514	kWh/a	
Specif. Losses of the DHW System	q_{WL}	$= Q_{WL} / A_{TFA}$					kWh/(m²a)	3.2
Utilisation Factor DHW Distrib and Storage	$\eta_{a,WL}$	$= q_{DHW} / (q_{DHW} + q_{WV})$				82.7%	-	
Total Heat Demand of DHW system	Q_{gDHW}	$= Q_{DHW}+Q_{WL}$				8730	kWh/a	
Total Spec. Heat Demand of DHW System	q_{gDHW}	$= Q_{gDHW} / A_{TFA}$					kWh/(m²a)	18.5

Secondary Calculation: Ψ-Values of Plumbing

Nominal Width		240	mm
Insulation Thickness:		100	mm
Reflective? Please mark with an "x"!			
x	Yes		
	No		
Thermal Conductivity		0.035	W/(mK)
$\Delta\vartheta$		30	K
Interior Pipe Diameter:		0.24000	m
Exterior Pipe Diameter		0.24225	m
Exterior Pipe Diameter		0.44225	m
α–Surface		2.72	W/(m²K)
Ψ-Value		**0.333**	**W/(mK)**
Surface Temperature Difference		0.000	K

Passive House Planning

HOT WATER PROVIDED BY SOLAR

Building:	Linesöya group 4	Building Type/Use:	dwelling/cultural
Location:	Linesöya	Treated Floor Area A_{TFA}:	472.0 m²

Solar Fraction with DHW Demand including Washing and Dish-Washing

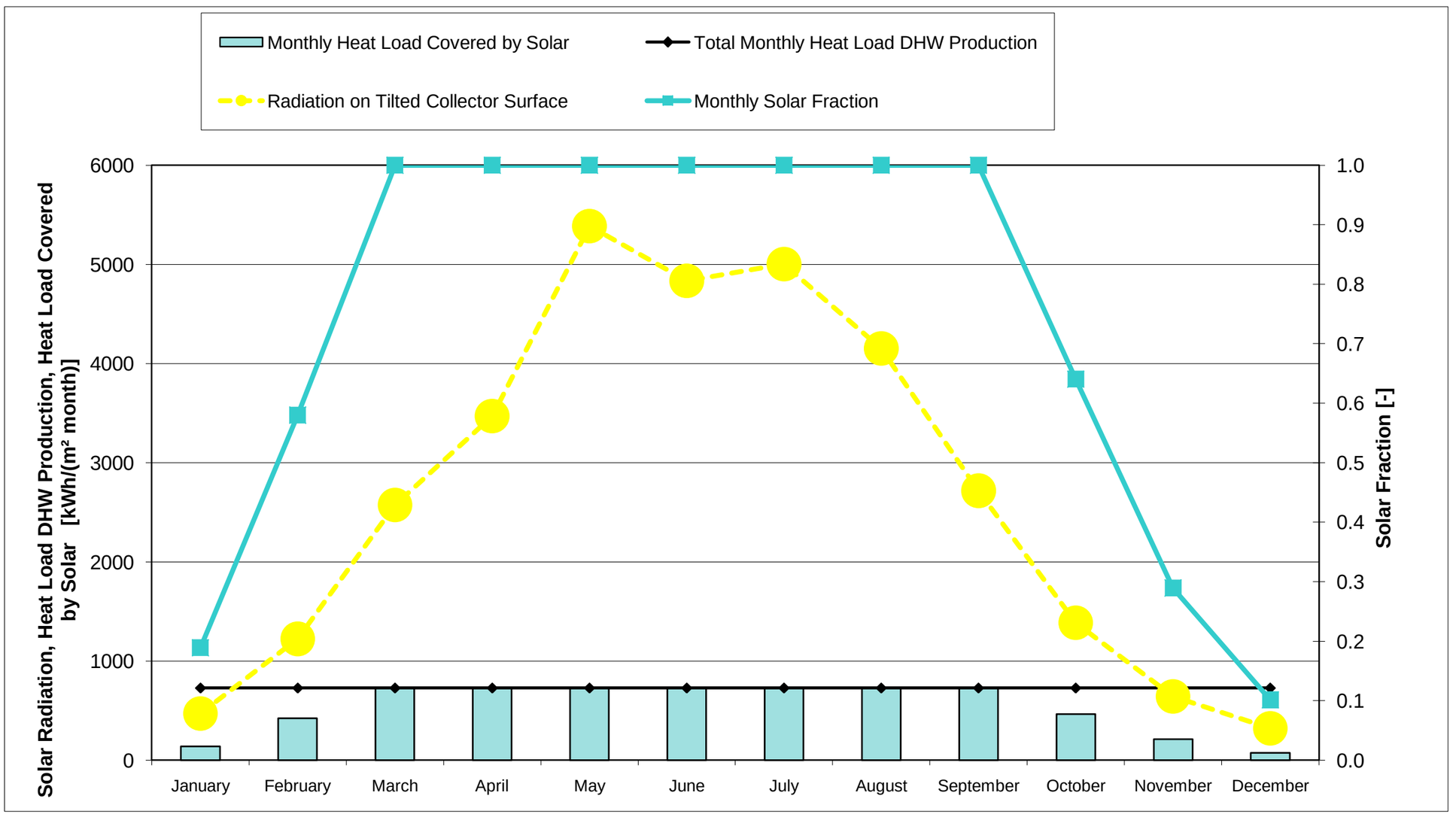
Heat Demand DHW	q_{gDHW}	8730	kWh/a	from DHW+Distribution worksheet
Latitude:		59.9	°	from Climate Data worksheet
Selection of collector from list (see below):		8	Selection:	8 Vacuum Tube Collector
Solar Collector Area		26.00	m²	
Deviation from North		164	°	
Angle of Inclination from the Horizontal		27	°	
Height of the Collector Field		1	m	
Height of Horizon	h_{Hori}		m	
Horizontal Distance	a_{Hori}		m	
Additional Reduction Factor Shading	r_{other}		%	

Occupancy	12.0	Persons
Specific Collector Area	2.2	m²/Pers

Estimated Solar Fraction of DHW Production	**73%**		
Solar Contribution to Useful Heat	**6402** kWh/a	**14**	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)	**98**	W
Total Storage Heat Losses	**132**	W



Passive House Planning

Building: Linesöya group 4

Calculation in Electricity Non-Dom worksheet!

ELECTRICITY DEMAND

# Households	1	HH
Persons	12.0	P
Living Area	472	m²
Annual Heat Demand	8	kWh/(m²a)

Solar Fraction of DHW Wash&Dish	61%
Marginal Performance Ratio DHW	56%
Marginal Performance Ratio Heating	64%

Prim. Energy Factors: Electricity	2.7	kWh/kWh
Natural Gas	1.1	kWh/kWh
Energy Carrier for Space Heating/DHW:	2.7	2.7

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)	12.0	P	858	*	50%		=	**429**										**1158**
DHW Connection													*	50%		=		* (1+	0.30	) *	0.56	*(1-	0.61	) =	**122**		**328**
Clothes Washing	1	1	0.95	kWh/Use		1.00	*	57	/(P*a)	12.0	P	650	*	55%		=	**357**										**965**
DHW Connection													*	45%		=		* (1+	0.05	) *	0.56	*(1-	0.61	) =	**67**		**181**
Clothes Drying with:	1	0	0.00	kWh/Use	Residual dampness 0.60	0.88	*	57	/(P*a)	12.0	P	0		0%		=	**0**										**0**
Clothesline											=	0		0%							1.00	*			**0**		**0**
Energy Consumed by Evaporation	1	0	0.00	kWh/Use		0.60	*	57	/(P*a)	12.0	P	=	0	*	100%			* (1+	0.00	) *	0.64	*(1-	0.74	) =	**0**		**0**
Refrigerating	1	1	0.28	kWh/d		1.00	*	365	d/a	1	HH	=	102	*	100%	=	**102**										**276**
Freezing	1	0	0.55	kWh/d		0.90	*	365	d/a	1	HH	=	181	*	100%	=	**181**										**488**
or Combined Unit	0	1	0.70	kWh/d		1.00	*	365	d/a	1	HH	=	0	*	100%	=	**0**										**0**
Cooking with:	1	1	0.25	kWh/Use		1.00	*	500	/(P*a)	12.0	P	=	1500	*	100%	=	**1500**										**4050**
Electricity					Percentage CFLs 80%									*	0%										**0**		**0**
Lighting	1	1	21	W		1.00	*	2.90	kh/(P*a)	12.0	P	=	724	*	100%	=	**724**										**1954**
Consumer Electronics	1	1	80	W		1.00	*	0.55	kh/(P*a)	12.0	P	=	528	*	100%	=	**528**										**1426**
Small Appliances, etc	1	1	50	kWh		1.00	*	1.00	/(P*a)	12.0	P	=	600	*	100%	=	**600**										**1620**
Total Aux. Electricity													890				**890**										**2402**
Other:																											
													0				**0**										**0**
													0				**0**										**0**
													0				**0**										**0**
Total													**6032** kWh				**5311**	kWh		DHW Non-Electric - Wash&Dish **865**		kWh		**188**		**14848**
Specific Demand																	**11.3**	kWh/(m²a)		Non-Renewable Non-Electric DHW Wash&Dish **0.7**		kWh/(m²a)		**0.4**		**31.5**
Recommended Maximum Value																	18										50

Passive House Planning

ELECTRICITY DEMAND Non-Domestic Use

Building: Linesöya group 4

Treated Floor Area A_{TFA}:	472.0	m²
Auxiliary Electricity Demand:	889.8	kWh/a
Primary Energy Factors:		
Electricity:	2.7	kWh/kWh
Gas:	1.1	kWh/kWh
Energy Carrier for DHW:	1.1	kWh/kWh
Solar Fraction of DHW	73%	
Marginal Performance Ratio DHW:		

Window Properties (from Windows worksheet):

	Shading	Dirt Factor	Non-Perpendicular Radiation	Glazing Fraction
North	0.75	0.95	0.85	0.59
East	0.75			0.60
South	0.75			0.72
West	0.75			0.00

Lighting / Non-Domestic	Fraction of Treated Floor Area	Room Category	Room Category	Nominal Illuminance Level	Facade with Windows: Deviation from North	Orientation	Light Transmission Glazing	Room Geometry: Input of a Typical Room or Room by Room: Room Depth	Room Width	Room Height	Lintel Height	Window Width	Input Warning	Daylight Utilisation	User Data: Installed Lighting Power	Installed Lighting Power (Standard)	Lighting Control	Motion Detector with/without (1/0)	Lighting Control		Utilisation Hours per Year [h/a]	User Determined: Lighting Full Load Hours	**Full Load Hours of Lighting**	**Electricity Demand (kWh/a)**	**Spec. Electricity Demand (kWh/(m²a))**	**Primary Energy Demand (kWh/a)**
Room / Zone				Lux	Degrees		-	m	m	m	m	m			W/m²	W/m²						h/a		kWh/a		
			2	15																	9					
CAFÈ	35%	31	Canteen	200	164	South	69%	8.9	18.4	3.2	2.9	13.3		low		7.2	1	0	manual	Without Motion	1750		1396.1	1660.5	10.1	4483.5
BEDROOM 1	6%	29	Bedroom	300	164	South	69%	5.9	4.6	3.2	2.7	4.5		medium		9.8	1	0	manual	Without Motion	8760	1460	1460.0	405.2	14.3	1094.0
BEDROOM 2	5%	29	Bedroom	300	344	North	69%	5.7	4.6	3.2	2.7	1.2		none		9.8	1	0	manual	Without Motion	8760	1460	1460.0	337.7	14.3	911.7
KITCHEN PUB	3%	33	Kitchen Non-Residential	500	74	East	69%	4.4	3.5	3.2	2.4	1.5		none		15.0	1	0	manual	Without Motion	3900		3550.0	754.0	53.3	2035.9
WC PUBLIC	6%	35	WC, Sanitary	200	74	East	69%	4.4	5.1	3.2	0.0	0.0	Contradiction: Check width and height inputs	none		7.2	3	1	autarkic, with off-mode	With Motion	2750		524.3	106.9	3.8	288.7
LIVING	6%	36	Other Habitable Rooms	300	164	South	69%	5.9	4.4	2.8	2.7	4.5	Contradiction: Check width and height inputs	low		9.8	1	0	manual	Without Motion	2750	2920	2920.0	810.4	28.6	2188.1
BEDROOM 3	5%	29	Bedroom	300	344	North	69%	5.7	4.6	2.8	2.7	1.5		none		9.8	1	0	manual	Without Motion	8760	1460	1460.0	337.7	14.3	911.7
GYM	26%	50	Gymnasium	300	164	South	69%	8.9	13.6	2.8	2.7	4.8		none		9.8	1	0	manual	Without Motion	4500	2920	2920.0	3511.8	28.6	9481.7
WC/CHANGE	8%	35	WC, Sanitary	200	164	South	69%	8.5	4.4	2.8	2.7	1.2		none		7.2	3	1	autarkic, with off-mode	With Motion	2750		490.6	133.4	3.5	360.1
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	
					90	East	69%									0.0	1	0	manual	Without Motion					0.0	

Office Equipment	Room Category	Room Category	In the thermal envelope? (1/0)	Existing/Planned? (1/0)		Quantity		Power Rating (W)		Utilisation Hours per Year (h/a)		relative absenteeism		Duration of Utilisation in Energy Saving Mode (h/a)		Useful Energy (kWh/a)				Electricity Demand (kWh/a)	Primary Energy Demand (kWh/a)
		2								9	20	18									
PC 1	31	Canteen	1	1	*	2	*	80	* (	1750	* (1-	0	)		=	280			=	280.0	756
PC in Energy Saving Mode			1		*	2	*	2.0	*	1750	*	0			=	0			=	0.0	0
Monitor 1	31	Canteen	1	1	*	2	*	28	* (	1750	* (1-	0	)		=	98			=	98.0	265
Monitor in Energy Saving Mode			1		*	2	*	2.0	*	1750	*	0			=	0			=	0.0	0
PC 2	0		1	0	*	0	*	80	* (	0	* (1-	0	)		=	0			=	0.0	0
PC in Energy Saving Mode			1		*	0	*	2.0	*	0	*	0			=	0			=	0.0	0
Monitor 2	0		1	0	*	0	*	28	* (	0	* (1-	0	)		=	0			=	0.0	0
Monitor in Energy Saving Mode			1		*	0	*	2.0	*	0	*	0			=	0			=	0.0	0
Copier	31	Canteen	1	1	*	1	*	400	* (	1750			-	1575	) =	70			=	70.0	189
Copier in Energy Saving Mode			1		*	1	*	30	*	1575					=	47			=	47.3	128
Printer	31	Canteen	1	1	*	2	*	300	* (	1750			-	1575	) =	105			=	105.0	284
Printer in Energy Saving Mode			1		*	2	*	2	*	1575					=	6			=	6.3	17
Server	31	Canteen	1	1	*	1	*	100	* (	1750					=	175			=	175.0	473
Server in Energy Saving Mode			1		*	1	*	2.0	* (	8760			-	1750	) =	14			=	14.0	38
Telephone System			1	1	*	1	*	94	*	8760					=	823			=	823.4	2223
Hand Dryer (WC)			1	1	*	6	*	2000	*	20					=	240			=	240.0	648
					*		*		*						=	0			=	0.0	0
					*		*		*						=	0			=	0.0	0
					*		*		*						=	0			=	0.0	0
					*		*		*						=	0			=	0.0	0

Kitchen / Aux. Electricity	Room Category	Predominant Utilisation Pattern of Building	In the thermal envelope? (1/0)	Existing/Planned? (1/0)		Utilisation Days per Year (d/a)		Number of Meals per Utilisation Day		Norm Consumption		Useful Energy (kWh/a)		Non-Electric Fraction		Electric Fraction	Additional Demand	Marginal Performance Ratio	Solar Fraction	Other Primary Energy Demand (kWh/a)		Electricity Demand (kWh/a)	Primary Energy Demand (kWh/a)
		8								kWh / Meal													
Cooking	33	tchen Non-Residenti	1	1	*	300	*	4	*	0.25	=	300	*	0%							=	0.0	0
Gas										kWh / Cover			*	100%						300	=		330
Dishwashing			1	1	*	300	*	4	*	0.10	=	120	*	55%							=	66.0	178
Hot Water Connection													*	45%	* (1+	0.30	) *	1.20	*(1-	0.73	) =	22	25
Refrigerating			1	1		365				kWh/d 0.38	=	140	*	100%							=	140.0	378
Coffee machine			1	1		200				0.25	=	50	*	100%							=	50.0	135
												0	*	100%							=	0.0	0
												0	*	100%							=	0.0	0
												0	*	100%							=	0.0	0
												0	*	100%							=	0.0	0
												0	*	100%							=	0.0	0
												0	*	100%							=	0.0	0
												0	*	100%							=	0.0	0
Total Auxiliary Electricity												890										889.8	2402
Total												11416	kWh			70				322		11062 kWh/a	30223 kWh/a
Specific Demand																0.0				0.7		23 kWh/(m²a)	64 kWh/(m²a)

Hot Water Non-Electric Dishwashing

Passive House Planning

AUXILIARY ELECTRICITY

Building: Linesöya group 4

1	Living Area	472	m²
2	Heating Period	205	d
3	Air Volume	1180	m³
4	Dwelling Units	1	HH
5	Enclosed Volume	1180	m³

Operation Vent. System Winter	4.91	kh/a
Operation Vent. System Summer	3.85	kh/a
Air Change Rate	0.30	h^{-1}
Defrosting HX from	-3.0	°C

Primary Energy Factor - Electricity	2.7	kWh/kWh
Annual Space Heat Demand	8	kWh/(m²a)
Boiler Rated Power	3	kW
DHW System Heat Demand	8730	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	0.40	Wh/m³ *	0.30	h^{-1} *	4.9	kh/a *	1180	m³ =	**695**		considered in heat recovery efficiency					**1877**
Summer Ventilation	0	1	0.40	Wh/m³ *	0.30	h^{-1} *	3.9	kh/a *	1180	m³ =	**0**		no summer contribution to IHG					**0**
Defroster HX	0	0	919	W *	1.00	*	0.1	kh/a *	1	=	**0**	*	1.0	/	4.91	=	**0**	**0**
Heating System					Controlled/Uncontrolled (1/0)													
Enter the Rated Power of the Pump			21	W	1													
Circulation Pump	1	0	21	W *	0.7	*	4.9	kh/a *	1	=	**77**	*	1.0	/	4.91	=	**0**	**207**
Boiler Electricity Consumption at 30% Load				W														
Aux. Energy - Heat. Boiler	0	0	25	W *	1.00	*	0.00	kh/a *	1	=	**0**	*	1.0	/	4.91	=	**0**	**0**
DHW system																		
Enter Average Power Consumption of Pump			6	W														
Circulation Pump	1	0	6	W *	1.00	*	5.5	kh/a *	1	=	**33**	*	0.6	/	8.76	=	**0**	**88**
Enter the Rated Power of the Pump				W														
Storage Load Pump DHW	0	0	66	W *	1.00	*	0.0	kh/a *	1	=	**0**	*	1.0	/	4.91	=	**0**	**0**
Boiler Electricity Consumption at 100% Load				W														
DHW Boiler Aux. Energy	0	0	76	W *	1.00	*	0.0	kh/a *	1	=	**0**	*	1.0	/	4.91	=	**0**	**0**
Enter the Rated Power of the Solar DHW Pump				W														
Solar Aux Electricity	1	1	49	W *	1.00	*	1.8	kh/a *	1	=	**86**	*	0.6	/	8.76	=	**6**	**231**
Misc. Aux. Electricity																		
Misc. Aux. Electricity	0	0	30	kWh/a *	1.00	*	1.0	*	1	HH =	**0**	*	1.0	/	8.76	=	**0**	**0**
Total											**890**						**6**	**2402**
Specific Demand kWh/(m²a)			Divide by Living Area:								**1.9**							**5.1**

Passive House Planning

PRIMARY ENERGY VALUE

Building:	Linesöya group 4	Building Type/Use:	dwelling/cultural
Location:	Linesöya	Treated Floor Area A_{TFA}:	472 m²
		Space Heat Demand incl. Distribution	9 kWh/(m²a)
		Useful Cooling Demand:	0 kWh/(m²a)

			Final Energy	Primary Energy	Emissions CO_2-Equivalent
			kWh/(m²a)	kWh/(m²a)	kg/(m²a)
Electricity Demand (without Heat Pump)				PE Value	CO_2-Emissions Factor (CO_2-Equivalent)
Covered Fraction of Space Heat Demand		*(Project)*	0%	kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*	0%	2.7	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)*	0.0	0.0	0.0
Electric Postheating DHW Wash&Dish		*(Electricity, SolarDHW)*	0.0	0.0	0.0
Electricity Demand Lighting/Equipment/Kitchen	Q_{EHH}	*(Electricity worksheet)*	21.6	58.2	14.7
Electricity Demand - Auxiliary Electricity			1.9	5.1	1.3
Total Electricity Demand (without Heat Pump)			**23.4**	**63.3**	**15.9**

				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
Heat Pump					
Covered Fraction of Space Heat Demand		*(Project)*	0%	kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*	0%	2.7	680
Energy Carrier - Supplementary Heating			Electricity	2.7	680
Annual Coefficient of Performance - Heat Pump		*Separate Calculation*	3.20		
Total System Performance Ratio of Heat Generator		*Separate Calculation*	0.45		
Electricity Demand Heat Pump (without DHW Wash&Dish)	Q_{HP}		0.0	0.0	0.0
Non-Electric Demand, DHW Wash&Dish		*(Electricity worksheet)*	0.0	0.0	0.0
Total Electricity Demand Heat Pump			**0.0**	**0.0**	**0.0**

				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
Compact Heat Pump Unit					
Covered Fraction of Space Heat Demand		*(Project)*	100%	kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*	100%	2.7	680
Energy Carrier - Supplementary Heating			Electricity	2.7	680
COP Heat Pump Heating		*(Compact worksheet)*	1.6		
COP Heat Pump DHW		*(Compact worksheet)*	1.8		
Performance Ratio of Heat Generator (Verification)		*(Compact worksheet)*	0.81		
Performance Ratio of Heat Generator (Planning)		*(Compact worksheet)*	0.81		
Electricity Demand Heat Pump (without DHW Wash&Dish)	Q_{HP}	*(Compact worksheet)*	10.8	29.3	7.4
Non-Electric Demand, DHW Wash&Dish			0.0	0.1	0.0
Total Compact Unit		*(Compact worksheet)*	**10.9**	**29.4**	**7.4**

				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
Boiler					
Covered Fraction of Space Heat Demand		*(Project)*	0%	kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*	0%	1.1	250
Boiler Type		*(Boiler worksheet)*			
Utilisation Factor 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**

				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
District Heat					
Covered Fraction of Space Heat Demand		*(Project)*	0%	kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*	0%	0.7	-70
Heat Source		*(District Heat worksheet)*			
Utilisation Factor Heat Generator		*(District Heat worksheet)*	95%		
Heat Demand District Heat (without DHW Wash&Dish)		*(District Heat worksheet)*	0.0	0.0	0.0
Non-Electric Demand, DHW Wash&Dish		*(Electricity worksheet)*	0.0	0.0	0.0
Total District Heat			**0.0**	**0.0**	**0.0**

				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
Other					
Covered Fraction of Space Heat Demand		*(Project)*	0%	kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*	0%	0.2	55
Heat Source		*(Project)*	Wood		
Utilisation Factor Heat Generator		*(Project)*	74%		
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		*(Electricity worksheet)*	0.0	0.0	0.0
Non-Electric Demand Cooking/Drying (Gas)		*(Blatt Strom)*	0.6	0.7	0.0
Total - Other			**0.6**	**0.7**	**0.0**

				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
Cooling with Electric Heat Pump				kWh/kWh	g/kWh
Covered Fraction of Cooling Demand		*(Project)*	100%	2.7	680
Heat Source			Electricity		
Annual Cooling COP			3.3		
Energy Demand Space Cooling			**0.0**	**0.0**	**0.0**

Heating, Cooling, DHW, Auxiliary and Household Electricity			**34.9**	**93.3**	**23.3**
Total PE Value		**93.3**	kWh/(m²a)		
Total Emissions CO_2-Equivalent		**23.3**	kg/(m²a)		(Yes/No)
Primary Energy Requirement			120	kWh/(m²a)	**Yes**

Heating, DHW, Auxiliary Electricity (No Household Applications)			**12.7**	**34.3**	**8.6**
Specific PE Demand - Mechanical System		**34.3**	kWh/(m²a)		
Total Emissions CO_2-Equivalent		**8.6**	kg/(m²a)		

			kWh/a	PE Value (Savings)	CO_2-Emission Factor
Solar Electricity				kWh/kWh	g/kWh
Planned Annual Electricity Generation		*Separate Calculation*	8628	0.7	250
Specific Demand			**18.3**	**12.8**	**4.6**
PE Value: Conservation by Solar Electricity		**36.6**	kWh/(m²a)		
CO_2-Emissions Avoided Due to Solar Electricity		**7.9**	kg/(m²a)		