AAR 4907 Integrated Energy Design

" L I P A M I L J Ø P R O S J E K T " L I N E S Ø Y A

Assignment 3

Group 5:
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1. Final design description

1.1 Design targets

The purpose of the Linesøya House project is to refurbish a building and at the same time trying to keep or preserve most of the old parts that not necessarily need to be modify. The parts of the building that should be removed (e.g. roof girders) will be reused for other purposes, for example in other buildings in the neighborhood.
It’s a case study for retro fitting where the main goal is to add new technologies to an old system in order to improve the energy efficiency or more precisely to achieve the passive house standard.
The challenge was to refurbish and redevelop the properties of the original building respecting its architectural, historic qualities and local context while creating a multifunctional house.

One of the main ideas of the project was to reveal the “inner life” of the building, to show the composition of the structure with a cut made throughout the house. This kind of work would be used as an educational tool, to let people know how a passive house works, to reveal the depth of the walls, the spaces and the passage of light. The cut has a specific solar orientation (9 degrees) which allows the sun’s rays to penetrate through the cut on the summer solstice.
The inspiration has been given by an American artist from the Sixties, Gordon Matta Clark, known for his "building cuts," a series of works in abandoned buildings in which he variously removed sections of floors, ceilings, and walls.
The building’s circulation system was another feature in the Linesøya project. It allows people to have an informative walkthrough the building, to experience and to learn more about the construction.

1.2 Perfomance targets

The initial goal was to have a zero net energy building but after some calculations it has been noticed that it’s not possible to achieve it, since the building needs always some energy delivered from the grid.
The new target of the project was to have a passive house in order to fulfill the passive house requirements (“Passivhus” and “Passivhaus”).

The maximization of the usable space within the existing volume was also important in the project. By working with this idea, it was possible to have a very compact building. No extensions have been added to the existing house. The existing storage (on the west side) has been left as it is so the inhabitants could have the possibility to transform the building in the future (the project doesn’t end up but is in a continuous transformation).
A new insulating envelope has been added on the outer part of the external walls which helps to reduce efficiently all the thermal bridges that existed in the old structure.

Air leakage is a major cause of energy loss so the air-tightness has been carefully designed into the building envelope during the initial concept design stage. The air barriers are impermeable to air, continuous, durable and vapor open in order to have a diffusion open construction. Internal air barriers are airtight; the external ones are wind-tight.
The materials used in this refurbishment project are environmental friendly: by using one of the “Homatherm” products instead of using the mineral wool and by using the foam glass gravel for the foundations.

2. Energy Performance Calculation

The energy performance was evaluated with the “Passive House Planning Package” (“PHPP”) in order to achieve verification with the passive house standard according to the German Passivhaus-Institut Darmstadt. As a general approach the input data was entered in a conservative manner to remain always on the ´safe side´.
According to PHPP the Passivhaus energy performance standard would be achieved with a specific heating demand of 15.4 kWh/(m²·a) resp. 15.1 kWh/(m²·a) according to EN 13790, a test result of the pressurisation test of 0.30 h^{-1}, a specific primary energy demand of 82 kWh/(m·a), and a specific cooling energy demand of 0.3 kWh/(m²·a). The maximum heating load is 10.8 W/m² and the maximum cooling load is 5.0 W/m².

Further comments to the individual spreadsheets as follows:

<u>“Verification” spreadsheet</u>
Since no appropriate climate data for Linesøya or nearby locations are available the climate data for Oslo provided by PHPP was selected.

<u>“Areas” spreadsheet</u>
The "treated floor area" of the building is 402 m². In contrast, the “bruksareal” according to Norwegian standard NS 3940 is 436 m². In general, the shape of the building was slightly simplified – the small protrusion of the elevator on the east elevation was neglected.
Even though a refurbishment project, the “thermal bridge-free construction” (Ψ ≤ 0.01 W/(m·K)) was chosen. Hence thermal bridges can be neglected and therefore no thermal bridges are to be entered.
Most transmission heat losses appear through south windows (21 %), north windows (16 %), slab to ground (11 %), north- and south-facing roof (each 9 %). If further calculations end in critical results, the reduction of the north window area shows the biggest potential for adjustments.

<u>“Windows” spreadsheet</u>
The big mullioned windows in the South façade on the first floor have been simplified. The

doors are accounted as windows.

“Window type” spreadsheet

Even though not certified by the PHI, “Nordan N-Tech0.7” windows were chosen initially. However, using the "Nordan Energi 2s SSP/Ar" glazing with a g-value of 0.37 a specific heating demand of 15 kWh/(m·a) cannot be achieveed due to the low g-value which allows less solar gains. Therefore the "Triple-low-e Kr12" glazing had to be chosen.

The unknown thermal properties of “Nordan N-Tech0.7” were substituted by those from the “Passive House frame, good thermal quality”. The structural glazing system “batimet TM50 SE” is PHI-certified. The values for the thermal bridge due to window installation $\Psi_{installation}$ is assumed as 0.010 W/(m·K).

“Shading” spreadsheet

Additional shading elements (e.g. trees) are considered for the windows at the ground and first floor with an “Additional shading reduction factor” of 90 %. For summer case see spreadsheet “Summer shading”.

“Ventilation” spreadsheet

The design air flow rate is 392 m^3/h. Even though the ventilation volume is 1005 m^3 (considering 2.50 m clear height) the net air volume for the pressurisation test is estimated as 1400 m^3.

The wind protection coefficient is 0.10 assuming no considerable screening. The efficiency of the heat recovery system has to be 93 % (and 0.4 Wh/m^3 electricity efficiency) and the test results of the pressurisation test at 50 Pa pressure difference n_{50} of less than 0.30 h^{-1} to achieve the Passive house requirement of 15 kWh/(m^2·a).

A subsoil heat exchanger is actually not intended and substituted by preheating the fresh air through cavities in the roof. Since no data for this is available the “Effective heat recovery efficiency subsoil heat exchanger” remained as provided by the example (93 %).

“Heating load” spreadsheet

The required heating power is 3.92 kW resulting in 9.8 W/m^2. The maximum heating load in the worst case (cold, clear day) is higher than the heating supplied by the ventilation system: 9.8 W/m^2 > 8.6 W/m^2. Hence an additional heating system is necessary (1.2 W/m^2 supplementary heating are required in worst case).

“Summer” spreadsheet

Since the building construction contains partly very heavy concrete elements and on the other hand light construction elements the specific heat capacity was altered to 132 Wh/(K·m^2_{TFA}). The air change rate of the mechanical system in summer is equal to the heating period = 0.3 h^{-1}.

At the required overheating limit of 25 °C the frequency of overheating is 1.0 %. Additional measures (shading of windows, natural ventilation and supply air cooling) are necessary.

“Summer shading” spreadsheet
Windows receive shading devices. Due to the local windy conditions internal shading with Venetian blinds is used. Except of the very small windows and the “cut” all windows on north, east, south, west facade have a “temporary shading reduction factor” of 70 %. The door on the east façade and the elevator door on the south façade have a shading reduction factor of 0 %. Shading of the surrounding trees is taken into account on the north, east, west side with an “additional shading reduction factor” of 70 % and 90 % on the south side.

“Summer ventilation” spreadsheet
Cross ventilation on all floors at a certain percentage are considered during daytime. The wind velocity is kept at 1 m/s.

“Cooling unit” spreadsheet
Supply air cooling is applied which covers the cooling demand.

“Heat distribution and DHW system” spreadsheet
No space heat distribution system is considered.

“Electricity” spreadsheet
80 % energy-saving fixtures are proposed. Using 100% can reduce the specific electricity demand by 0.8 kWh/(m^2·a).

“Auxiliary electricity” spreadsheet
According to input in the “Summer” spreadsheet ”Summer ventilation” is used. The circulation pumps for the DHW are placed inside the thermal envelope.

“Primary energy value” spreadsheet
A heat pump covers 100 % of heating and DHW demand. The input data related to the heat pump remained unchanged.
The energy production of the Photovoltaic system refers to the “PVGIS” website.

3. Commissioning and Monitoring Plan

Based on the Kyoto pyramid and the output from the PHPP a monitoring plan can be established which should be the binding and compulsory reference for all partners regarding planning and construction of the building:

1.	**Heat loss reduction**	
1.1	*super insulation*	
	wall below ground	U ≤ 0.10 W/m²K
	wall above ground	U ≤ 0.09 W/m²K
	roof	U ≤ 0.08 W/m²K
	slab to ground	U ≤ 0.10 W/m²K
	thermal bridges	"thermal bridge-free construction", Ψ ≤ 0.01 W/(m·K)
	windows, doors	casing: U ≤ 0.72 W/m²K glazing: U ≤ 0.58 W/m²K installation: Ψ ≤ 0.01 W/(m·K)
	structural glazing	casing: U ≤ 0.92 W/m²K glazing: U ≤ 0.58 W/m²K installation: Ψ ≤ 0.01 W/(m·K)
1.2	*air-tightness*	
	test result pressurisation test at 50 Pa	n_{50} = 0.30 h^{-1}
	detailing	sealed joints, taped gaps, vapour barrier and wind barrier fixed to window frame
	"blower-door-test"	
1.3	*heat recovery*	
1.3.1	ventilation system	
	type	balanced passive house ventilation
	design air flow rate	392 m³/h
	average air change rate	≥ 0.3 h^{-1}
	ventilation heat recovery	efficiency ≥ 93 %, electricity efficiency ≤ 0.40 Wh/m³
	supply air preheating	cavities under photovoltaics or subsoil heat exchanger
	ventilation ducts	insulated
1.3.2	heating system	
	nominal design power	4.3 kW (10.8 W/m²)
	supplementary heating system	nominal power 1.0 kW (2.6 W/m²); efficient, small capacity, portable systems, low temperature (PHPP manual recommendation: liquid gas heaters) ; post-heating of ventilation air if possible

1.3.3	cooling system	
	maximum cooling load	2.0 kW (5.0 W/m²)
1.3.4	domestic hot water	
	heat recovery	desirable
	DHW pipes	insulated (minimum 20 mm, reflective)
2.	**reduce energy consumption**	
2.1	*exploitation of daylight*	
	windows	increasing window sizes by splaying
2.2	*reduction of cooling*	
	summer shading	shading devices on south, east and west façades
	natural ventilation	window ventilation, cross ventilation in day and night time during summer
2.3	*energy efficient lighting and appliances*	
	energy saving light fixtures	≥ 80 %
	energy label household appliances	at least energy label A
3	**utilise solar gains**	
3.1	*passive solar*	
	glazing	g-value ≥ 0.5
	windows	splayed sides
	supply air preheating / (-cooling?)	through cavities under roofing
3.2	*active solar*	
	photovoltaic system	18 kWp mounted on south-facing roof with optimised slope
4	**display and control of energy use**	
4.1	*display*	
	design	visible energy systems, ducts and pipes as part of the educational program of the building

	visualisation of consumption	
4.2	control	
	"smart-house-technologies"	
5	**renewable energy source**	
5.1	*heating / DHW*	
	ground – water -heat pump	COP ≥ 3.2
5.2	*electricity*	
	photovoltaic system	18 kWp

4. Construction and Operation strategies

4.1 Construction

Given here are the issues of thermal bridges and air-tightness as incomplete examples for strategies of construction.

The energy performance target reached in the calculation construction was only reached taking into account a "thermal bridge-free" construction according to the Passivhaus Institut Darmstadt with almost non-existing thermal bridges. Therefore the planning of details and the construction in situ have to pay a great deal of attention to the compliance with this standard. Certified "thermal bridge-free" details can be obtained from the manufacturer or the PHI. Alterations (even because of national or local ´customs and habits´) are only allowed after consultation and in agreement with the planners after evaluations of the risks.

The required air-tightness has to be ensured. Thus the "Blower-door-test" has to be considered as milestone during the construction phase. All relevant layers of the construction have to be in place by then (e.g. vapour barrier, wind barrier, windows, doors - all fixed, sealed, and taped). The test has to be announced two weeks in advance in order to allow the work to be finished. If the result of the "blower-door-test" fails the required result then a second test has to undertaken. The costs for the second test are split among the hitherto working contractors. If the test result meet or even beat the requirements incentives are to be considered (white-list of contractors?).

4.2 Operation

Improving operation and maintenance practices can significantly improve the energy

efficiency of the building.
HVAC (heating, ventilation, and air conditioning) systems have a major impact on energy usage. Proper selection, installation, operation, and maintenance of HVAC systems can yield substantial energy savings, help control seasonal spikes in energy usage, and can improve comfort and air quality in the building.

Ventilation

Opening the windows in the winter time is not required as the ventilation system with heat recovery ensures an adequate supply of fresh air. The moisture generated in the house and the indoor pollution are completely removed whether the residents open the windows or not. In the summer time, the building is like a normal house where windows are opened at night for cooling.
The maintenance requirements for the ventilation unit are the following: changing filters; permanent use or shutdown with dry filters.
Since the building is essentially air-tight, the rate of air change should be optimized and carefully controlled at 0.3 air changes per hour.

Heating

In the building, the period when heating does take place corresponds from mid-December to mid-March (depending on the regional climate, usage and building details, this can vary by ± one month). Doors to unheated spaces or rooms should be closed to reduce heating. When the occupants are not at home, the heating system must not be completely switched off.
During the rest of the time (summer Time), the heating is not in operation and the windows are used to ventilate as described previously.

Lighting

Also lighting represents a large portion of electrical consumption for the building. If it is used in a proper way it will provide benefits such as: instant energy savings, improved lighting quality, and enhanced productivity, as well as experiencing the long term benefit of having longer-lasting lamps that will reduce the maintenance expenses. The less efficient incandescent light sources should be replace with LEDs (light-emitting diode) which have lower energy consumption and longer lifetime, improved robustness, smaller size, faster switching, and greater durability and reliability.
Lighting controls can further increase the energy savings, by automatically turning the fixtures on and off, or by simply dimming the light output when natural light sources are available.

Shading

Internal shading devices should be added on the windows facing south to have control over the solar gain, natural light and glare. They should be adjustable and movable responding easily to changing requirements and provide benefits in the regulation of insulation level of the windows. At night they also reduce heat losses through the window.

Passive House Verification

Building:	"LIPA Miljøprosjekt"	
Location and Climate:	Linesøya	N - Oslo
Street:		
Postcode/City:	Linesøya	
Country:	Norge	
Building Type:	Residential	
Home Owner(s) / Client(s):	Sukhi + Thomas	
Street:		
Postcode/City:		
Architect:		
Street:		
Postcode/City:		
Mechanical System:		
Street:		
Postcode/City:		

Year of Construction:	2012				
Number of Dwelling Units:	1		Interior Temperature:	20.0	°C
Enclosed Volume V_e:	2100.0	m³	Internal Heat Gains:	2.1	W/m²
Number of Occupants:	11.5				

Specific Demands with Reference to the Treated Floor Area

Treated Floor Area: 402.0 m²

	Applied:	Annual Method	PH Certificate:	Fulfilled?
Specific Space Heat Demand:	**15**	**kWh/(m²a)**	**15 kWh/(m²a)**	**Yes**
Pressurization Test Result:	**0.3**	**h^{-1}**	0.6 h^{-1}	**Yes**
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	**82**	**kWh/(m²a)**	120 kWh/(m²a)	**Yes**
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	**50**	**kWh/(m²a)**		
Specific Primary Energy Demand Energy Conservation by Solar Electricity:	**70**	**kWh/(m²a)**		
Heating Load:	**11**	**W/m²**		
Frequency of Overheating:		**%**	over 25 °C	
Specific Useful Cooling Energy Demand:	**0**	**kWh/(m²a)**	15 kWh/(m²a)	**Yes**
Cooling Load:	**5**	**W/m²**		

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: "LIPA Miljøprosjekt" — Heat Demand 15 kWh/(m²a)

Group Nr.	Area Group	Temp Zone	Area	Unit	Comments (Summary)	Building Element Overview	Average U-Value [W/(m²K)]
1	Treated Floor Area		402.00	m²	*Living area or useful area within the thermal envelope*		
2	North Windows	A	21.31	m²	Results are from the Windows worksheet.	North Windows	0.785
3	East Windows	A	7.12	m²		East Windows	0.753
4	South Windows	A	35.50	m²		South Windows	0.730
5	West Windows	A	3.40	m²		West Windows	0.777
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	360.20	m²	*Window areas are subtracted from the individual areas specified in the "Windows" worksheet.*	Exterior Wall - Ambient	0.086
9	Exterior Wall - Ground	B	91.40	m²	*Temperature Zone "A" is ambient air.*	Exterior Wall - Ground	0.099
10	Roof/Ceiling - Ambient	A	309.67	m²	*Temperature zone "B" is the ground.*	Roof/Ceiling - Ambient	0.081
11	Floor Slab	B	229.70	m²		Floor Slab	0.090
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			1058.30	m²		Average Therm. Envelope	0.129

Area Input

Area Nr.	Building Element Description	Group Nr.	Assigned to Group	Quantity	x (	a [m]	x	b [m]	+	User-Determined [m²]	-	User Subtraction [m²]	-	Subtraction Window Areas [m²]	) =	Area [m²]	Selection of the Corresponding Building Element Assembly	Nr.	U-Value [W/(m²K)]
	Treated Floor Area	1	Treated Floor Area	1	x (		x		+	402.00	-				) =	402.0			
	North Windows	2	North Windows	Please complete in Windows worksheet only!												21.3	From Windows sheet		0.785
	East Windows	3	East Windows													7.1	From Windows sheet		0.753
	South Windows	4	South Windows													35.5	From Windows sheet		0.730
	West Windows	5	West Windows													3.4	From Windows sheet		0.777
	Horizontal Windows	6	Horizontal Windows													0.0	From Windows sheet		0.000
	Exterior Door	7	Exterior Door		x (		x		+		-		) -		=		U-Value Exterior Door		
1	north below ground	9	Exterior Wall - Ground	1	x (		x		+	25.00	-		) -	0.0	=	25.0		1	0.099
2	north above ground 1	8	Exterior Wall - Ambient	1	x (		x		+	44.50	-		) -	11.4	=	33.1		2	0.093
3	north above ground 2	8	Exterior Wall - Ambient	1	x (		x		+	81.90	-		) -	6.0	=	75.9		3	0.083
4	north roof	10	Roof/Ceiling - Ambient	1	x (		x		+	142.80	-		) -	4.0	=	138.8		4	0.081
5	east below ground	9	Exterior Wall - Ground	1	x (		x		+	18.60	-		) -	0.0	=	18.6		1	0.099
6	east above ground 1	8	Exterior Wall - Ambient	1	x (		x		+	11.30	-		) -	1.1	=	10.2		2	0.093
7	east above ground 2	8	Exterior Wall - Ambient	1	x (		x		+	69.90	-		) -	6.0	=	63.9		3	0.083
8	east roof	10	Roof/Ceiling - Ambient	1	x (		x		+	26.10	-		) -	0.0	=	26.1		4	0.081
9	south below ground	9	Exterior Wall - Ground	1	x (		x		+	33.40	-		) -	0.0	=	33.4		1	0.099
10	south above ground 1	8	Exterior Wall - Ambient	1	x (		x		+	38.90	-		) -	5.5	=	33.4		2	0.093
11	south above ground 2	8	Exterior Wall - Ambient	1	x (		x		+	78.40	-		) -	26.0	=	52.4		3	0.083
12	south roof	10	Roof/Ceiling - Ambient	1	x (		x		+	142.80	-		) -	4.0	=	138.8		4	0.081
13	west below ground	9	Exterior Wall - Ground	1	x (		x		+	14.40	-		) -	0.0	=	14.4		1	0.099
14	west above ground 1	8	Exterior Wall - Ambient	1	x (		x		+	25.10	-		) -	0.0	=	25.1		2	0.093
15	west above ground 2	8	Exterior Wall - Ambient	1	x (		x		+	69.60	-		) -	3.4	=	66.2		3	0.083
16	west roof	10	Roof/Ceiling - Ambient	1	x (		x		+	5.90	-		) -	0.0	=	5.9		4	0.081
17	slab to ground	11	Floor Slab	1	x (		x		+	229.70	-		) -	0.0	=	229.7		5	0.090
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: "LIPA Miljøprosjekt" Heat Demand 15 kWh/(m²a)

Group Nr.	Area Group	Temp Zone	Area	Unit	Comments		Building Element Overview	Average U-Value [W/(m²K)]
	Summary							
1	Treated Floor Area		402.00	m²	*Living area or useful area within the thermal envelope*			
2	North Windows	A	21.31	m²	Results are from the Windows worksheet.		North Windows	0.785
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4	South Windows	A	35.50	m²			South Windows	0.730
5	West Windows	A	3.40	m²			West Windows	0.777
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	360.20	m²	*Window areas are subtracted from the individual areas specified in the "Windows" worksheet.*		Exterior Wall - Ambient	0.086
9	Exterior Wall - Ground	B	91.40	m²	*Temperature Zone "A" is ambient air.*		Exterior Wall - Ground	0.099
10	Roof/Ceiling - Ambient	A	309.67	m²	*Temperature zone "B" is the ground.*		Roof/Ceiling - Ambient	0.081
11	Floor Slab	B	229.70	m²			Floor Slab	0.090
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			1058.30	m²			Average Therm. Envelope	0.129

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												

Passive House Planning

U - L I S T

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

Assembly No.	Type Assembly Description	Total Thickness	U-Value
		m	W/(m²K)
1	wall below ground	0.655	0.10
2	wall above ground 1	0.475	0.09
3	wall above ground 2	0.575	0.08
4	roof	0.559	0.08
5	slab to ground	1.001	0.09
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21	Wood24-old	0.275	1.440
22	Solid Brick 38-old	0.415	1.640
23	Framework18-old	0.210	1.800
24	VerticalCoringBrick30-old	0.335	1.230
25	PrecastConcrete-old	0.275	1.300
26	WoodenJoistCeiling-old	0.284	0.990
27	BasementFloor-old	0.242	1.230
28			
29	AW-ALS032-mas: alseco, exterior insulation compound system on masonry	0.500	0.100
30	AW-ALS034/035-mas: alseco, exterior insulation compound system on masonry	0.500	0.110
31	AW-ALS040/041-mas: alseco, exterior insulation compound system on masonry	0.500	0.130
32	AW-ALG032-mas: Alligator, exterior insulation compound system on masonry	0.500	0.100
33	AW-ALG034/035-mas: Alligator, exterior insulation compound system on masonry	0.500	0.110
34	AW-ALG040/041-mas: Alligator, exterior insulation compound system on masonry	0.500	0.130
35	AW-CAP032-mas: Caparol, exterior insulation compound system on masonry	0.500	0.100
36	AW-CAP034/035-mas: Caparol, exterior insulation compound system on masonry	0.500	0.110
37	AW-CAP040/041-mas: Caparol, exterior insulation compound system on masonry	0.500	0.130
38	AW-FGH035-lei: Fingerhaus, wooden beam load-bearing wall with ETICS	0.415	0.100
39	AW-FIN040-lei: Finnforest Merk, FJI-beam	0.404	0.120
40	AW-GPT031-mas: Gisoplan-Therm 375/225, ICF from expanded clay	0.400	0.120
41	AW-GRE050-mas: Greisel, exterior insulation compound system on porous concre	0.515	0.119
42	AW-HEB045-mas: Hebel, exterior insulation compound system on porous concret	0.470	0.140
43	AW-HVH035-mas: Heinz von Heiden, exterior insulation compound system on Yton	0.497	0.101
44	AW-HVH040-lei: Heinz von Heiden, lightweight wall with exterior insulation c	0.453	0.094
45	AW-ISR035-dws: isorast, insulating concrete form Dickwandstein	0.400	0.140
46	AW-ISR035-sdw: isorast, insulating concrete form Superdickwandstein	0.463	0.110
47	AW-MAR035-mas: Marmorit, ETICS from limestone and PS	0.500	0.110
48	AW-MAR040-mas: Marmorit, ETICS from limestone and MW	0.500	0.130
49	AW-NUS035-mas: Naumann&Stahr, wooden lightweight elements with DokAW-beams	0.423	0.120
50	AW-STO035-mas: Sto, ETICS from limestone and PS 035	0.495	0.110
51	AW-STO040-mas: Sto, ETICS from limestone and PS 040	0.495	0.130
52	AW-WOC250-mas: Wochner, ETICS from porous concrete and PS, 250	0.460	0.130
53	AW-WOC300-mas: Wochner, ETICS from porous concrete and PS, 250	0.510	0.110
54	DA-ALS045-lei: alseco, lightweight roof	0.395	0.140
55	DA-ALS040-Fla: alseco, Flachdach	0.515	0.130
56	DA-ALG045-lei: Alligator, lightweight roof	0.395	0.140
57	DA-ALG040-Fla: Alligator, flat roof	0.515	0.130
58	DA-CAP045-lei: Caparol, lightweight roof	0.395	0.140
59	DA-CAP040-Fla: Caparol, flat roof	0.515	0.130
60	DA-FGH035-lei: Fingerhaus, lightweight roof	0.333	0.130
61	DA-FIN040-lei: Finnforest Merk, lightweight roof	0.344	0.141

Passive House Planning
U-VALUES OF BUILDING ELEMENTS

Building: "LIPA Miljøprosjekt"

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

Assembly No.	Building Assembly Description
1	wall below ground

Heat Transfer Resistance [m²K/W] interior R_{si}: 0.13
exterior R_{se}: 0.00

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.	cladding, spruce	0.130					15
2.	homatherm holzflex	0.040					50
3.	concrete, reinforced	2.500					250
4.	foamglas	0.040					340
5.							
6.							
7.							
8.							

Percentage of Sec. 2:
Percentage of Sec. 3:
Total: 65.5 cm
1/R

U-Value: 0.099 W/(m²K)

Assembly No.	Building Assembly Description
2	wall above ground 1

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.	cladding, spruce	0.130					15
2.	homatherm holzflex	0.040					50
3.	osb-board	0.130					15
4.	homatherm holzflex	0.040	stud, spruce	0.130			200
5.	homatherm hdp-q11	0.042					160
6.	homatherm ud-q11	0.046					35
7.							
8.							

Percentage of Sec. 2: 8.0%
Percentage of Sec. 3:
Total: 47.5 cm
1/R

U-Value: 0.093 W/(m²K)

Assembly No.	Building Assembly Description
3	wall above ground 2

Heat Transfer Resistance [m²K/W] interior R_{si}: 0.13
exterior Rse: 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.	cladding, spruce	0.130					15
2.	homatherm holzflex	0.040					60
3.	osb-board	0.130					15
4.	reisverk	0.130					60
5.	homatherm holzflex	0.040	stud, spruce	0.130			230
6.	homatherm hdp-q11	0.042					160
7.	homatherm ud-q11	0.046					35
8.							

Percentage of Sec. 2: 8.0%
Percentage of Sec. 3:
Total: 57.5 cm
1/R

U-Value: 0.083 W/(m²K)

Passive House Planning

U-VALUES OF BUILDING ELEMENTS

Building: "LIPA Miljøprosjekt"

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

Assembly No.	Building Assembly Description
4	roof

Heat Transfer Resistance [m²K/W] interior R_{si}: 0.10
exterior R_{se}: 0.10

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.	cladding, spruce	0.130					15
2.	homatherm holzflex	0.040					50
3.	osb-board	0.130					15
4.	homatherm holzflex	0.040	rafter, spruce	0.130			225
5.	sheating, spruce	0.130					19
6.	homatherm hdp-q11	0.042					200
7.	homatherm ud-q11	0.046					35
8.							

Percentage of Sec. 2: 8.0%
Percentage of Sec. 3:
Total: 55.9 cm
1/R

U-Value: **0.081** W/(m²K)

Assembly No.	Building Assembly Description
5	slab to ground

Heat Transfer Resistance [m²K/W] interior R_{si}: 0.17
exterior R_{se}: 0.00

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.	homatherm holzflex	0.040					80
2.	concrete, reinforced	2.500					120
3.	pe-film	0.400					1
4.	glass foam gravel	0.090					800
5.							
6.							
7.							
8.							

Percentage of Sec. 2:
Percentage of Sec. 3:
Total: 100.1 cm
1/R

U-Value: **0.090** W/(m²K)

Assembly No.	Building Assembly Description
6	

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
1/R

U-Value: 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 Temperatur	$T_{g,ave}$	6.1	°C
Amplitude of $T_{g,ave}$	$T_{g,^}$	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 Area	A	229.7	m²	Floor Slab U-Value	U_f	0.090	W/(m²K)
Floor Slab Perimeter	P	67.6	m	Thermal Bridges at Floor Slab	Ψ_B*l	0.00	W/K
Charact. Dimension of Floor Slab	B'	6.80	m	Floor Slab U-Value incl. TB	U_f'	0.090	W/(m²K)
				Eq. Thickness Floor	d_t	22.2	m

Floor Slab Type (select only one) Please choose one option only.

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

For Basement or Underground Floor Slab							
Basement Depth	z	1.00	m	U-Value Belowground Wall	U_{wB}	0.099	W/(m²K)
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	0.000	W/(m²K)
Basement Volume	V	0	m³	U-Value Basement Floor Slab	U_{fB}	0.000	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	0.10	-

Additional Thermal Bridge Heat Losses at Perimeter							
Phase Shift	β		months	Steady-State Fraction	$\Psi_{P,stat}$*l	0.000	W/K
				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}	27.37	W/K
Groundwater Flow Rate	q_W	0.05	m/d	Relative Insulation Standard	d_t/B'	3.20	-
				Relative Groundwater Depth	z_W/B'	0.44	-
Groundwater Correction Factor	G_W	1.00687594	-	Relative Groundwater Velocity	l/B'	0.12	-

Basement or Underground Floor Slab							
Eq. Thickness Floor Slab	d_t	22.2	m	Phase Shift	β	1.44	months
U-Value Floor Slab	U_{bf}	0.08	W/(m²K)	Exterior Periodic Transmittance	L_{pe}	8.81	W/K
Eq. Thickness Basement Wall	d_w	20.20	m				
U-Value Wall	U_{bw}	0.09	W/(m²K)				
Steady-State Transmittance	L_S	24.10	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	$\Delta\Psi$		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	1.44	months	Steady-State Heat Flow	Φ_{stat}	333.7	W
Steady-State Transmittance	L_S	24.10	W/K	Periodic Heat Flow	Φ_{harm}	37.9	W
Exterior Periodic Transmittance	L_{pe}	8.81	W/K	Heat Losses During Heating Period	Q_{tot}	1824	kWh

Ground Reduction Factor for "Annual Heat Demand" Sheet 0.643

Monthly Average Ground Temperatures for Monthly Method

Month	1	2	3	4	5	6	7	8	9	10	11	12	Average Val
Winter	5.3	4.5	4.5	5.5	7.0	8.8	10.3	11.1	11.1	10.1	8.6	6.8	7.8
Summer	5.9	5.1	5.1	6.1	7.6	9.4	10.9	11.7	11.7	10.7	9.2	7.4	8.4

Design Ground Temperature for Heat Load Sheet 4.5 **for Cooling Load Sheet** 11.7

Passive House Planning

REDUCTION FACTOR SOLAR RADIATION, WINDOW U-VALUE

Building: "LIPA Miljøprosjekt"

Annual Heat Demand: 15 kWh/(m²a)

Heating Degree Hours: 103.6

Climate: N - Oslo

Window Area Orientation	Global Radiation (Cardinal Points)	Shading	Dirt	Non-Perpendicular Incident Radiation	Glazing Fraction	g-Value	Reduction Factor for Solar Radiation	Window Area	Window U-Value	Glazing Area	Average Global Radiation	Transmission Losses	Heat Gains Solar Radiation
maximum:	kWh/(m²a)	0.75	0.95	0.85				m²	W/(m²K)	m²	kWh/(m²a)	kWh/a	kWh/a
North	63	0.79	0.95	0.85	0.703	0.50	0.45	21.31	0.78	15.0	72	1732	344
East	180	0.74	0.95	0.85	0.683	0.50	0.41	7.12	0.75	4.9	132	555	191
South	432	0.93	0.95	0.85	0.767	0.50	0.57	35.50	0.73	27.2	418	2684	4261
West	182	0.76	0.95	0.85	0.637	0.50	0.39	3.40	0.78	2.2	242	274	161
Horizontal	233	0.75	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	233	0	0
		Total or Average Value for All Windows.				0.50	0.51	67.33	0.75	49.2		5245	4956

					Window Rough Openings		Installed		Glazing		Frame		g-Value	U-Value		Window Frame Dimensions				Installation				Ψ-Value		Results			
Quantity	Description	Deviation from North	Angle of Inclination from the Horizontal	Orientation	Width	Height	in Area in the Areas worksheet	Nr.	Select glazing from the WinType worksheet	Nr.	Select window from the WinType worksheet	Nr.	Perpendicular Radiation	Glazing	Frames	Width - Left	Width - Right	Width - Below	Width - Above	Left 1/0	Right 1/0	Sill 1/0	Head 1/0	Ψ_{Spacer}	$\Psi_{Installation}$	Window Area	Glazing Area	U-Value Window	Glazed Fraction per Window
		Degrees	Degrees		m	m	Select:		Select:		Select:		-	W/(m²K)	W/(m²K)	m	m	m	m					W/(mK)	W/(mK)	m²	m²	W/(m²K)	%
6	n 00 120x160	343	90	North	1.100	1.500		2		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	9.9	6.89	0.75	0.70
1	n 00 80x55	343	90	North	0.800	0.550		2		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	0.4	0.20	0.87	0.46
1	n 00 cut	343	90	North	0.550	1.900		2		2		6	0.50	0.58	0.92	0.05	0.05	0.05	0.05	1	1	1	0	0.035	0.010	1.0	0.81	0.85	0.78
1	n 01 120x120	343	90	North	1.100	1.100		3		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	1.2	0.79	0.77	0.65
4	n 01 110x80	343	90	North	1.000	0.700		3		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	2.8	1.55	0.82	0.55
1	n 01 cut	343	90	North	0.550	3.540		3		2		6	0.50	0.58	0.92	0.05	0.05	0.05	0.05	1	1	0	0	0.035	0.010	1.9	1.55	0.83	0.80
1	n roof cut	343	45	North	0.550	7.210		4		2		6	0.50	0.58	0.92	0.05	0.05	0.05	0.05	1	1	0	0	0.035	0.010	4.0	3.20	0.82	0.81
1	e 00 door	73	90	East	1.200	0.900		6		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	1.1	0.68	0.78	0.63
1	e 01 door	73	90	East	1.200	1.500		7		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	1.8	1.28	0.74	0.71
1	e 01 90x90	73	90	East	0.800	0.800		7		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	0.6	0.35	0.82	0.54
2	e 02 120x150	73	90	East	1.200	1.500		7		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	3.6	2.55	0.74	0.71
4	s 00 120x75	163	90	South	1.100	0.650		10		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	2.9	1.57	0.82	0.55
1	s 00 elevato	163	90	South	1.100	2.400		10		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	2.6	1.95	0.72	0.74
6	s 01 190x190	163	90	South	1.800	1.800		11		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	19.4	15.17	0.70	0.78
1	s 01 glazed	163	90	South	1.800	2.650		11		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	4.8	3.88	0.68	0.81
1	s 01 cut	163	90	South	0.550	3.320		11		2		6	0.50	0.58	0.92	0.05	0.05	0.05	0.05	1	1	1	0	0.035	0.010	1.8	1.45	0.83	0.79
1	s roof cut	163	45	South	0.550	7.210		12		2		6	0.50	0.58	0.92	0.05	0.05	0.05	0.05	1	1	0	0	0.035	0.010	4.0	3.20	0.82	0.81
1	w 01 110x80	253	90	West	1.000	0.700		15		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	0.7	0.39	0.82	0.55
1	w 02 150x60	253	90	West	1.500	0.600		15		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	0.9	0.50	0.82	0.56
1	w 02 120x150	253	90	West	1.200	1.500		15		2		5	0.50	0.58	0.72	0.11	0.11	0.11	0.11	1	1	1	1	0.035	0.010	1.8	1.28	0.74	0.71
								0		0		0																	
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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	nordan energi 2s ssp/ar	0.370	0.500
7			
8			
9			
10			
11			

Passive House Planning

FRAME TYPE ACCORDING TO CERTIFICATION

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	nordan ntech0.7	0.72	0.105	0.105	0.105	0.105	0.035	0.010
6	batimet tm50 se	0.92	0.050	0.050	0.050	0.050	0.035	0.010
7								
8								
9								
10								
11								

Passive House Planning

CALCULATING SHADING FACTORS

Climate: N - Oslo

Building: "LIPA Miljøprosjekt"

Latitude: 59.93 °

Orien-tation	Glazing Area	Reduction Factor
	m²	r_S
North	14.99	79%
East	4.86	74%
South	27.21	93%
West	2.17	76%
Horizontal	0.00	100%

Quantity	Description	Deviation from North	Angle of Inclination from the Horizontal	Orientation	Glazing Width	Glazing Height	Glazing Area	Height of the Shading Object	Horizontal Distance	Window Reveal Depth	Distance from Glazing Edge to Reveal	Overhang Depth	Distance from Upper Glazing Edge to Overhang	Additional Shading Reduction Factor	Horizontal Shading Reduction Factor	Reveal Shading Reduction Factor	Overhang Shading Reduction Factor	Total Shading Reduction Factor
		Degrees	Degrees		m	m		m	m	m	m	m	m	%	%	%	%	%
					w_G	h_G	A_G	h_{Hori}	d_{Hori}	o_{Reveal}	d_{Reveal}	o_{over}	d_{over}	r_{other}	r_H	r_R	r_O	r_S
6	n 00 120x160	343	90	North	0.89	1.29	6.9			0.34	0.105			90%	100%	83%	100%	75%
1	n 00 80x55	343	90	North	0.59	0.34	0.2			0.34	0.105			90%	100%	78%	100%	70%
1	n 00 cut	343	90	North	0.45	1.80	0.8			0.34	0.105			90%	100%	74%	100%	67%
1	n 01 120x120	343	90	North	0.89	0.89	0.8			0.32	0.105			90%	100%	84%	100%	75%
4	n 01 110x80	343	90	North	0.79	0.49	1.5			0.32	0.105			90%	100%	82%	100%	74%
1	n 01 cut	343	90	North	0.45	3.44	1.5			0.32	0.050			90%	100%	72%	100%	65%
1	n roof cut	343	45	North	0.45	7.11	3.2			0.00	0.05				100%	100%	100%	100%
1	e 00 door	73	90	East	0.99	0.69	0.7			0.34	0.105			90%	100%	77%	100%	70%
1	e 01 door	73	90	East	0.99	1.29	1.3			0.34	0.105			90%	100%	77%	100%	70%
1	e 01 90x90	73	90	East	0.59	0.59	0.3			0.32	0.105			90%	100%	70%	100%	63%
2	e 02 120x150	73	90	East	0.99	1.29	2.6			0.32	0.105				100%	78%	100%	78%
4	s 00 120x75	163	90	South	0.89	0.44	1.6			0.34	0.105				100%	89%	100%	89%
1	s 00 elevator	163	90	South	0.89	2.19	1.9			0.34	0.105				100%	89%	100%	89%
6	s 01 190x190	163	90	South	1.59	1.59	15.2			0.32	0.105				100%	93%	100%	93%
1	s 01 glazed do	163	90	South	1.59	2.44	3.9			0.32	0.105				100%	93%	100%	93%
1	s 01 cut	163	90	South	0.45	3.22	1.4			0.32	0.05				100%	80%	100%	80%
1	s roof cut	163	45	South	0.45	7.11	3.2			0.00	0.05				100%	100%	100%	100%
1	w 01 110x80	253	90	West	0.79	0.49	0.4			0.32	0.05			90%	100%	73%	100%	66%
1	w 02 150x60	253	90	West	1.29	0.39	0.5			0.32	0.05				100%	81%	100%	81%
1	w 02 120x150	253	90	West	0.99	1.29	1.3			0.32	0.05				100%	77%	100%	77%

Passive House Planning

VENTILATION DATA

Building: "LIPA Miljøprosjekt"

Treated Floor Area A_{TFA}	m²	402	(Areas worksheet)
Room Height h	m	2.5	(Annual Heat Demand worksheet)
Room Ventilation Volume $(A_{TFA}*h) = V_V$	m³	1005	(Annual Heat Demand worksheet)

Ventilation System Design - Standard Operation

Occupancy	m²/P	35				
Number of Occupants	P	11.5				
Supply Air per Person	m³/(P*h)	30				
Supply Air Requirement	m³/h	345				
Extract Air Rooms		Kitchen	Bathroom	Shower	WC	
Quantity		1	1	0	2	
Extract Air Requirement per Room	m³/h	60	40	20	20	
Total Extract Air Requirement	m³/h	140				

Design Air Flow Rate (Maximum) m³/h 392

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	392	0.39
Standard	24.0	0.77	302	0.30
Basic		0.54	211	0.21
Minimum		0.40	157	0.16

x Residential Building — Average value 0.77 — Average Air Flow Rate (m³/h) 302 — 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	0.30	0.30	1400	m³	0.40 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	0.042	0.104

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}		0.93	
Transmittance Ambient Air Duct	Ψ	W/(mK)	0.168	Calculation see Secondary Calculation
Length Ambient Air Duct		m	1	
Transmittance Exhaust Air Duct	Ψ	W/(mK)	0.234	Calculation see Secondary Calculation
Length Exhaust Air Duct		m	1	Room Temperature (°C): 20
Temperature of Mechanical Services Room		°C	20	Av. Ambient Temp. Heating P. (°C): -1.1
(Enter only if the central unit is outside of the thermal envelope.)				Av. Ground Temp (°C): 6.1

Effective Heat Recovery Efficiency $\eta_{HR,eff}$ 92.7%

Effective Heat Recovery Efficiency Subsoil Heat Exchanger

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

Passive House Planning

SPECIFIC ANNUAL HEAT DEMAND

Climate: N - Oslo
Building: "LIPA Miljøprosjekt"
Location: Linesøya

Interior Temperature: 20.0 °C
Building Type/Use: Residential
Treated Floor Area A_{TFA}: 402.0 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	360.2	*	0.086	*	1.00	*	103.6	=	3192	
2.	Exterior Wall - Ground	B	91.4	*	0.099	*	0.64	*	103.6	=	603	
3.	Roof/Ceiling - Ambient	A	309.7	*	0.081	*	1.00	*	103.6	=	2601	
4.	Floor Slab	B	229.7	*	0.090	*	0.64	*	103.6	=	1378	
5.		A		*		*	1.00	*		=		
6.		A		*		*	1.00	*		=		
7.		X		*		*	0.75	*		=		
8.	Windows	A	67.3	*	0.752	*	1.00	*	103.6	=	5245	
9.	Exterior Door	A		*		*	1.00	*		=		
10.	Exterior TB (length/m)	A		*		*	1.00	*		=		
11.	Perimeter TB (length/m)	P		*		*	0.64	*		=		
12.	Ground TB (length/m)	B		*		*	0.64	*		=		
	Total of All Building Envelope Areas		1058.3									kWh/(m²a)
	Transmission Heat Losses Q_T									Total	13019	32.4

			A_{TFA} m²		Clear Room Height m		m³
Ventilation System:	Effective Air Volume, V_V		402.0	*	2.50	=	1005.0
Effective Heat Recovery Efficiency of Heat Recovery	η_{eff}	93%					
Efficiency of Subsoil Heat Exchanger	η_{SHX}	32%					

	$n_{V,system}$ 1/h		Φ_{HR}		$n_{V,Res}$ 1/h		1/h
Energetically Effective Air Exchange n_v	0.300	(1 -	0.95	) +	0.042	=	0.057

	V_V m³		n_V 1/h		c_{Air} Wh/(m³K)		G_t kKh/a		kWh/a	kWh/(m²a)
Ventilation Heat Losses Q_V	1005	*	0.057	*	0.33	*	103.6	=	1949	4.8

		Q_T kWh/a		Q_V kWh/a		Reduction Factor Night/Weekend Saving		kWh/a	kWh/(m²a)
Total Heat Losses Q_L	(	13019	+	1949	) *	1.0	=	14968	37.2

	Orientation of the Area	Reduction Factor See Windows Sheet		g-Value (perp. radiation)		Area m²		Radiation HP kWh/(m²a)		kWh/a	kWh/(m²a)
1.	North	0.45	*	0.50	*	21.31	*	72	=	344	
2.	East	0.41	*	0.50	*	7.12	*	132	=	191	
3.	South	0.57	*	0.50	*	35.50	*	418	=	4261	
4.	West	0.39	*	0.50	*	3.40	*	242	=	161	
5.	Horizontal	0.40	*	0.00	*	0.00	*	233	=	0	
	Available Solar Heat Gains Q_S								Total	4956	12.3

	kh/d		Length Heat. Period d/a		Spec. Power q_I W/m²		A_{TFA} m²		kWh/a	kWh/(m²a)
Internal Heat Gains Q_I	0.024	*	205	*	2.10	*	402.0	=	4144	10.3

			kWh/a	kWh/(m²a)
Free Heat Q_F	$Q_S + Q_I$	=	9100	22.6
Ratio of Free Heat to Losses	Q_F / Q_L	=	0.61	
Utilisation Factor Heat Gains η_G	$(1 - (Q_F/Q_L)^5) / (1 - (Q_F/Q_L)^6)$	=	97%	
Heat Gains Q_G	$\eta_G * Q_F$	=	8788	21.9
Annual Heat Demand Q_H	$Q_L - Q_G$	=	6180	15

Limiting Value (kWh/(m²a)): 15

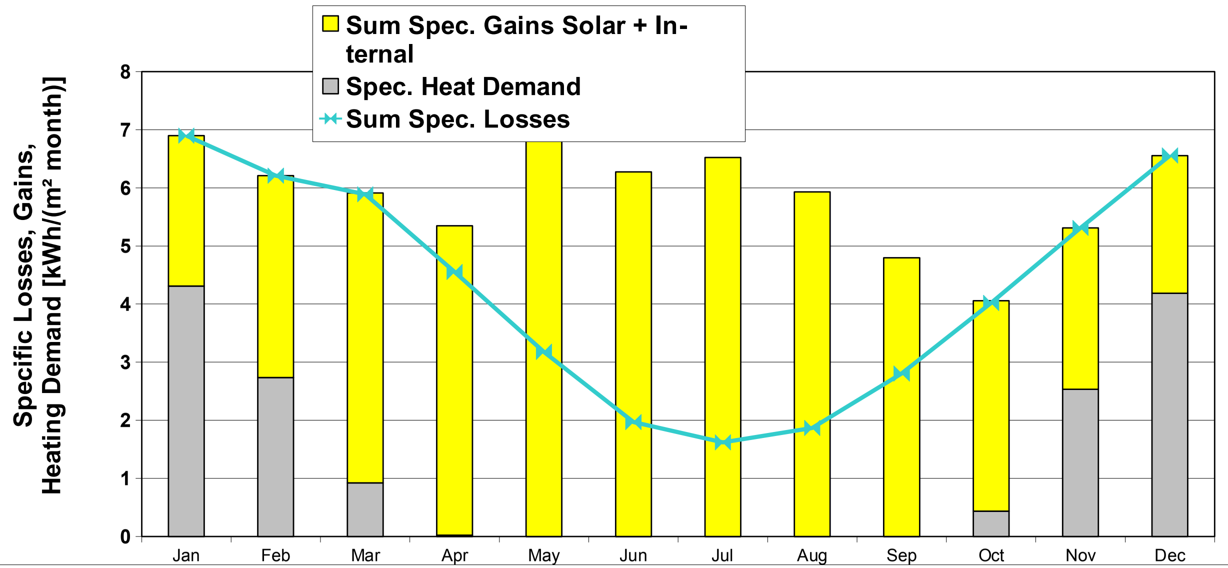
Requirement met? (Yes/No): Yes

PASSIVE HOUSE PLANNING

SPECIFIC ANNUAL HEAT DEMAND
MONTHLY METHOD

Climate:	N - Oslo	Interior Temperature:	20	°C
Building:	"LIPA Miljøprosjekt"	Building Type/Use:	Residential	
Location:	Linesøya	Treated Floor Area A_{TFA}:	402	m²

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Heating Degree Hours - E	19.6	17.5	16.1	12.0	7.6	4.1	3.3	4.2	7.4	11.1	15.2	18.8	137	kKh
Heating Degree Hours - G	10.9	10.4	11.5	10.5	9.7	8.1	6.8	6.6	6.4	7.3	8.2	9.8	106	kKh
Losses - Exterior	2374	2116	1947	1448	925	497	403	510	893	1348	1835	2278	16574	kWh
Losses - Ground	399	381	420	382	353	295	247	241	235	268	300	358	3877	kWh
Sum Spec. Losses	6.9	6.2	5.9	4.6	3.2	2.0	1.6	1.9	2.8	4.0	5.3	6.6	50.9	kWh/m²
Solar Gains - North	17	39	98	158	295	304	298	216	118	58	22	15	1638	kWh
Solar Gains - East	7	23	56	88	146	141	133	103	59	30	10	6	803	kWh
Solar Gains - South	356	693	1079	1101	1468	1212	1295	1213	993	659	435	280	10785	kWh
Solar Gains - West	10	24	45	56	88	72	77	69	46	25	13	7	530	kWh
Solar Gains - Horiz.	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Solar Gains - Opaque	23	51	99	130	204	186	190	156	103	56	29	18	1244	kWh
Internal Heat Gains	628	567	628	608	628	608	628	628	608	628	608	628	7395	kWh
Sum Spec. Gains Solar +	2.6	3.5	5.0	5.3	7.0	6.3	6.5	5.9	4.8	3.6	2.8	2.4	55.7	kWh/m²
Utilisation Factor	100%	100%	100%	85%	45%	31%	25%	32%	59%	99%	100%	100%	64%	
Annual Heat Demand	1732	1099	371	9	0	0	0	0	0	175	1018	1682	6085	kWh
Spec. Heat Demand	**4.3**	**2.7**	**0.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.4**	**2.5**	**4.2**	**15.1**	kWh/m²



Passive House Planning

SPECIFIC SPACE HEATING LOAD

Building:	"LIPA Miljøprosjekt"	Building Type/Use:	Residential
Location:	Linesøya	Treated Floor Area A_{TFA}:	402.0 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.	4.5	°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	360.2	*	0.086	*	1.00	*	33.5	or	27.6	=	1034	or	850
2.	Exterior Wall - Ground	B	91.4	*	0.099	*	1.00	*	15.5	or	15.5	=	140	or	140
3.	Roof/Ceiling - Ambient	A	309.7	*	0.081	*	1.00	*	33.5	or	27.6	=	842	or	693
4.	Floor Slab	B	229.7	*	0.090	*	1.00	*	15.5	or	15.5	=	321	or	321
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	67.3	*	0.752	*	1.00	*	33.5	or	27.6	=	1699	or	1397
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	*	15.5	or	15.5	=		or	
12.	Ground TB (length/m)	B		*		*	1.00	*	15.5	or	15.5	=		or	
13.	House/DU Partition Wall	I		*		*	1.00	*	3.0	or	3.0	=		or	

Transmission Heat Losses P_T

Total = 4036 or 3401

Ventilation System:

	A_{TFA} m²		Clear Room Height m		m³
Effective Air Volume, V_V	402.0	*	2.50	=	1005

					η_{SHX} 1		η_{SHX} 2
Efficiency of Heat Recovery of the Heat Exchanger	η_{HR}	93%	Heat Recovery Efficiency SHX	93%	Efficiency SHX 55%	or	46%

	$n_{V,Res}$ (Heating Load) 1/h		$n_{V,system}$ 1/h		Φ_{HR}		Φ_{HR}		1/h		1/h
Energetically Effective Air Exchange n_V	0.104	+	0.300	*(1-	0.97	or	0.96	) =	0.114	or	0.116

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
1005.0	*	0.114	or	0.116	*	0.33	*	33.5	or	27.6	=	1273	or	1064

Total Heating Load P_L

		P_L 1 W		P_L 2 W
$P_T + P_V$	=	5309	or	4465

	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	21.3	*	0.5	*	0.4	*	6	or	5	=	30	or	23
2.	East	7.1	*	0.5	*	0.4	*	7	or	4	=	10	or	6
3.	South	35.5	*	0.5	*	0.6	*	28	or	10	=	287	or	98
4.	West	3.4	*	0.5	*	0.4	*	19	or	6	=	13	or	4
5.	Horizontal	0.0	*	0.0	*	0.4	*	15	or	5	=	0	or	0

Solar Heat Gain, P_S

Total = 339 or 131

Internal Heat Gains P_I

Spec. Power W/m²		A_{TFA} m²		P_I 1 W		P_I 2 W
1.6	*	402	=	643	or	643

Heat Gains P_G

		P_G 1 W		P_G 2 W
$P_S + P_I$	=	982	or	774
$P_L - P_G$	=	4326	or	3691

Heating Load P_H

= **4326** W

Specific Heating Load P_H / A_{TFA}

= **10.8** W/m²

					°C	°C
Input Max. Supply Air Temperature	52	°C				
Max. Supply Air Temperature $\vartheta_{Supply,Max}$	52	°C	Supply Air Temperature Without Heating	$\vartheta_{Supply,Min}$	18.9	18.9

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

= 3298 W specific: 8.2 W/m²

Supply Air Heating Sufficient? (Yes/No) **No**

Passive House Planning

S U M M E R

Climate:	N - Oslo	Interior Temperature:	20 °C
Building:	"LIPA Miljøprosjekt"	Building Type/Use:	Residential
Location:	Linesøya	Treated Floor Area A_{TFA}:	402.0 m²
Spec. Capacity:	132 Wh/K pro m² TFA		
Overheating Limit:	25 °C		

	Building Element	Temperature Zone	Area m²		U-Value W/(m²K)		Red. Factor $f_{T,Summer}$		H_{Summer} Heat Conductance
1.	Exterior Wall - Ambien	A	360.2	*	0.086	*	1.00	=	30.8
2.	Exterior Wall - Ground	B	91.4	*	0.099	*	1.00	=	9.1
3.	Roof/Ceiling - Ambient	A	309.7	*	0.081	*	1.00	=	25.1
4.	Floor Slab	B	229.7	*	0.090	*	1.00	=	20.7
5.		A		*		*	1.00	=	
6.		A		*		*	1.00	=	
7.		X		*		*	0.75	=	
8.	Windows	A	67.3	*	0.752	*	1.00	=	50.6
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, $H_{T,e}$ 106.6 W/K

Ground Thermal Transmittance, $H_{T,g}$ 29.7 W/K

			A_{TFA} m²		Clear Room Height m		m³
Heat Recovery Efficiency η_{HR}	93%	Effective Air Volume V_V	402.0	*	2.50	=	1005
SHX Efficiency η^*_{SHX}	93%						

Summer Ventilation

continuous ventilation to provide sufficient indoor air quality

Air Change Rate by Natural (Windows & Leakages) or Exhaust-Only Mechanical Ventilation, Summer: 0.04 1/h

Mechanical Ventilation Summer: 0.30 1/h   [ ] with HR (check if applicable)

	$n_{L,nat}$ 1/h		$n_{V,system}$ 1/h		Φ_{HR}			$n_{V,Rest}$ 1/h		1/h
Energetically Effective Airchange Rate n_V	0.039	+	0.300	* (1 -	0.000	)	+	0.000	=	0.339

	V_V m³		$n_{V,equi,fraction}$ 1/h		c_{Air} Wh/(m³K)			
Ventilation Transm. Ambient $H_{V,e}$	1005	*	0.060	*	0.33	=	20.0	W/K
Ventilation Transm. Ground $H_{V,g}$	1005	*	0.279	*	0.33	=	92.5	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 0.04 1/h

(for window ventilation: at 1 K temperature difference indoor - outdoor)

Minimum Acceptable Indoor Temperature 22.0 °C

	Orientation of the Area	Angle Factor Summer		Shading Factor Summer		Dirt		g-Value (perp. radiation)		Area m²		Portion of Glazing		**Aperture** m²
1.	North	0.9	*	0.57	*	0.95	*	0.50	*	21.3	*	70%	=	3.6
2.	East	0.9	*	0.28	*	0.95	*	0.50	*	7.1	*	68%	=	0.6
3.	South	0.9	*	0.59	*	0.95	*	0.50	*	35.5	*	77%	=	6.9
4.	West	0.9	*	0.44	*	0.95	*	0.50	*	3.4	*	64%	=	0.4
5.	Horizontal	0.9	*	1.00	*	0.95	*	0.00	*	0.0	*	0%	=	0.0
6	Sum Opaque Areas													1.5

Solar Aperture Total 13.0   0.03 m²/m²

	Specif. Power q_I W/m²		A_{TFA} m²		W	W/m²
Internal Heat Gains Q_I	2.10	*	402	=	844	2.1

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.

	Solar Load kWh/d		1/k		Spec. Capacity Wh/(m²K)		A_{TFA} m²			
Daily Temperature Swing due to Solar Load	63.8	*	1000	/ (	132	*	402	) =	1.2	K

Passive House Planning

CALCULATING SUMMER SHADING FACTORS

Climate: N - Oslo

Building: "LIPA Miljøprosjekt"

Latitude: 59.93

Summer!

Orien-tation	Glazing Area	Summer Shading Factor
	m²	r_s
North	14.99	57%
East	4.86	28%
South	27.21	59%
West	2.17	44%
Horizontal	0.00	100%

Results from the Summer worksheet:
Frequency of Overheating $h_{\vartheta \geq \vartheta max}$ **0.0%**

														Input Field					
															Summer	Summer			
Quantity	Description:	Deviation from North	Angle of Inclination from the Horizontal	Orientation	Glazing Width	Glazing Height	Glazing Area	Height of the Shading Object	Horizontal Distance	Reveal Depth	Distance from Glazing Edge to Reveal	Overhang Depth	Distance from Upper Glazing Edge to Overhang	Additional Shading Reduction Factor (Summer)	Temporary Shading Reduction Factor, z	Horizontal Shading Reduction Factor	Reveal Shading Reduction Factor	Overhang Shading Reduction Factor	Total Summer Shading Reduction Factor
		Degrees	Degrees			m		m	m	m	m	m	m	%	%	%	%	%	%
					w_G	h_G	A_G	h_{Hori}	d_{Hori}	o_{Reveal}	d_{Reveal}	o_{over}	d_{over}	r_{other}		r_H	r_R	r_O	r_S
6	n 00 120x160	343	90	North	0.89	1.29	6.9			0.34	0.11			70%	70%	100%	87%	100%	42%
1	n 00 80x55	343	90	North	0.59	0.34	0.2			0.34	0.11			70%		100%	83%	100%	58%
1	n 00 cut	343	90	North	0.45	1.80	0.8			0.34	0.11			70%		100%	80%	100%	56%
1	n 01 120x120	343	90	North	0.89	0.89	0.8			0.32	0.11			70%	70%	100%	87%	100%	43%
4	n 01 110x80	343	90	North	0.79	0.49	1.5			0.32	0.11			70%	70%	100%	86%	100%	42%
1	n 01 cut	343	90	North	0.45	3.44	1.5			0.32	0.05			70%		100%	78%	100%	55%
1	n roof cut	343	45	North	0.45	7.11	3.2			0.00	0.05					100%	100%	100%	100%
1	e 00 door	73	90	East	0.99	0.69	0.7			0.34	0.11			70%	0%	100%	90%	100%	0%
1	e 01 door	73	90	East	0.99	1.29	1.3			0.34	0.11			70%	0%	100%	90%	100%	0%
1	e 01 90x90	73	90	East	0.59	0.59	0.3			0.32	0.11			70%		100%	86%	100%	61%
2	e 02 120x150	73	90	East	0.99	1.29	2.6			0.32	0.11			70%	70%	100%	91%	100%	44%
4	s 00 120x75	163	90	South	0.89	0.44	1.6			0.34	0.11			90%	70%	100%	87%	100%	55%
1	s 00 elevator do	163	90	South	0.89	2.19	1.9			0.34	0.11			90%	0%	100%	87%	100%	0%
6	s 01 190x190	163	90	South	1.59	1.59	15.2			0.32	0.11			90%	70%	100%	92%	100%	58%
1	s 01 glazed door	163	90	South	1.59	2.44	3.9			0.32	0.11			90%	70%	100%	92%	100%	58%
1	s 01 cut	163	90	South	0.45	3.22	1.4			0.32	0.05			90%		100%	77%	100%	70%
1	s roof cut	163	45	South	0.45	7.11	3.2			0.00	0.05					100%	100%	100%	100%
1	w 01 110x80	253	90	West	0.79	0.49	0.4			0.32	0.05			70%	70%	100%	88%	100%	43%
1	w 02 150x60	253	90	West	1.29	0.39	0.5			0.32	0.05			70%	70%	100%	92%	100%	45%
1	w 02 120x150	253	90	West	0.99	1.29	1.3			0.32	0.05			70%	70%	100%	90%	100%	44%

Passive House Planning

SUMMER VENTILATION

Building:	"LIPA Miljøprosjekt"	Building Type/Use:	Residential
Location:	Linesøya	Building Volume	1005 m³

Description	00 day	00 night	01 day	01 night	02 day	02 night	
Fraction of Opening Duration	13%	0%	13%	100%	50%	100%	
Climate Boundary Conditions							
Temperature Diff Interior - Exterior	4	1	4	1	4	1	K
Wind Velocity	1	0	1	0	1	0	m/s
Window Group 1							
Quantity	6		12	4	2	2	
Clear Width	1.40		0.45	0.45	1.00	1.00	m
Clear Height	1.00		0.75	0.75	1.30	1.30	m
Tilting Windows?	x		x	x	x	x	
Opening Width (for tilting windows)	0.050		0.050	0.050	0.050	0.050	m
Window Group 2 (Cross Ventilation)							
Quantity	4		4	4	1	1	
Clear Width	1.00		0.90	0.90	1.00	1.00	m
Clear Height	0.55		0.70	0.70	1.30	1.30	m
Tilting Windows?	x		x	x	x	x	
Opening Width (for Tilting Windows)	0.050		0.050	0.050	0.050	0.050	m
Difference in Height to Window 1	0.00		0.00	0.00	0.00	0.00	m
Single-Sided Ventilation 1 - Airflow Volume	120	0	122	19	49	24	m³/h
Single-Sided Ventilation 2 - Airflow Volume	37	0	47	21	25	12	m³/h
Cross Ventilation Airflow Volume	305	0	302	40	103	35	m³/h
Contribution to Air Change Rate	0.04	0.00	0.04	0.04	0.05	0.04	1/h

Summary of Summer Ventilation Distribution

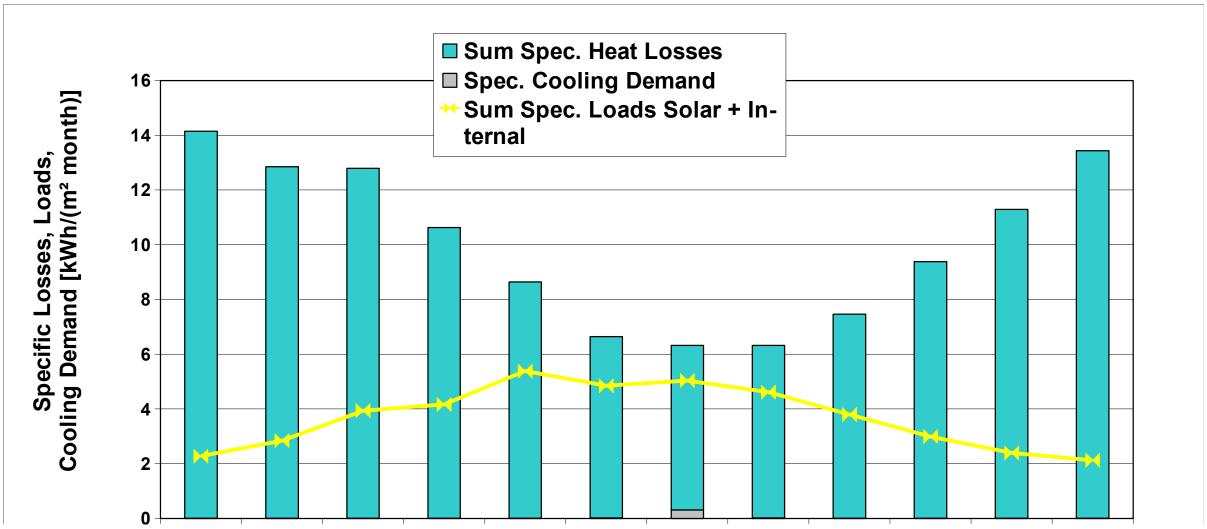
Description Ventilation Type	Daily Average Air Change Rate	
Nighttime Window Ventilation	0.04	1/h
Daytime Window Ventilation	0.04	1/h
		1/h

PASSIVE HOUSE PLANNING

SPECIFIC USEFUL COOLING DEMAND MONTHLY METHOD

Climate:	N - Oslo	Interior Temperature:	25 °C
Building:	"LIPA Miljøprosjekt"	Building Type/Use:	Residential
Location:	Linesøya	Treated Floor Area A_{TFA}:	402 m²

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Heating Degree Hours - E	23.3	20.8	19.8	15.6	11.3	7.7	7.0	7.9	11.0	14.8	18.7	22.5	181	kKh
Heating Degree Hours - G	14.6	13.8	15.2	14.1	13.4	11.7	10.5	10.3	10.0	11.0	11.8	13.5	150	kKh
Losses - Exterior	2951	2637	2506	1969	1437	973	891	1003	1388	1878	2372	2850	22857	kWh
Losses - Ground	1790	1685	1861	1719	1635	1427	1284	1262	1226	1351	1444	1653	18338	kWh
Losses Summer Ventilatio	943	841	773	582	398	262	244	270	385	541	720	896	6854	kWh
Sum Spec. Heat Losses	14.1	12.8	12.8	10.6	8.6	6.6	6.0	6.3	7.5	9.4	11.3	13.4	119.5	kWh/m²
Solar Load North	13	30	75	121	226	233	229	166	91	45	17	12	1257	kWh
Solar Load East	3	9	22	35	58	56	53	41	24	12	4	2	319	kWh
Solar Load South	241	469	730	745	994	821	877	821	672	446	295	190	7300	kWh
Solar Load West	6	15	27	35	54	44	47	42	28	15	8	4	325	kWh
Solar Load Horiz.	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Solar Load Opaque	23	51	99	130	204	186	190	156	103	56	29	18	1244	kWh
Internal Heat Gains	628	567	628	608	628	608	628	628	608	628	608	628	7395	kWh
Sum Spec. Loads Solar +	2.3	2.8	3.9	4.2	5.4	4.8	5.0	4.6	3.8	3.0	2.4	2.1	44.4	kWh/m²
Utilisation Factor Losses	16%	22%	31%	39%	62%	73%	79%	73%	51%	32%	21%	16%	37%	
Useful Cooling Energy De	0	0	0	0	1	6	122	6	0	0	0	0	135	kWh
Spec. Cooling Demand	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	kWh/m²



Passive House Planning

COMPRESSOR COOLING UNITS

Climate:	N - Oslo		Interior Temperature Summer:	25 °C
Building:	"LIPA Miljøprosjekt"		Building Type/Use:	Residential
Location:	Linesøya		Treated Floor Area A_{TFA}:	402.0 m²

				A_{TFA}		Clear Room Height			
Effective Air Volume V_V				m²		m		m³	
				402	*	2.50	=	1005	
		$n_{V,system}$		Φ_{HR} Efficiency Humidity Rec.					
		1/h						1/h	
Hygrically Effective Mech. Air Change Rate Summer		0.300	* (1 -		)		=	0.300	
	$n_{V,nat}$		$n_{V,Res}$		$n_{Night,Windows}$		$n_{Night,mechanical}$		
	1/h		1/h		1/h		1/h		
Direct Ambient Air Change Rate Summer	0.039	+	0.000	+	0.074	+	0.000	= 0.113	
Ambient Air Change Rate Summer							Total	0.41	1/h

x Supply Air Cooling
check as appropriate

On/Off Mode (check as appropriate)	x	
Minimum Temperature of Cooling Coil Surface	0	°C

Recirculation Cooling
check as appropriate

On/Off Mode (check as appropriate)	x	
Minimum Temperature of Cooling Coil Surface	10	°C
Volume Flow Rate	300	m³/h

Additional Dehumidification
check as appropriate

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

Panel Cooling
check as appropriate

	sensible	latent		Sensible Fraction
Useful Cooling Demand	0.3	0.0		
of which				
Supply Air Cooling	0.3	0.0	kWh/(m²a)	93.7%
Recirculation Cooling			kWh/(m²a)	
Dehumidification			kWh/(m²a)	
Remaining for Panel Cooling			kWh/(m²a)	
Total	0.3	0.0	kWh/(m²a)	93.7%
Unsatisfied Demand	0.0	0.0	kWh/(m²a)	

Passive House Planning

COOLING LOAD

Building:	"LIPA Miljøprosjekt"	Building Type/Use:	Residential	Interior Temperature:	25 °C
Location:	Linesøya	Treated Floor Area A_{TFA}:	402.0 m²		
Spec. Capacity:	132 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	11.7 °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	360.2	*	0.086	*	1.00	*	-1.0	=	-31
2.	Exterior Wall - Ground	B	91.4	*	0.099	*	1.00	*	-13.3	=	-120
3.	Roof/Ceiling - Ambient	A	309.7	*	0.081	*	1.00	*	-1.0	=	-25
4.	Floor Slab	B	229.7	*	0.090	*	1.00	*	-13.3	=	-274
5.		A		*		*	1.00	*	-1.0	=	
6.		A		*		*	1.00	*	-1.0	=	
7.		X		*		*	0.75	*	-1.0	=	
8.	Windows	A	67.3	*	0.752	*	1.00	*	-1.0	=	-51
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	*	-13.3	=	
12.	Ground TB (length/m)	B		*		*	1.00	*	-13.3	=	
13.	House/DU Partition Wall	I		*		*	1.00	*	3.0	=	
			$L_{ambient}$ W/K		TempDiff K		L_{Sky} W/K		TempDiff K		
14.	Radiation Correction		-6.0	*	-1.0	+	6.0	*	-10.8	=	-59

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

Ventilation System:

	A_{TFA} m²		Clear Room Height m		m³
Effective Air Volume, V_V	402.0	*	2.50	=	1005

	Vent. Transm. W/K		TempDiff kKh/a		W
Exterior	20.0	*	-1.0	=	-20
Ground	92.5	*	-13.3	=	-1228

Additional Summer Ventilation:

x	Window Night Ventilation, Manual	Corresponding Air Change Rate	0.04	1/h
	Mechanical, Automatically Controlled Ventilation	Minimum Indoor Temperature	22.0	°C

		kWh/d		kh/d		W
Heat Removal Cooling Design Day	Window Ventilation	-2.2	/	0.024	=	-90
(from Cooling worksheet)	Automatic Night Ventilation	0.0	/	0.024	=	0

Ventilation Heat Load P_V Total = W **-1339**

	Orientation of the Area	Area m²		g-Value (perp. radiation)		Reduction Factor		Radiation W/m²		P_S W
1.	North	21.3	*	0.5	*	0.34	*	130	=	475
2.	East	7.1	*	0.5	*	0.16	*	198	=	114
3.	South	35.5	*	0.5	*	0.39	*	231	=	1592
4.	West	3.4	*	0.5	*	0.24	*	231	=	94
5.	Horizontal	0.0	*	0.0	*	0.40	*	350	=	0
6.	Sum Opaque Areas									381

Heat Gain - Solar Heat Load, P_S Total = **2656**

	Spec. Power W/m²		A_{TFA} m²		P_I W
Internal Heat Load P_I	3.1	*	402	=	**1246**

Cooling Load P_C $P_T + P_V + P_S + P_I$ = **2004** W

Specific Maximum Cooling Load P_C / A_{EB} = **5.0** W/m²

	Solar Load W		Time h/d		Spec. Capacity Wh/(m²K)		A_{TFA} m²			
Daily Temperature Swing due to Solar Load	2656.4	*	24	/ (	132	*	402	) =	1.2	K

Passive House Planning

HEAT DISTRIBUTION AND DHW SYSTEM

Building:	"LIPA Miljøprosjekt"	
Location:	Linesøya	
Interior Temperature:	20	°C
Building Type/Use:	Residential	
Treated Floor Area A_{TFA}:	402	m²
Occupancy:	11.5	Pers
Number of Residences:	1	
Annual Heat Demand $q_{heating}$:	6180	kWh/a
Length of Heating Period:	205	d
Average Heat Load P_{ave}:	1.3	kW
Marginal Utilisability of Additional Heat Gains:	84%	

			Parts: Warm Region	Cold Region		Total		
Space Heat Distribution			1	2	3			
Length of Distribution Pipes	L_H *(Project)*		0.00				m	
Heat Loss Coefficient per m Pipe	Ψ *(Project)*		0.528				W/(mK)	
Temperature of the Room Through Which the Pipes	ϑ_X *Mechanical Room*		20				°C	
Design Flow Temperature	ϑ_{dist} *Flow, Design Value*		35.0				°C	
Design System Heat Load	$P_{heating}$ *(exist./calc.)*		2.0				kW	
Flow Temperature Control (check)			x					
Design Return Temperature	ϑ_R	$=0.714*(\vartheta_{dist}-20)+20$	30.7				°C	
Annual Heat Emission per m of Plumbing	q^*_{HL}	$=\Psi\ (\vartheta_m-\vartheta_X)\ t_{Heating}*0.024$	24			Total 1,2,3	kWh/(m·a)	
Possible Utilization Factor of Released Heat	η_G		84%				-	
Annual Losses	Q_{HL}	$= L_H \cdot q^*_{HL} \cdot (1-\eta_G)$	0	0	0	0	kWh/a	
Specif. Losses	q_{HL}	$= \Sigma Q_{HL} / A_{TFA}$					kWh/(m²a)	0.0
Utilisation Factor of Space Heat Distribution	$h_{a,HL}$	$= q_H / (q_H + q_{HL})$				100%	-	

DHW: Standard Useful Heat					
DHW Consumption per Person and Day (60 °C)	V_{DHW}	*(Project or Average Value 25 Litres/P/d)*	25.0	Litre/Person/d	
Average Cold Water Temperature of the Supply	ϑ_{DW}	*Temperature of Drinking Water (10°)*	10.0	°C	
DHW Non-Electric Wash and Dish		*(Electricity worksheet)*	0	kWh/a	
Useful Heat - DHW	Q_{DHW}		6079	kWh/a	
Specif. Useful Heat - DHW	q_{DHW}	$= Q_{DHW} / A_{TFA}$		kWh/(m²a)	15.1

DHW Distribution and Storage			Warm Region	Cold Region		Total		
Length of Circulation Pipes (Flow + Return)	L_{HS} *(Project)*		32.0				m	
Heat Loss Coefficient per m Pipe	Ψ *(Project)*		0.182				W/m/K	
Temperature of the Room Through Which the Pipes	ϑ_X *Mechanical Room*		20				°C	
Design Flow Temperature	ϑ_{dist} *Flow, Design Value*		60.0				°C	
Daily circulation period of operation.	td_{Circ} *(Project)*		18.0				h/d	
Design Return Temperature	ϑ_R	$=0.875*(\vartheta_{dist}-20)+20$	55				°C	
Circulation period of operation per year	t_{Circ}	$= 365\ td_{Circ}$	6570				h/a	
Annual Heat Released per m of Pipe	q^*_Z	$=\Psi\ (\vartheta_m-\vartheta_X)\ t_{Circ}$	44.8				kWh/m/a	
Possible Utilization Factor of Released Heat	η_{GDHW}	$=t_{heating}/365d * \eta_G$	46.9%				-	
Annual Heat Loss from Circulation Lines	Q_Z	$= L_{HS} \cdot q^*_Z \cdot (1-\eta_{GDHW})$	762			762	kWh/a	
Total Length of Individual Pipes	L_U *(Project)*		16.00				m	
Exterior Pipe Diameter	d_{U_Pipe} *(Project)*		0.012				m	
Heat Loss Per Tap Opening	$q_{individual}$	$=(c_{pH2O}V_{H2O}+c_{pMat}V_{Mat})(\vartheta_{dist}-\vartheta_X)$	0.0573				kWh/tap opening	
Occupancy Coefficient	n_{Tap}	$= n_{Pers} \cdot 3 \cdot 365 / n_{LU}$	12577				Tap openings per year	
Annual Heat Loss	q_U	$= n_{Tap} \cdot q_{individual}$	720.4				kWh/a	
Possible Utilization Factor of Released Heat	η_{G_U}	$=t_{heating}/8760*\eta_G$	46.9%				-	
Annual Heat Loss of Individual Pipes	Q_U	$= q_U \cdot (1-\eta_{G\_U})$	382.7			383	kWh/a	
						Total 1,2,3		
Average Heat Released From Storage	P_S		100.0				W	
Possible Utilization Factor of Released Heat	η_{G_S}	$=t_{heating}/8760*\eta_G$	46.9%					
Annual Heat Losses from Storage	Q_S	$= P_S \cdot 8.760\ kh \cdot (1-\eta_{G\_S})$	465.4			465	kWh/a	
						Total 1,2,3		
Total Heat Losses of the DHW System	Q_{WL}	$= Q_Z+Q_U+Q_S$				1611	kWh/a	
Specif. Losses of the DHW System	q_{WL}	$= Q_{WL} / A_{TFA}$					kWh/(m²a)	4.0
Utilisation Factor DHW Distrib and Storage	$\eta_{a,WL}$	$= q_{DHW} / (q_{DHW} + q_{WV})$				79.1%	-	
Total Heat Demand of DHW system	Q_{gDHW}	$= Q_{DHW}+Q_{WL}$				7689	kWh/a	
Total Spec. Heat Demand of DHW System	q_{gDHW}	$= Q_{gDHW} / A_{TFA}$					kWh/(m²a)	19.1

Passive House Planning

HOT WATER PROVIDED BY SOLAR

Building:	"LIPA Miljøprosjekt"	Building Type/Use:	Residential
Location:	Linesøya	Treated Floor Area A_{TFA}:	402.0 m²

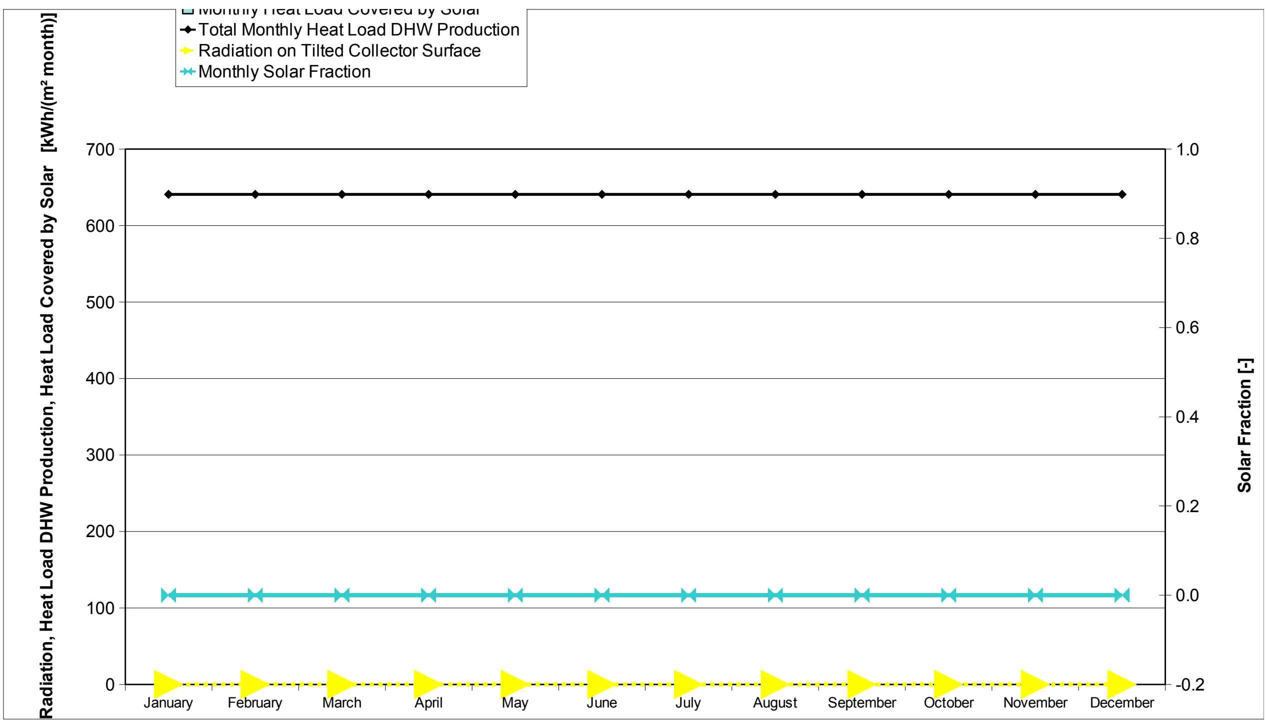
Solar Fraction with DHW Demand including Washing and Dish-Washing

Heat Demand DHW	q_{gDHW}	7689	kWh/a	from DHW+Distribution worksheet
Latitude:		59.9	°	from Climate Data worksheet
Selection of collector from list (see below):		8	Selection:	
Solar Collector Area			m²	
Deviation from North		180	°	
Angle of Inclination from the Horizontal		45	°	
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		11.5	Persons	
Specific Collector Area		0.0	m²/Pers	

Estimated Solar Fraction of DHW Production	**0%**			
Solar Contribution to Useful Heat	**0**	kWh/a	**0**	kWh/(m²a)

Secondary Calculation of Storage Losses

Selection of DHW storage from list (see below):	1	Selection:	
Total Storage Volume		litre	
Volume Standby Part (above)		litre	
Volume Solar Part (below)		litre	
Specific Heat Losses Storage (total)		W/K	
Typical Temperature DHW	60	°C	
Room Temperature	20	°C	
Storage Heat Losses (Standby Part Only)	0	W	
Total Storage Heat Losses		W	



Passive House Planning

LECTRICITY DEMAND

Building: "LIPA Miljøprosjekt"

# Households	1	HH
#Persons	11.5	P
#Living Area	402	m²
#Annual Heat Demand	15	kWh/(m²a)

Solar Fraction of DHW Wash&Dish	
Marginal Performance Ratio DHW	42%
Marginal Performance Ratio Heating	31%

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)	11.5	P	821	100%		821					2217
Cold Water Connect													0%		0.30	0.42			
Clothes Washing	1	1	0.95	kWh/Use		1.00	57	/(P*a)	11.5	P	622	100%		622					1679
Cold Water Connection													0%		0.05	0.42			
Clothes Drying with:	1	0	0.00	kWh/Use	Residual dampness	0.88	57	/(P*a)	11.5	P	0	0%		0					0
Clothesline					0.60						0		0%			1.00		0	0
Energy Consumed by Evaporation	1	0	0.00	kWh/Use		0.60	57	/(P*a)	11.5	P	0		100%		0.00	0.31	0.64	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	0.20	kWh/Use	Percentage CFLs	1.00	500	/(P*a)	11.5	P	1149	100%		1149					3101
Electricity													0%					0	0
Lighting	1	1	21	W	80%	1.00	2.90	kh/(P*a)	11.5	P	693	100%		693					1871
Consumer Electronics	1	1	80	W		1.00	0.55	kh/(P*a)	11.5	P	505	100%		505					1365
Small Appliances, etc	1	1	50	kWh		1.00	1.00	/(P*a)	11.5	P	574	100%		574					1551
Total Aux. Electricity											1173			1173					3166
Other:																			
											0			0					0
											0			0					0
											0			0					0
Total											5820 kWh			5820 kWh		DHW Non-Electric - Wash&Dish: 0		kWh 0	15713
Specific Demand														14.5 kWh/(m²a)		Non-Renewable Non-Electric DHW Wash&Dish: 0.0		kWh/(m²a) 0.0	39.1
Recommended Maximum Value														18					50

Passive House Planning

AUXILIARY ELECTRICITY

Building: "LIPA Miljøprosjekt"

1	Living Area	402	m²
2	Heating Period	205	d
3	Air Volume	1005	m³
4	Dwelling Units	1	HH
5	Enclosed Volume	2100	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	15	kWh/(m²a)
Boiler Rated Power	3	kW
DHW System Heat Demand	7689	kWh/a
Design Flow Temperature	35	°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	* 1005	m³	= 593	considered in heat recovery efficiency			1600
Summer Ventilation	1	1	0.40	Wh/m³	* 0.30	h^{-1}	* 3.9	kh/a	* 1005	m³	= 465	no summer contribution to IHG			1255
Defroster HX	1	1	784	W	* 1.00		* 0.1	kh/a	* 1		= 78	* 1.0	/ 4.91	= 16	211
Heating System					Controlled/Uncontrolled (1/0)										
Enter the Rated Power of the Pump			21	W	1										
Circulation Pump	0	1	21	W	* 0.7		* 4.9	kh/a	* 1		= 0	* 1.0	/ 4.91	= 0	0
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	1	6	W	* 1.00		* 6.2	kh/a	* 1		= 37	* 0.6	/ 8.76	= 3	100
Enter the Rated Power of the Pump				W											
Storage Load Pump DHW	0	0	84	W	* 1.00		* 2.6	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	0	1	64	W	* 1.00		* 1.8	kh/a	* 1		= 0	* 0.6	/ 8.76	= 0	0
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											1173			19	3166
Specific Demand	kWh/(m²a)		Divide by Living Area:								2.9				7.9

Passive House Planning

PRIMARY ENERGY VALUE

Building:	"LIPA Miljøprosjekt"	Building Type/Use:	Residential
Location:	Linesøya	Treated Floor Area A_{TFA}:	402 m²
		Space Heat Demand incl. Distribution	15 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 Household Appliances	Q_{EHH}	*(Electricity worksheet)*	11.6	31.2	7.9
Electricity Demand - Auxiliary Electricity			2.9	7.9	2.0
Total Electricity Demand (without Heat Pump)			**14.5**	**39.1**	**9.8**
Heat Pump				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
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
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}		15.7	42.3	10.7
Non-Electric Demand, DHW Wash&Dish		*(Electricity worksheet)*	0.0	0.0	0.0
Total Electricity Demand Heat Pump			**15.7**	**42.3**	**10.7**
Compact Heat Pump Unit				PE Value	CO_2-Emission 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
Energy Carrier - Supplementary Heating				2.7	680
COP Heat Pump Heating		*(Compact worksheet)*	0.0		
COP Heat Pump DHW		*(Compact worksheet)*	0.0		
Performance Ratio of Heat Generator (Verification)		*(Compact worksheet)*			
Performance Ratio of Heat Generator (Planning)		*(Compact worksheet)*			
Electricity Demand Heat Pump (without DHW Wash&Dish)	Q_{HP}	*(Compact worksheet)*	0.0	0.0	0.0
Non-Electric Demand, DHW Wash&Dish			0.0	0.0	0.0
Total Compact Unit		*(Compact worksheet)*	**0.0**	**0.0**	**0.0**
Boiler				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
Covered Fraction of Space Heat Demand		*(Project)*	0%	kWh/kWh	g/kWh
Covered Fraction of DHW Demand		*(Project)*	0%	0.2	50
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**
District Heat				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
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**
Other				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
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)*	0.0	0.0	0.0
Total - Other			**0.0**	**0.0**	**0.0**
Cooling with Electric Heat Pump				PE Value	CO_2-Emission Factor (CO_2-Equivalent)
				kWh/kWh	g/kWh
Covered Fraction of Cooling Demand		*(Project)*	100%	2.7	680
Heat Source			Electricity		
Annual Cooling COP			3.3		
Energy Demand Space Cooling			**0.1**	**0.3**	**0.1**

Heating, Cooling, DHW, Auxiliary and Household Electricity		30.3	81.7	20.6
Total PE Value	**81.7**	kWh/(m²a)		
Total Emissions CO_2-Equivalent	**20.6**	kg/(m²a)		(Yes/No)
Primary Energy Requirement		120	kWh/(m²a)	**Yes**

Heating, DHW, Auxiliary Electricity (No Household Applications)		18.6	50.2	12.6
Specific PE Demand - Mechanical System	**50.2**	kWh/(m²a)		
Total Emissions CO_2-Equivalent	**12.6**	kg/(m²a)		

Solar Electricity		kWh/a	PE Value (Savings)	CO_2-Emission Factor
Planned Annual Electricity Generation	*Separate Calculation*	14000	kWh/kWh	g/kWh
			0.7	250
Specific Demand		34.8	24.4	8.7
PE Value: Conservation by Solar Electricity	**69.7**	kWh/(m²a)		
CO_2-Emissions Avoided Due to Solar Electricity	**15.0**	kg/(m²a)		

Passive House Planning

COMPACT UNIT WITH EXHAUST AIR HEAT PUMP

(Calculation from Values Measured in the Laboratory Test for Unit Certification)

Building: "LIPA Miljøprosjekt" — Building Type/Use: Residential

Location: Linesøya — Treated Floor Area A_{TFA}: 402 m²

Covered Fraction of Space Heat Demand		*(PE Value worksheet)*	0%	
Space Heat Demand + Distribution Losses	Q_H+Q_{HL}:	*(DHW+Distribution)*	6180	kWh
Solar Fraction for Space Heat	$\eta_{Solar, H}$	*(Separate Calculation)*	0%	
Effective Annual Heat Demand	$Q_{H,Wi}=Q_H*(1-\eta_{Solar, H})$		0	kWh
Covered Fraction of DHW Demand		*(PE Value worksheet)*	0%	
Total Heat Demand of DHW system	Q_{gDHW}	*(DHW+Distribution)*	7689	kWh
Solar Fraction for DHW	$\eta_{Solar, DHW}$	*(SolarDHW worksheet)*	0%	
Effective DHW Demand	$Q_{DHW,Wi}=Q_{DHW}*(1-\eta_{Solar, DHW})$		0	kWh

Selection of Compact Unit (Data Inputs from Row 173):

Measured Values from Laboratory Test

Ventilation

Effective Heat Recovery Efficiency	η_{eff}	*(Test Stand)*	80%	
Electric Efficiency		*(Test Stand)*	0.43	Wh/m³

Heating

		Test Point 1	*Test Point 2*	*Test Point 3*	*Test Point 4*	
Ambient Air Temperature	T_{amb}	-5.9	2.0	8.1		°C
Measured Thermal Power Heat Pump Heating	$P_{HP,Heating}$	1.02	1.18	1.49		kW
Measured COP Heating	$COP_{Heating}$	1.52	1.41	1.91		-

DHW

		Test Point 1	*Test Point 2*	*Test Point 3*	*Test Point 4*	
Ambient Air Temperature	T_{amb}	2.0	10.0	20.0		°C
Measured Thermal Power DHW Storage Heating-Up	$P_{DHW,Heating-Up}$	1.41	1.76	2.05		kW
Measured Thermal Power DHW Storage Reload	$P_{DHW,Reload}$	1.17	1.64	1.94		kW
Measured COP DHW Storage Heating-Up	$COP_{DHW,Heating-Up}$	1.90	2.30	2.70		-
Measured COP DHW Storage Reload	$COP_{DHW,Reload}$	1.45	1.97	2.25		-

Standby (Inputs required only if different from storage reload)

		Test Point 1	*Test Point 2*	*Test Point 3*	*Test Point 4*	
Ambient Air Temperature	T_{amb}	2.0	10.0	20.0		°C
Measured Thermal Power Heat Pump Standby	$P_{HP,Standby}$	1.17	1.64	2.05		kW
Measured COP Standby	$COP_{Standby}$	1.45	1.97	2.25		-

Specific Heat Loss Storage incl. Connections	$U * A_{Storage}$	*(Test Stand)*	2.00	W/K
Average Storage Temperature in Standby Mode	$T_{DHW,Standby}$	*(Test Stand)*	36	°C

Heat Pump Priority — (please check as appropriate) *(Manufacturer, Techn. Data)* — DHW Priority: x — Heating Priority:

	Room Temperature (°C)		20	
	Av. Ambient Temp. Heating P. (°C)		-1	
	Av. Ground Temp (°C)		6	
Efficiency SHX Exhaust Air Mixing	$\eta*_{SHX}$		50%	
Heat Recovery Efficiency SHX Exhaust Air Mixing (if applicable)	$\eta_{SHX,add}$	*(Design Value)*	17%	
Volume Flow Rate of Added Exhaust Air (if applicable)	V_{add}	*(Test Stand)*	150	m³/h

Heat Supplied by Direct Electricity	$Q_{E,dir}$	0	kWh/a
Space Heat Supplied by HP	$Q_{HP,Heating}$	0	kWh/a
Winter DHW Supplied by HP	$Q_{HP,DHW,Winter}$	0	kWh/a
Winter Standby Heat Supplied by HP	$Q_{HP,Standby,Winter}$	0	kWh/a
Summer DHW Supplied by HP	$Q_{HP,DHW,Summer}$	0	kWh/a
Summer Standby Heat Supplied by HP	$Q_{HP,Standby,Summer}$	0	kWh/a

Performance Ratio of Heat Generator, DHW & Space Heating

Annual Coefficient of Performance — **COP**

		kWh/a	kWh/(m²a)
Final Energy Demand Heat Generation	Q_{final}		
Annual Primary Energy Demand			

	kg/a	kg/(m²a)
Annual CO_2-Equivalent Emissions		

Passive House Planning

EFFICIENCY OF HEAT GENERATION (GAS, OIL, WOOD)

Building:	"LIPA Miljøprosjekt"	Building Type/Use:	Residential	
Location:	Linesøya	Treated Floor Area A_{TFA}:	402	m²

Covered Fraction of Space Heat Demand		*(PE Value worksheet)*	0%	
Space Heat Demand + Distribution Losses	$Q_H + Q_{HS}$:	*(DHW+Distribution)*	6180	kWh
Solar Fraction for Space Heat	$\eta_{Solar, H}$	*(Separate Calculation)*	0%	
Effective Annual Heat Demand	$Q_{H,Wi} = Q_H * (1 - \eta_{Solar, H})$		**0**	kWh
Space Heat Demand without Distribution Losses	Q_H	*(Annual Heat Demand)*	6180	kWh
Covered Fraction of DHW Demand		*(PE Value worksheet)*	0%	
Total Heat Demand of DHW system	Q_{gDHW}	*(DHW+Distribution)*	7689	kWh
Solar Fraction for DHW	$\eta_{Solar, DHW}$	*(SolarDHW worksheet)*	0%	
Effective DHW Demand	$Q_{DHW,Wi} = Q_{DHW} * (1 - \eta_{Solar, DHW})$		**0**	kWh

Boiler Type		*(Project)*	g (Direct and Indirect Release of Heat)		7
Primary Energy Factor		*(Data worksheet)*	0.2	kWh/kWh	
CO_2-Emissions Factor (CO_2-Equivalent)			50	g/kWh	
Useful Heat Provided	Q_{Use}			kWh/a	
Max. Heating Power Required for Heating the Building	P_{BH}	*(Heating Load worksheet)*	4.33	kW	
Length of the Heating Period	t_{HP}		0	h	
Length of DHW Heating Period	t_{DHW}		8760	h	

Use characteric values entered (check if appropriate)? x

			Project Data		Standard Values	
Design Output	$P_{nominal}$	*(Rating Plate)*	3	kW	15	kW
Installation of Boiler (Outdoor: 0, Indoor: 1)			0		0	
Input Values (Oil and Gas Boiler)			Project Data		Standard Values	
Boiler Efficiency at 30% Load	$\eta_{30\%}$	*(Manufacturer)*				
Boiler Efficiency at Nominal Output	$\eta_{100\%}$	*(Manufacturer)*				
Standby Heat Loss Boiler at 70 °C	$q_{B,70}$	*(Manufacturer)*				
Average Return Temperature Measured at 30% Load	$\vartheta_{30\%}$	*(Manufacturer)*		°C		
Input Values (Biomass Heat Generator)			Project Data		Standard Values	
Efficiency of Heat Generator in Basic Cycle	η_{GZ}	*(Manufacturer)*	72%		72%	
Efficiency of Heat Generator in Constant Operation	η_{SO}	*(Manufacturer)*	80%		80%	
Average Fraction of Heat Output Released to Heating Circuit	$z_{HC,m}$	*(Manufacturer)*	0.5		0.5	
Temperature Difference Betw. Power-On and Power-Off	$\Delta\vartheta$	*(Manufacturer)*	10	K	10	
For Interior Installations: Area of Mechanical Room	$A_{install}$	*(Project)*	0	m²	0	m²
Useful Heat Output per Basic Cycle	$Q_{N,GZ}$	*(Manufacturer)*	2.7		2.7	
Average Power Output of the Heat Generator	$Q_{N,m}$	*(Manufacturer)*	1.5	kW	1.5	

Utilisation Factor Heat Generator Heating Run	$h_{H,g,K} = f_\varphi * \eta_{k*}$	**0%**
Utilisation Factor Heat Generator DHW Run	$h_{TW,g,K} = \eta_{100\%} / f_{\varphi,TW}$	**0%**
Utilisation Factor Heat Generator DHW & Heating	$h_{g,K}$	**0%**

		kWh/a	kWh/(m²a)
Final Energy Demand Space Heating	$Q_{Final, HE} = Q_{H,wi} * e_{H,g,K}$	**0**	
Final Energy Demand DHW	$Q_{Final, DHW} = Q_{WW,wi} * e_{TW,g,K}$	**0**	
Total Final Energy Demand	$Q_{Final} = Q_{Final,DHW} + Q_{Final,HE}$	**0**	**0.0**
Annual Primary Energy Demand		**0**	**0.0**
		kg/a	kg/(m²a)
Annual CO_2-Equivalent Emissions		**0**	**0.0**

Passive House Planning

EFFICIENCY OF DISTRICT HEATING STATIONS

Building:	"LIPA Miljøprosjekt"	Building Type/Use:	Residential
Location:	Linesøya	Treated Floor Area A_{TFA}:	402 m²

Covered Fraction of Space Heat Demand		*(PE Value worksheet)*	0%	
Annual Heat Demand kWh/a	Q_H	*(DHW+Distribution)*	6180	kWh
Solar Fraction for Space Heat	$\eta_{Solar, H}$	*(Separate Calculation)*		
Effective Annual Heat Demand	$Q_{H,Wi}=Q_H*(1-\eta_{Solar, H})$		**0**	kWh
Covered Fraction of DHW Demand		*(PE Value worksheet)*	0%	
DHW Demand	Q_{DHW}	*(DHW+Distribution)*	7689	kWh
Solar Fraction for DHW	$\eta_{Solar, DHW}$	*(SolarDHW worksheet)*	0%	
Effective DHW Demand	$Q_{DHW,Wi}=Q_{DHW}*(1-\eta_{Solar, DHW})$		**0**	kWh
Heat Source				
Primary Energy Factor		*(Data worksheet)*	0.7	kWh/kWh
CO_2-Emissions factor (CO_2-Equivalent)		*(Data worksheet)*	-70	g/kWh
Utilisation Factor Heat Transfer Station	$\eta_{a,HX}$		95%	

		kWh/a	kWh/(m²a)
Final Energy Demand Heat Generation	$Q_{final} = Q_{Use} * e_{a,DH}$	**0**	**0.0**
Annual Primary Energy Demand		**0**	**0.0**
		kg/a	kg/(m²a)
Annual CO_2-Equivalent Emissions		**0**	**0.0**

Passive House Planning

INTERNAL HEAT GAINS

Building: "LIPA Miljøprosjekt"

Utilisation Pattern: 2.10 W/m²

Type of Values Used:

No Input Required W/m²

Calculation Internal Heat Household

Persons: 11.5 P

Living Area: 402 m²

Annual Heat Dema: 15 kWh/(m²a)

Heating Period: 205 d/a

Column Nr.	1	2	3		4	5		6		7		8		9		10
Application	Existing (1/0), or number of people	In the Thermal Envelope (1/0)	Norm Consumption		Utilization Factor	Frequency		Useful Energy (kWh/a)		Included in Electricity Balance?		Availability		Used During Time Period (kh/a)		Internal Heat Source (W)
Dishwashing	1	1	1.1	kWh/Use	1.00	65	/(P*a)	821	*			0.30	/	8.76	=	28
Clothes Washing	1	1	1.0	kWh/Use	1.00	57	/(P*a)	622	*			0.30	/	8.76	=	21
Clothes Drying with:	1	0	0.0	kWh/Use	0.88	57	/(P*a)	0	*			1.00	/	8.76	=	0
Clothesline		0	0.0					0				0.80				
Energy Consumed by Evaporation	1	0	0.0	kWh/Use	0.60	57	/(P*a)	0	* (1-	0	) *	1.00	/	8.76	=	0
Refrigerating	1	1	0.3	kWh/d	1.00	365	d/a	102	*			1.00	/	8.76	=	12
Freezing	1	0	0.6	kWh/d	0.90	365	d/a	181	*			1.00	/	8.76	=	0
or Combination	0	1	0.7	kWh/d	1.00	365	d/a	0	*			1.00	/	8.76	=	0
Cooking	1	1	0.2	kWh/Use	1.00	500	/(P*a)	1149	*			0.50	/	8.76	=	66
Lighting	1	1	20.8	W	1.00	2.9	kh/(P*a)	693	*			1.00	/	8.76	=	79
Consumer Electronics	1	1	80.0	W	1.00	0.55	kh/(P*a)	505	*			1.00	/	8.76	=	58
Household Appliances/Other	1	1	50.0	kWh	1.00	1.0	/(P*a)	574	*			1.00	/	8.76	=	66
Auxiliary Appliances (cf. Aux Electricity Sheet)															=	19
Other Applications (cf. Electricity Sheet)	0	0.0						0	*			0	/	8.76	=	0
Persons	11	1	80.0	W/P	1.00	8.76	kh/a	8049	*			0.55	/	8.76	=	505
Cold Water	11	1	-5.0	W/P	1.00	8.76	kh/a								=	-57
Evaporation	11	1	-25.0	W/P	1.00	8.76	kh/a	-2515	*			1.00	/	8.76	=	-287
Total														W		**508**
Specific Demand														W/m²		**1.26**
Heat Available From Internal Sources										204.52	d/a			kWh/(m²a)		**6.2**