EuroPHit

D2.4 Balancing tool for step-by-step energy efficient refurbishment incl. RES / English

INTELLIGENT ENERGY – EUROPE II

Energy efficiency and renewable energy in buildings

IEE/12/070

EuroPHit

[Improving the energy performance of step-by-step refurbishment and integration of renewable energies]

Contract N°: SI2.645928

Co-funded by the Intelligent Energy Europe Programme of the European Union

EnerPHit Verification (step-by-step)

calculated step:
5-Heat pump + solar thermal

Building:	End-of-terrace Passive House
Street:	Example Street 99
Postcode/City:	99999 Example City
Province/Country:	Example Province DE-Germany
Building type:	Row house
Climate data set:	DE-9999-PHPP-Standard
Climate zone:	3: Cool-temperate Altitude of location: -
Home owner / Client:	Passivhaus Association of Owners
Street:	Example Street 99
Postcode/City:	99999 Example City
Province/Country:	Example Province DE-Germany

Architecture:	Example Architectural Firm
Street:	Example Street 99
Postcode/City:	99999 Example City
Province/Country:	Example Province DE-Germany
Energy consultancy:	Example Energy Consultant
Street:	Example Street 99
Postcode/City:	99999 Example City
Province/Country:	Example Province DE-Germany

Mechanical engineer:	Example Mechanical Services Firm
Street:	Example Street 99
Postcode/City:	99999 Example City
Province/Country:	Example Province DE-Germany
Certification:	Passive House Institute
Street:	Rheinstr. 44/46
Postcode/City:	64289 Darmstadt
Province/Country:	DE-Germany

Year of construction:	2016	Interior temperature winter [°C]:	20,0
No. of dwelling units:	1	Internal heat gains (IHG) heating case [W/m²]:	2,4
No. of occupants:	2,9	Specific capacity [Wh/K per m² TFA]:	204
		Interior temp. summer [°C]:	25,0
		IHG cooling case [W/m²]:	2,4
		Mechanical cooling:	x

Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	156,0				
Space heating	Heating demand	kWh/(m²a)	20	≤	-	-	-
	Heating load	W/m²	16	≤	-	-	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	0	≤	-	-	-
	Cooling load	W/m²	4	≤	-	-	
	Frequency of overheating (> 25 °C)	%	-	≤	-		-
	Frequency of excessively high humidity (> 12 g/kg)	%	0	≤	10		yes
Airtightness	Pressurization test result n_{50}	1/h	1,0	≤	1,0		yes
Moisture protection							
	Smallest temperature factor $f_{Rsi=0.25\ m²K/W}$	-	0,95	≥	0,70		yes
Thermal Comfort	All requirements fulfilled?	-			yes		yes
	U-value	W/(m²K)		≤	0,86		
	U-value	W/(m²K)		≤	1,02		
	U-value	W/(m²K)		≤	1,12		
	U-value	W/(m²K)		≤	0,47		
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	46	≤	-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	39	≤	36	39	yes
	Generation of renewable energy (in relation to projected building footprint area)	kWh/(m²a)	128	≥	120	126	

EnerPHit (retrofit): Component characteristics

Building envelope to exterior air[1] (U-value)	W/(m²K)	0,14	≤	0,15	yes
Building envelope to ground[1] (U-value)	W/(m²K)	0,26	≤	0,27	yes
Wall w/int. insulation in contact w/exterior air (U-value)	W/(m²K)	-	≤	0,35	-
Wall w/interior insulation in contact w/ground (U-value)	W/(m²K)	-	≤	0,51	-
Flat roof (SRI)	-	-	≥	-	-
Inclined and vertical external surface (SRI)	-	33	≥	-	-
Windows/Entrance doors ($U_{W/D,installed}$)	W/(m²K)	0,78	≤	0,85	yes
Windows ($U_{W,installed}$)	W/(m²K)	-	≤	1,00	-
Windows ($U_{W,installed}$)	W/(m²K)	-	≤	1,10	-
Glazing (g-value)	-	0,50	≥	0,36	yes
Glazing/sun protection (max. solar load)	kWh/(m²a)	13	≤	-	-
Ventilation (effective heat recovery efficiency)	%	82	≥	75	yes
Ventilation (humidity recovery efficiency)	%		≥	-	-

[1] Without windows, doors and external walls with interior insulation
[2] Empty field: Data missing; '-': No requirement

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

EnerPHit Premium? yes

Task:	First name:	Surname:	Signature:
1-Designer			
	Issued on:	City:	

PHPP Check

EnerPHit with PHPP Version 9.6a

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a

▼ Overview input errors

Congratulations! There are no error messages in your PHPP.

Verification	-
Climate	-
U-Values	-
Areas	-
Ground	-
Components	-
Windows	-
Shading	-
Ventilation	-
Addl vent	-
SummVent	-
Cooling units	-
DHW+Distribution	-
SolarDHW	-
PV	-
Electricity	-
Use non-res	-
Electricity non-res	-
Aux Electricity	-
IHG	-
IHG non-res	-
PER	-
Compact	-
HP	-
HP Ground	-
Boiler	-
District Heating	-

▼ **Are results missing from 'Verification' worksheet? Possible causes can be found next**

Heating demand / heating load will not be calculated because:

-
-
-
-
-
-

Cooling demand / cooling load is not calculated because:

-
-
-
-
-
-
-

PE / PER specific value is not calculated because:

-
-
-

▼ The following information is based on the energy balance calculation entered

-
-
-
-
The selected climate data set is not admissible for building certification
-
-

▼ Plausibility check

			Comment:
Verification	-		
	-		
	-		
	-		
Climate	-		
U-Values	-		
	-		
Areas	Info: compactness of the building: 2,5 m² envelope area per m² of treated floor area		
	-		
	-		
	-		
	-		
	-		
	-		
	-		
	-		
	-		
	-		
	Average reduction factor of building elements: 93 % -> Very little shading		
	-		
Ground	-		
	-		
	-		
	-		
	-		
	-		
	The conductances in contact with the ground differ from each other. 'Ground' worksheet to 'Areas' worksheet: 53%. Probably varying information has been entered in these two worksheets		
Components	-		
	-		
	-		
	-		
	-		
	-		
	-		
	Are there roller blinds, venetian blinds or similar? Has the installation TB been entered? In which worksheet?		
	-		
	An extremely small window/door installation thermal bridge value [W/mk] has been given for the bottom: 0,005		

	-		
	-		
	-		
Windows	-		
Shading	North, West: is there any horizontal shading for these alignments? Trees, houses, mountains that are further away almost always have an influence as well.		
	-		
	Warning: reduction factor for shading in winter: minimum: 77% , maximal: 87% , average: 84%		
	Information: reduction factor for shading [%] in summer: average: 54%		
	-		
	-		
Ventilation	-		
	-		
	Airtightness: the n50 value is larger than 0.6. Written confirmation of leakage detection should be submitted for EnerPhit certification.		
	-		
	-		
	-		
	-		
	-		
	-		
	-		
	-		
Addl vent	-		
	-		
	-		
	-		
Heating	-		
	-		
	-		
	-		
Heating load	-		
SummVent	-		
	-		
	-		
	234m³/h: the volumetric flow in summer is much higher than the maximum value in winter. Is the ventilation unit so large?		
	-		
	-		
	-		
Cooling units	-		
Cooling load	The total cooling load cannot be transferred via the supply air volume flow rate. Have additional cooling devices been dimensioned adequately?		
DHW+Distribution	-		
	-		
	-		
	-		
	-		
	-		
	-		
Electricity	-		
Electricity non-res	-		
	-		
	-		
	-		
Aux Electricity	-		

Variant calculation

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

			Active							
		Select the active variant here >>>>>>>	5-Heat pump + solar thermal	Existing	Window + ventilation	Basement ceiling + roof	Exterior wall + entrance door	Heat pump + solar thermal	Passive House
Results		**Units**	5	1	2	3	4	5	6
	Heating demand	kWh/(m²a)	**20,3**	329,3	245,2	155,6	20,3	20,3	13,7
	Heating load	W/m²	**15,5**	141,9	97,7	67,0	15,5	15,5	10,2
	Cooling & dehum. demand	kWh/(m²a)	**0,1**	6,7	2,1	0,7	0,2	0,1	0,1
	Cooling load	W/m²	**3,7**	32,6	17,4	10,2	5,5	3,7	3,5
	Frequency of overheating (> 25 °C)	%							
	PER demand	kWh/(m²a)	**38,9**	994,4	784,5	558,9	224,3	38,9	32,7
	EnerPHit Premium?	yes / no	**yes**		no	no	no	yes	yes
	Final energy		-	-	-	-	-	-	-
Space heating	Electricity (HP compact unit)	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Electricity (heat pump)	kWh/(m²a)	9,8	0,0	0,0	0,0	0,0	9,8	6,5
	District heating: 1-None	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Wood and other biomass	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Natural gas / RE gas	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Heating oil / RE methanol	kWh/(m²a)	0,0	360,1	268,4	171,4	27,2	0,0	0,0
	Solar thermal system	kWh/(m²a)	2,5	0,0	0,0	0,0	0,0	2,5	1,8
	Electricity (direct)	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Other	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Aux. electricity (heating, wintertime ventilation)	kWh/(m²a)	2,5	5,9	7,5	6,4	4,8	2,5	2,5
Space cooling	Electricity cooling (heat pump)	kWh/(m²a)	0,0	3,0	0,5	0,2	0,1	0,0	0,0
	Auxiliary electricity cooling, ventilation summer	kWh/(m²a)	1,1	0,0	1,1	1,1	1,1	1,1	1,1
	Electricity dehumidification (heat pump)	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Auxiliary electricity (dehumidification)	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Domestic hot water	Electricity (HP compact unit)	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Electricity (heat pump)	kWh/(m²a)	3,5	0,0	0,0	0,0	0,0	3,5	3,3
	District heating: 1-None	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Wood and other biomass	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Natural gas / RE gas	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Heating oil / Methanol	kWh/(m²a)	0,0	70,8	70,5	70,5	70,5	0,0	0,0
	Solar thermal system	kWh/(m²a)	12,2	0,0	0,0	0,0	0,0	12,2	12,8
	Electricity (direct)	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Other	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Aux. electricity (DHW + solar DHW)	kWh/(m²a)	0,6	0,7	0,9	0,9	0,9	0,6	0,6
Electricity	Electricity (household or non-residential lighting, etc.)	kWh/(m²a)	8,0	8,0	8,0	8,0	8,0	8,0	8,0
	Auxiliary electricity (other)	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Gas / RE gas dry/cook	kWh/(m²a)	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	User determined results		-	-	-	-	-	-	-
	Non-renewable primary energy demand, PE-demand	**kWh/(m²a)**	**45,9**	505,6	405,1	295,7	134,1	45,9	39,5
	Space heating and hot water source	**kW**	**5,4**	25,1	18,2	13,4	5,4	5,4	4,6
				0,0	0,0	0,0	0,0	0,0	0,0
				0,0	0,0	0,0	0,0	0,0	0,0
				0,0	0,0	0,0	0,0	0,0	0,0

Input variables		**Units**	**Value**	**1**	**2**	**3**	**4**	**5**	**6**
	Building assembly layers	U-Value							
a	**Interior insulation layer**	W/(mK)	0,13	0,093	0,093	0,093	0,13	0,13	0,13
		mm	16	50	50	50	16	16	16
b	**Insulation layer external wall**	W/(mK)	0,032				0,032	0,032	0,032
		mm	200				200	200	250
c	**Insulation layer roof**	W/(mK)	0,04			0,04	0,04	0,04	0,04
		mm	300			300	300	300	400
d	**Insulation layer of basement ceiling**	W/(mK)	0,028			0,028	0,028	0,028	0,028
		mm	70			70	70	70	70
e	**Masonry outside wall (old building)**	W/(mK)	0,9	0,90	0,90	0,90	0,90	0,90	0,90
		mm	360	360	360	360	360	360	360
f	**Insulation layer (old building under rafters)**	W/(mK)	0,1	0,10	0,10	0,10	0,10	0,10	0,10
		mm	100	100	100	100	100	100	100
	Radiation balance	Areas							
a	**Facade**								
	Coefficient of absorption exterior	-	0,60	0,6	0,6	0,6	0,6	0,6	0,6
	Coefficient of emission exterior	-	0,90	0,9	0,9	0,9	0,9	0,9	0,9
b	**Roof**								
	Coefficient of absorption exterior	-	0,90	0,9	0,9	0,9	0,9	0,9	0,9
	Coefficient of emission exterior	-	0,90	0,9	0,9	0,9	0,9	0,9	0,9
c									
	Coefficient of absorption exterior	-	0,00						
	Coefficient of emission exterior	-	0,00						
d									
	Coefficient of absorption exterior	-	0,00						
	Coefficient of emission exterior	-	0,00						
e									
	Coefficient of absorption exterior	-	0,00						
	Coefficient of emission exterior	-	0,00						
f									
	Coefficient of absorption exterior	-	0,00						
	Coefficient of emission exterior	-	0,00						
	Thermal bridges	Areas							
1	**Ext. wall-basement**	W/(mK) or W/K	-0,038915	0	0	-0,038915	-0,038915	-0,038915	-0,038915
2	**Int. wall-basement**	W/(mK) or W/K	0,06128	0	0	0,06128	0,06128	0,06128	0,06128
3	**Partition walls**	W/(mK) or W/K	0,00044	0	0	0	0,00044	0,00044	0,00044
4	**Interior ceilings**	W/(mK) or W/K	0,0018	0	0	0	0,0018	0,0018	0,0018
5	**Partition wall-roof**	W/(mK) or W/K	0,00472	0	0	0,00472	0,00472	0,00472	0,00472
6	**Ext. wall-roof**	W/(mK) or W/K	-0,06097	0	0	-0,06097	-0,06097	-0,06097	-0,06097
7	**Ext. wall edge**	W/(mK) or W/K	-0,06186	0	0	0	-0,06186	-0,06186	-0,06186
8		W/(mK) or W/K	0						
9		W/(mK) or W/K	0						
10		W/(mK) or W/K	0						
	Windows and shading	Windows	Shading						
a	**Opening casement 1**	Glazing list	Frame list						
	Active variant: g-Value:0,5 U-Value: 0,58 W/(m²K)	Glazing	02ud-Triple-insulated-Kr12	93ud-Double insulated glazing 4/12mm air /4	02ud-Triple-insulated-Kr12	02ud-Triple-insulated-Kr12	02ud-Triple-insulated-Kr12	02ud-Triple-insulated-Kr12	02ud-Triple-insulated-Kr12

U-Value [W/(m²K)]: left: 0,72 right: 0,72 bottom: 0,72 top: 0,72 Width [m]: left: 0,14 right: 0,14 bottom: 0,14 top: 0,14	Frame	52ud-PH-FRAME: good thermal quality	53ud-EXISTING: timber 45 mm	52ud-PH-FRAME: good thermal quality	52ud-PH-FRAME: good thermal quality	52ud-PH-FRAME: good thermal quality	52ud-PH-FRAME: good thermal quality	52ud-PH-FRAME: good thermal quality	
Reveal depth (o_{Reveal})	m	0,160	0,12	0,12	0,12	0,16	0,16	0,16	
Distance from glazing edge to reveal (d_{Reveal})	m	0,000	0,12	0	0	0	0	0	
Overhang depth (o_{over})	m	0,160	0,12	0,12	0,12	0,16	0,16	0,16	
Distance from upper glazing edge to overhang (d_{over})	m	0,000	0,12	0	0	0	0	0	
Reduction factor for temporary sun protection (z)	%	37%		37%	37%	37%	37%	37%	
b **Opening casement 2**	Glazing list	Frame list							
Active variant: g-Value:0,5 U-Value: 0,58 W/(m²K)	Glazing	02ud-Triple-insulated-Kr12	93ud-Double insulated glazing 4/12mm air /4	02ud-Triple-insulated-Kr12	02ud-Triple-insulated-Kr12	02ud-Triple-insulated-Kr12	02ud-Triple-insulated-Kr12	02ud-Triple-insulated-Kr12	
U-Value [W/(m²K)]: left: 0,72 right: 0,72 bottom: 0,72 top: 0,72 Width [m]: left: 0,14 right: 0,14 bottom: 0,14 top: 0,14	Frame	52ud-PH-FRAME: good thermal quality	54ud-EXISTING: timber 68 mm	52ud-PH-FRAME: good thermal quality	52ud-PH-FRAME: good thermal quality	52ud-PH-FRAME: good thermal quality	52ud-PH-FRAME: good thermal quality	52ud-PH-FRAME: good thermal quality	
Window reveal depth	m	0,160	0,14	0,12	0,12	0,16	0,16	0,16	
Distance from glazing edge to reveal	m	0,000	0,12	0	0	0	0	0	
Overhang depth	m	0,160	0,14	0,12	0,12	0,16	0,16	0,16	
Distance from upper glazing edge to overhang	m	0,000	0,12	0	0	0	0	0	
Reduction factor for temporary sun protection	%								
c **Entrance door**	Glazing list	Frame list							
Active variant: g-Value:0,5 U-Value: 0,58 W/(m²K)	Glazing	02ud-Triple-insulated-Kr12	93ud-Double insulated glazing 4/12mm air /4	93ud-Double insulated glazing 4/12mm air /4	93ud-Double insulated glazing 4/12mm air /4	02ud-Triple-insulated-Kr12	02ud-Triple-insulated-Kr12	02ud-Triple-insulated-Kr12	
U-Value [W/(m²K)]: left: 0,75 right: 0,75 bottom: 0,75 top: 0,75 Width [m]: left: 0,14 right: 0,14 bottom: 0,14 top: 0,14	Frame	51ud-PH-FRAME: medium thermal quality	53ud-EXISTING: timber 45 mm	53ud-EXISTING: timber 45 mm	53ud-EXISTING: timber 45 mm	51ud-PH-FRAME: medium thermal quality	51ud-PH-FRAME: medium thermal quality	51ud-PH-FRAME: medium thermal quality	
Window reveal depth	m	0,160	0,22	0,22	0,22	0,16	0,16	0,16	
Distance from glazing edge to reveal	m	0,098	0,1	0,1	0,1	0,098	0,098	0,098	
Overhang depth	m	0,430	0,22	0,22	0,22	0,43	0,43	0,43	
Distance from upper glazing edge to overhang	m	0,550	0,1	0,1	0,1	0,55	0,55	0,55	
Reduction factor for temporary sun protection	%	50%				50%	50%	50%	
Ventilation	Ventilation								
Ventilation type	select	1-Balanced PH ventilation with HR	3-Only window ventilation	1-Balanced PH ventilation with HR	1-Balanced PH ventilation with HR	1-Balanced PH ventilation with HR	1-Balanced PH ventilation with HR	1-Balanced PH ventilation with HR	
Air change rate at pressurisation test (n_{50})	1/h	1,00	5	1	1	1	1	0,3	
Design air flow rate (maximum)	m³/h	152	152,1	152,1	152,1	152,1	152,1	152,1	
Installation site ventilation unit	Inside / Outside	1-Inside thermal envelope	1-Inside thermal envelope	1-Inside thermal envelope	1-Inside thermal envelope	1-Inside thermal envelope	1-Inside thermal envelope	1-Inside thermal envelope	
Ventilation unit selection	select	01ud-HRV		01ud-HRV	01ud-HRV	01ud-HRV	01ud-HRV	01ud-HRV	
Summer ventilation	SummVent								
Summer basic ventilation to ensure adequate air quality			Go to ventilation units list						
Air change rate via vent. system with supply air:	1/h	0,30		0,3	0,3	0,3	0,3	0,3	
HR/ER in summer (check one field with an 'x'): none	check as appropriate	x	x	x	x	x	x	x	
Automatic bypass, controlled by temperature difference	check as appropriate								
Automatic bypass, controlled by enthalpy difference	check as appropriate								
Always	check as appropriate								
Air change rate via extract air system	1/h	0,00							
Specific power consumption (for extract air system)	Wh/m³	0,00							
Window ventilation air change rate	1/h	0,35	0,35	0,35	0,35	0,35	0,35	0,35	
Additional summer ventilation for cooling:									
Window night ventilation, manual: amount of night ventilation	1/h	0,15	0,15	0,15	0,15	0,15	0,15	0,15	
Mechanical, automatically controlled ventilation: corresponding air change	1/h	0,30		0,3	0,3	0,3	0,3	0,3	
Controlled by temperature difference?	check as appropriate	x		x	x	x	x	x	
Specific power consumption	Wh/m³	0,40		0,4	0,4	0,4	0,4	0,4	
Heat generator	PER								
Primary heat generator	Select	2-Heat pump	4-Heating boiler	4-Heating boiler	4-Heating boiler	4-Heating boiler	2-Heat pump	2-Heat pump	
	Heating fraction	100%	100%	100%	100%	100%	100%	100%	
	DHW fraction	100%	100%	100%	100%	100%	100%	100%	
Secondary heat generator (optional)	Select								
Further input for heat generator (selection unit)	HP								
Heat pump	HP heating	1-Standard Air/Water heat pump	0-None	0-None	0-None	0-None	1-Standard Air/Water heat pump	1-Standard Air/Water heat pump	
	HP DHW	1-Standard Air/Water heat pump	0-None	0-None	0-None	0-None	1-Standard Air/Water heat pump	1-Standard Air/Water heat pump	
	Compact								
Passive House compact unit with exhaust air heat pump	Unit selection								
	Boiler								
Boiler (gas, oil and wood)	Boiler selection	1-None	21-Low temperature boiler oil	21-Low temperature boiler oil	21-Low temperature boiler oil	21-Low temperature boiler oil	1-None	1-None	
	Fuel	-	20-Heating oil	20-Heating oil	20-Heating oil	20-Heating oil	-	-	
	District heating								
District heating	Selection of heat source	1-None	1-None	1-None	1-None	1-None	1-None	1-None	
Other heat generators (heating)	Description	Other	Other	Other	Other	Other	Other	Other	
	Contribution	0%	0%	0%	0%	0%	0%	0%	
	PER-factor								
	PE factor								
	CO_2 factor								
Other heat generators (DHW)	Description	Other	Other	Other	Other	Other	Other	Other	
	Contribution	0%	0%	0%	0%	0%	0%	0%	
	PER-factor								
	PE factor								
	CO_2 factor								
External RE-generation plant	Description								
	kWh/a								
Compressor cooling units	Cooling units								
Supply air cooling	check as appropriate	x		x	x	x	x	x	
On/Off mode	check as appropriate	x		x	x	x	x	x	
Max. cooling capacity (sensible + latent)	kW	2		2,1	2,1	2,1	2,1	2,1	
Seasonal performance factor	-	3		3,2	3,2	3,2	3,2	3,2	
Recirculation cooling	check as appropriate		x						
On/Off mode	check as appropriate		x						
Max. cooling capacity (sensible + latent)	kW	0	10						
Volume flow rate at nominal power	m³/h	0	600						
Variable volume flow (check if appropriate)	check as appropriate								
Seasonal performance factor	-	1	2,4						
Additional dehumidification	check as appropriate	x		x	x	x	x	x	
Waste heat to room (check if appropriate)	check as appropriate	x		x	x	x	x	x	
Seasonal performance factor	-	3		2,6	2,6	2,6	2,6	2,6	
Panel cooling	check as appropriate								
Seasonal performance factor	-	1							

User determined parameters

	Description: exemplary configuration	Units							
2	Solar thermal system (collector area)	m²	8,1	0	0	0	0	8,1	8,1
3	Heat losses storage tank	W/K	3,0	5	5	5	5	3	3
4	Volume DHW storage tank	litre	700,0	200	200	200	200	700	700
5	Length of distribution pipes (heating)	m	13,5	25	25	25	25	13,5	13,5
6	Length of distribution pipes (DHW)	m	13,5	25	25	25	25	13,5	13,5
7	Insulation thickness pipe (heating and DHW)	(factor)	2,0	0,3	0,3	0,3	0,3	2	2
8	Insulation quality of mountings	–	3 - Good	1-None	1-None	1-None	1-None	3 - Good	3 - Good
9	Forward flow temperature control	–	x					x	x
10	Heating: electrical performance of circulation pump	W	21,0	100	100	100	100	21	21
11	run time of circulation pump (DHW)	h/d	18,0	24	24	24	24	18	18
12	PV-modules (number)	–	40,0	0	0	40	40	40	40
13	if cooling units are used check 'mechanical cooling' in sheet 'verification' cell N29	x	x	x	x	x	x	x	x
14									

Comparison between two variants

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

▼ Surface temperature
▼ Annual rate
▼ Energy; CO_2; Costs
▼ Boundary conditions

Selection of comparison configuration

Description	1-External wall	
Component type	1-Building assemblies ('U-values')	
Building component	01ud-External wall	

Performance ratio of the heating system for the variant 'Poorer energy efficiency' more than 10% higher than for variant 'Better energy efficiency'!

Calculation of the selected configuration

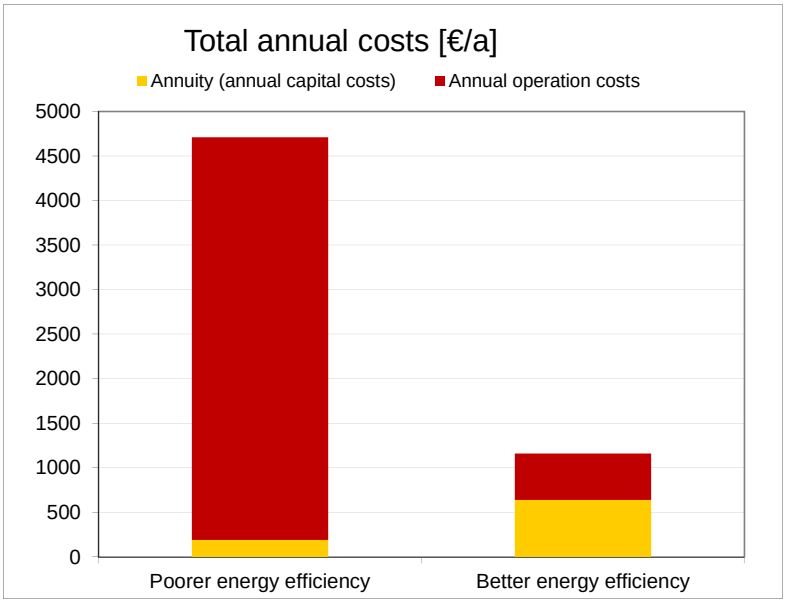
	Poorer energy efficiency	Better energy efficiency	Difference / Savings / Profit	
Design according to variant	1-Existing	5-Heat pump + solar thermal		
U-Value	1,568	0,145		W/(m²K)
Minimum inside surface temperature	9,9	18,9		°C

Mould!

	Investment costs						
	Per m² of building element	Complete building element	Per m² of building element	Complete building element	Per m² of building element	Complete building element	
Area of building element	1	184	1	184	1	184	m²
Investment costs minus financial support	33	6000	110	20240	77	14240	€
Annuity (annual capital costs)	1,0	190	3,48	641	**2,45**	**451**	€/a

	Operation (heating + cooling + mechanical ventilation)						
	Per m² of TFA	Entire building	Per m² of TFA	Entire building	Per m² of building element	Complete building element	
Area	1	156	1	156	1	184	m²
Heating demand	155,7	24290	20,3	3166	114,6	21124	kWh/a
Cooling + dehumidification demand	0,31	49	0,10	16	0,18	33	kWh/a
CO_2 emissions	61,67	9621	7,11	1109	46,19	8512	kg/a
Primary energy renewable (PER)	5,65	31634	385,17	60087	-154,40	-28453	kWh/a
Annual operation costs	28,98	4521	3,34	521	**21,71**	**4000**	€/a

	Cost-effectiveness						
			Maximal economically viable additional investment costs		684,92	126213	€
			Average cost for saved kWh of final energy		2,82		Cent/kWh
Total annual costs	30,20	4711	7,45	1163	**19,26**	**3548,54**	€/a



Input of comparison configurations	1	2	3	4	5
Description	**External wall**	**TB-Basement**	**Windows**	**Ventilation**	**Entire building**
Component type	1-Building assemblies ('U-value	2-Thermal bridges ('Areas')	3-Windows ('Windows')	4-Ventilation system ('Ventilatio	5-Entire building
Building component	01ud-External wall	1-Ext. wall-basement	a-Opening casement 1	-no additional input	-no additional input
Variant "Poorer energy efficiency"	1-Existing	1-Existing	1-Existing	1-Existing	1-Existing
Investment costs [€]	**6000**	**0**	**2700**	**1560**	**156000**
Annual maintenance costs [€/a]	**0**	**0**	**0**	**20**	**0**
Variant "Better energy efficiency"	5-Heat pump + solar thermal	6-Passive House	6-Passive House	6-Passive House	6-Passive House
Investment costs [€]	**20240**	**500**	**4050**	**7800**	**171600**
Annual maintenance costs [€/a]	**0**	**0**	**0**	**40**	**100**
Financial support (present value) [€]	**0**	**0**	**400**	**1000**	**5000**

Results (manual transfer)

Description					

Climate data

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Selection of climate data

Country:	DE-Germany
Region:	All
2-Sorting: BY ID	
Climate data set:	DE-9999-PHPP-Standard
Climate zone:	3: Cool-temperate

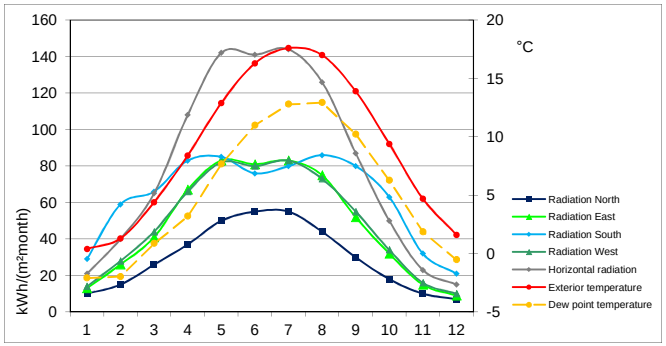
Altitude

Weather station:		m
Building location:		m

Result overview

Annual heating demand	20,3	kWh/(m²a)
Heating load	15,5	W/m²
Frequency of overheating	-	%
Sensible cooling	0,1	kWh/(m²a)
Latent cooling	0,0	kWh/(m²a)
Cooling load	3,7	W/m²
PER demand	38,9	kWh/(m²a)

	Data for heating Annual method	Data from monthly balance Heating	Cooling	
Heating / cooling period	219	212	17	d/a
Heating / cooling degree hours	82	83	-2	kKh/a
Radiation North	129	123	34	kWh/(m²a)
Radiation East	212	203	55	kWh/(m²a)
Radiation South	359	353	57	kWh/(m²a)
Radiation West	221	212	55	kWh/(m²a)
Horizontal radiation	339	322	99	kWh/(m²a)



	Month	1	2	3	4	5	6	7	8	9	10	11	12	Heating load Weather 1	Heating load Weather 2	Cooling load Weather 1	Cooling load Weather 2	PER factors	
	Days	31	28	31	30	31	30	31	31	30	31	30	31						
	DE-9999-PHPP-Standard	Latitude °	51,3	Longitude °	9,4	Altitude [m]		Daily temperature swing Summer [K]			11,7			Radiation: [W/m²]		Radiation: [W/m²]			
° C	Exterior temperature	0,4	1,3	4,4	8,4	12,9	16,3	17,6	17,0	13,9	9,4	4,7	1,6	-10,6	-1,2	24,0	24,0	1,30	Household electric
kWh/(m²month)	Radiation North	10	15	26	37	50	55	55	44	30	18	10	7	10	5	100	100	1,30	Domestic hot wat
kWh/(m²month)	Radiation East	13	26	41	67	83	81	83	75	52	32	15	9	30	5	180	180	1,80	Heating
kWh/(m²month)	Radiation South	29	59	66	83	85	76	80	86	80	63	32	21	90	10	200	200	1,10	Cooling
kWh/(m²month)	Radiation West	14	28	44	66	82	80	83	73	55	34	16	10	35	5	180	180	1,15	Dehumidification
kWh/(m²month)	Horizontal radiation	21	40	65	108	142	141	144	126	87	50	23	15	40	10	330	330		
° C	Dew point temperature	-2,1	-2,0	0,9	3,2	7,7	11,0	12,8	12,9	10,2	6,3	1,9	-0,5			15,9	15,9		
° C	Sky temperature	-9,7	-9,5	-5,4	-2,0	4,3	8,8	11,2	11,4	7,8	2,3	-3,9	-7,4			13,1	15,9		
° C	Ground temperature	10,0	9,6	9,7	10,3	12,2	13,3	14,2	14,7	14,6	13,1	12,0	10,9	9,6	9,6	14,7	14,7		
	Comment:	Representative of typical climate conditions in Central Europe. This dataset can be used for an assessment independent of the location.																	

U-value of building assemblies

EnerPHit with PHPP Version 9.6a

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

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

Assembly no. 01ud | Building assembly description: **External wall** | Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: **2-Wall** | interior R_{si}: 0,13
Adjacent to: **1-Outdoor air** | exterior R_{se}: 0,04

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Interior plaster	**0,350**					**15**
Lime sand brick	**0,900**					**360**
Polystyrene	**0,032**					**200**
Exterior Render	**0,800**					**20**

Percentage of sec. 1: 100% | Percentage of sec. 2 | Percentage of sec. 3 | Total: **59,5** cm

U-value supplement: W/(m²K) | **U-value: 0,145** W/(m²K)

Assembly no. 02ud | Building assembly description: **Roof** | Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: **1-Roof** | interior R_{si}: 0,10
Adjacent to: **1-Outdoor air** | exterior R_{se}: 0,04

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Chipboard	**0,130**					**50**
Blown Mineral Wool	**0,040**	**I-Beam**	**0,374**			**300**
Gypsum Plasterboard	**0,700**					**13**

Percentage of sec. 1: 98% | Percentage of sec. 2: **2,0%** | Percentage of sec. 3 | Total: **36,3** cm

U-value supplement: W/(m²K) | **U-value: 0,140** W/(m²K)

Assembly no. 03ud | Building assembly description: **Basement ceiling** | Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: **3-Floor** | interior R_{si}: 0,17
Adjacent to: **3-Ventilated** | exterior R_{se}: 0,17

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Parquet	**0,130**					**22**
Screed	**1,050**					**48**
Impact sound insulation	**0,040**					**30**
Concrete	**2,100**					**160**
Polystyrene	**0,028**					**70**
Plaster Coat	**0,800**					**10**

Percentage of sec. 1: 100% | Percentage of sec. 2 | Percentage of sec. 3 | Total: **34,0** cm

U-value supplement: W/(m²K) | **U-value: 0,257** W/(m²K)

Assembly no. 04ud — **Partition wall** — Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: **2-Wall** — interior R_{si}: 0,13

Adjacent to: **3-Ventilated** — exterior R_{se}: 0,13

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]
Interior plaster	**0,350**					**15**
Calcium Silicate Blocks	**1,100**					**175**
Insulation	**0,040**					**80**
Calcium Silicate Blocks	**1,100**					**175**
Interior plaster	**0,350**					**15**

Percentage of sec. 1: 90% — Percentage of sec. 2: **10,0%** — Percentage of sec. 3: — Total: **46,0** cm

U-value supplement: — W/(m²K) — **U-value:** **0,375** W/(m²K)

Assembly no. 05ud — Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: — interior R_{si}: —

Adjacent to: — exterior R_{se}: —

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]

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

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

Assembly no. 06ud — Interior insulation?

Heat transmission resistance [m²K/W]

Orientation of building element: — interior R_{si}: —

Adjacent to: — exterior R_{se}: —

Area section 1	λ [W/(mK)]	Area section 2 (optional)	λ [W/(mK)]	Area section 3 (optional)	λ [W/(mK)]	Thickness [mm]

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

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

Areas determination

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Summary

Temp.-zone	Area group	Group no.	Area / Length	Unit	Comment	Building assembly overview	Average U-value [W/(m²K)]	Radiation-gains heating season [kWh/a]	Radiation-load cooling period [kWh/a]
								7 Months	0 Months
	Treated floor area	1	**156,00**	m²	*Treated floor area according to PHPP manual*				
A	**North windows**	2	**11,04**	m²	Results come from the 'Windows' worksheet.	**North windows**	**0,768**	**318**	**97**
A	**East windows**	3	**0,00**	m²	Window areas are subtracted from individual opaque areas.	**East windows**			
A	**South windows**	4	**30,42**	m²	which is displayed in the 'Windows' worksheet.	**South windows**	**0,777**	**2373**	**198**
A	**West windows**	5	**2,00**	m²		**West windows**	**0,849**	**79**	**15**
A	**Horizontal windows**	6	**0,00**	m²		**Horizontal windows**			
A	**Exterior door**	7	**0,00**	m²	*Please subtract area of door from respective building assembly*	**Exterior door**			
A	**External wall - Ambient**	8	**184,28**	m²	*Temperature zone "A" is ambient air*	**External wall - Ambient**	**0,145**	**37**	
B	**External wall - Ground**	9	**0,00**	m²	*Temperature zone "B" is the ground*	**External wall - Ground**			
A	**Roof/Ceiling - Ambient**	10	**83,41**	m²		**Roof/Ceiling - Ambient**	**0,140**	**18**	
B	**Floor slab / Basement ceiling**	11	**80,93**	m²		**Floor slab / Basement ceiling**	**0,257**		
		12	**0,00**	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"*				
		13	**0,00**	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"* Factor for X				
X		14	**0,00**	m²	*Temperature zone "X": Please provide user-defined reduction factor (0 < ft < 1):*				
						Thermal bridges - Overview	**Ψ [W/(mK)]**		
A	**Thermal bridges Ambient**	15	**116,85**	m	*Units in m*	**Thermal bridges Ambient**	**-0,030**		
P	**Perimeter thermal bridges**	16	**0,00**	m	*Units in m; temperature zone "P" is perimeter (see 'Ground' worksheet)*	**Perimeter thermal bridges**			
B	**Thermal bridges FS/BC**	17	**11,35**	m	*Units in m*	**Thermal bridges FS/BC**	**0,061**		
I	**Building element towards neigh**	18	**100,90**	m²	*No heat losses, only considered for the heating load calculation*	**Building element towards neighbour**	0,375		
Total thermal envelope			**392,07**	**m²**		**Average therm. envelope**	**0,230**		

Go to building components list

Area input

2-Sorting: BY ID

Area no.	Building assembly description	To group No.	Assigned to group	Quantity	x (	a [m]	x	b [m]	+	User determined [m²]	-	User subtraction [m²]	-	Subtraction window areas [m²]	) =	Area [m²]	Selection building assembly / Building system	U-Value [W/(m²K)]	Deviation from North	Angle of inclination from the horizontal	Orientation	Reduction factor shading	Exterior absorptivity	Exterior emissivity
	Projected building footprint	**0**	Projected building footprint	**1**	x (	**7,13**	x	**11,35**	+		-		)		=	80,9									
	Treated floor area	**1**	Treated floor area	**1**	x (		x		+	**156,00**	-		)		=	156,0									
	Exterior door	**7**	Exterior door		x (		x		+		-		) -		=		Exterior door								
1	**External wall south**	**8**	External wall - Ambient	**1**	x (	**7,13**	x	**10,31**	+		-		) -	**30,4**	=	43,1	**01ud-External wall**	**0,145**	**180**	**90**	**South**	**0,90**	**0,60**	**0,90**
2	**External wall north**	**8**	External wall - Ambient	**1**	x (	**7,13**	x	**7,48**	+		-		) -	**11,0**	=	42,3	**01ud-External wall**	**0,145**	**0**	**90**	**North**	**0,90**	**0,60**	**0,90**
3	**External wall west**	**8**	External wall - Ambient	**1**	x (	**11,35**	x	**8,89**	+		-		) -	**2,0**	=	98,9	**01ud-External wall**	**0,145**	**270**	**90**	**West**	**0,90**	**0,60**	**0,90**
4	**Roof**	**10**	Roof/Ceiling - Ambient	**1**	x (	**7,13**	x	**11,70**	+		-		) -	**0,0**	=	83,4	**02ud-Roof**	**0,140**	**0**	**14**	**Hor**	**1,00**	**0,90**	**0,90**
5	**Basement floor**	**11**	Floor slab / Basement ceiling	**1**	x (	**7,13**	x	**11,35**	+		-		) -	**0,0**	=	80,9	**03ud-Basement ceiling**	**0,257**	**0**	**180**	**Hor**			
6					x (		x		+		-		) -	**0,0**	=									
7	**Partition wall**	**18**	Building element towards neighb	**1**	x (	**11,35**	x	**8,89**	+		-		) -	**0,0**	=	100,9	**04ud-Partition wall**	**0,375**	**90**	**90**	**East**			
8					x (		x		+		-		) -	**0,0**	=									
9					x (		x		+		-		) -	**0,0**	=									
10					x (		x		+		-		) -	**0,0**	=									
11					x (		x		+		-		) -	**0,0**	=									
12					x (		x		+		-		) -	**0,0**	=									
13					x (		x		+		-		) -	**0,0**	=									
14					x (		x		+		-		) -	**0,0**	=									
15					x (		x		+		-		) -	**0,0**	=									
16					x (		x		+		-		) -	**0,0**	=									
17					x (		x		+		-		) -	**0,0**	=									
18					x (		x		+		-		) -	**0,0**	=									
19					x (		x		+		-		) -	**0,0**	=									
20					x (		x		+		-		) -	**0,0**	=									
21					x (		x		+		-		) -	**0,0**	=									
22					x (		x		+		-		) -	**0,0**	=									
23					x (		x		+		-		) -	**0,0**	=									
24					x (		x		+		-		) -	**0,0**	=									
25					x (		x		+		-		) -	**0,0**	=									
26					x (		x		+		-		) -	**0,0**	=									
27					x (		x		+		-		) -	**0,0**	=									
28					x (		x		+		-		) -	**0,0**	=									
29					x (		x		+		-		) -	**0,0**	=									
30					x (		x		+		-		) -	**0,0**	=									

Areas determination

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Summary

Temp.-zone	Area group	Group no.	Area / Length	Unit	Comment	Building assembly overview	Average U-value [W/(m²K)]	Radiation-gains heating season [kWh/a]	Radiation-load cooling period [kWh/a]
	Treated floor area	1	**156,00**	m²	*Treated floor area according to PHPP manual*			7 Months	0 Months
A	**North windows**	2	**11,04**	m²	Results come from the 'Windows' worksheet.	**North windows**	**0,768**	**318**	**97**
A	**East windows**	3	**0,00**	m²	Window areas are subtracted from individual opaque areas.	**East windows**			
A	**South windows**	4	**30,42**	m²	which is displayed in the 'Windows' worksheet.	**South windows**	**0,777**	**2373**	**198**
A	**West windows**	5	**2,00**	m²		**West windows**	**0,849**	**79**	**15**
A	**Horizontal windows**	6	**0,00**	m²		**Horizontal windows**			
A	**Exterior door**	7	**0,00**	m²	*Please subtract area of door from respective building assembly*	**Exterior door**			
A	**External wall - Ambient**	8	**184,28**	m²	*Temperature zone "A" is ambient air*	**External wall - Ambient**	**0,145**	**37**	
B	**External wall - Ground**	9	**0,00**	m²	*Temperature zone "B" is the ground*	**External wall - Ground**			
A	**Roof/Ceiling - Ambient**	10	**83,41**	m²		**Roof/Ceiling - Ambient**	**0,140**	**18**	
B	**Floor slab / Basement ceiling**	11	**80,93**	m²		**Floor slab / Basement ceiling**	**0,257**		
		12	**0,00**	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"*				
		13	**0,00**	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"* Factor for X				
X		14	**0,00**	m²	*Temperature zone "X": Please provide user-defined reduction factor (0 < ft < 1):*				
						Thermal bridges - Overview	**Ψ [W/(mK)]**		
A	**Thermal bridges Ambient**	15	**116,85**	m	*Units in m*	**Thermal bridges Ambient**	**-0,030**		
P	**Perimeter thermal bridges**	16	**0,00**	m	*Units in m; temperature zone "P" is perimeter (see 'Ground' worksheet)*	**Perimeter thermal bridges**			
B	**Thermal bridges FS/BC**	17	**11,35**	m	*Units in m*	**Thermal bridges FS/BC**	**0,061**		
I	**Building element towards neigh**	18	**100,90**	m²	*No heat losses, only considered for the heating load calculation*	**Building element towards neighbour**	0,375		
Total thermal envelope			**392,07**	**m²**		**Average therm. envelope**	**0,230**		

Go to building components list

31					x (		x		+		-		) -	0,0	=								
32					x (		x		+		-		) -	0,0	=								
33					x (		x		+		-		) -	0,0	=								
34					x (		x		+		-		) -	0,0	=								
35					x (		x		+		-		) -	0,0	=								
36					x (		x		+		-		) -	0,0	=								
37					x (		x		+		-		) -	0,0	=								
38					x (		x		+		-		) -	0,0	=								
39					x (		x		+		-		) -	0,0	=								
40					x (		x		+		-		) -	0,0	=								
41					x (		x		+		-		) -	0,0	=								
42					x (		x		+		-		) -	0,0	=								
43					x (		x		+		-		) -	0,0	=								
44					x (		x		+		-		) -	0,0	=								
45					x (		x		+		-		) -	0,0	=								
46					x (		x		+		-		) -	0,0	=								
47					x (		x		+		-		) -	0,0	=								
48					x (		x		+		-		) -	0,0	=								
49					x (		x		+		-		) -	0,0	=								
50					x (		x		+		-		) -	0,0	=								

Aend

Areas determination

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Summary

Temp.-zone	Area group	Group no.	Area / Length	Unit	Comment	Building assembly overview	Average U-value [W/(m²K)]	Radiation-gains heating season [kWh/a]
	Treated floor area	1	**156,00**	m²	*Treated floor area according to PHPP manual*			7 Months
A	**North windows**	2	**11,04**	m²	Results come from the 'Windows' worksheet.	**North windows**	**0,768**	**318**
A	**East windows**	3	**0,00**	m²	Window areas are subtracted from individual opaque areas.	**East windows**		
A	**South windows**	4	**30,42**	m²	which is displayed in the 'Windows' worksheet.	**South windows**	**0,777**	**2373**
A	**West windows**	5	**2,00**	m²		**West windows**	**0,849**	**79**
A	**Horizontal windows**	6	**0,00**	m²		**Horizontal windows**		
A	**Exterior door**	7	**0,00**	m²	*Please subtract area of door from respective building assembly*	**Exterior door**		
A	**External wall - Ambient**	8	**184,28**	m²	*Temperature zone "A" is ambient air*	**External wall - Ambient**	**0,145**	**37**
B	**External wall - Ground**	9	**0,00**	m²	*Temperature zone "B" is the ground*	**External wall - Ground**		
A	**Roof/Ceiling - Ambient**	10	**83,41**	m²		**Roof/Ceiling - Ambient**	**0,140**	**18**
B	**Floor slab / Basement ceiling**	11	**80,93**	m²		**Floor slab / Basement ceiling**	**0,257**	
		12	**0,00**	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"*			
		13	**0,00**	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"* Factor for X			
X		14	**0,00**	m²	*Temperature zone "X": Please provide user-defined reduction factor (0 < ft < 1):*			
						Thermal bridges - Overview	**Ψ [W/(mK)]**	
A	**Thermal bridges Ambient**	15	**116,85**	m	*Units in m*	**Thermal bridges Ambient**	**-0,030**	
P	**Perimeter thermal bridges**	16	**0,00**	m	*Units in m; temperature zone "P" is perimeter (see 'Ground' worksheet)*	**Perimeter thermal bridges**		
B	**Thermal bridges FS/BC**	17	**11,35**	m	*Units in m*	**Thermal bridges FS/BC**	**0,061**	
I	**Building element towards neigh**	18	**100,90**	m²	*No heat losses, only considered for the heating load calculation*	**Building element towards neighbour**	0,375	
Total thermal envelope			**392,07**	**m²**		**Average therm. envelope**	**0,230**	

Go to building components list

Thermal bridge inputs

Change order

No.	Thermal bridge - denomination	Group No.	Assigned to group	Quantity	x (	Length [m]	-	Subtraction length [m]	)=	Length ℓ [m]	User determined psi value [W/(mK)]	User determined $f_{Rsi=0,25}$ (optional)	or	Selection building system	Ψ-Value [W/(mK)]	f_{Rsi}-Requirement met?
1	**Ext. wall-basement**	**15**	Thermal bridges Ambient	**1**	x (	**24,85**	-		) =	24,85	**-0,039**	**0,950**	or		**-0,039**	
2	**Int. wall-basement**	**17**	Thermal bridges FS/BC	**1**	x (	**11,35**	-		) =	11,35	**0,061**	**0,950**	or		**0,061**	
3	**Partition walls**	**15**	Thermal bridges Ambient	**1**	x (	**17,36**	-		) =	17,36	**0,000**	**0,950**	or		**0,000**	
4	**Interior ceilings**	**15**	Thermal bridges Ambient	**1**	x (	**20,25**	-		) =	20,25	**0,002**	**0,950**	or		**0,002**	
5	**Partition wall-roof**	**15**	Thermal bridges Ambient	**1**	x (	**11,77**	-		) =	11,77	**0,005**	**0,950**	or		**0,005**	
6	**Ext. wall-roof**	**15**	Thermal bridges Ambient	**1**	x (	**25,27**	-		) =	25,27	**-0,061**	**0,950**	or		**-0,061**	
7	**Ext. wall edge**	**15**	Thermal bridges Ambient	**1**	x (	**17,36**	-		) =	17,36	**-0,062**	**0,950**	or		**-0,062**	
8					x (		-		) =				or			
9					x (		-		) =				or			
10					x (		-		) =				or			
11					x (		-		) =				or			
12					x (		-		) =				or			
13					x (		-		) =				or			
14					x (		-		) =				or			
15					x (		-		) =				or			
16					x (		-		) =				or			
17					x (		-		) =				or			
18					x (		-		) =				or			
19					x (		-		) =				or			
20					x (		-		) =				or			
21					x (		-		) =				or			
22					x (		-		) =				or			
23					x (		-		) =				or			
24					x (		-		) =				or			
25					x (		-		) =				or			
26					x (		-		) =				or			
27					x (		-		) =				or			
28					x (		-		) =				or			
29					x (		-		) =				or			
30					x (		-		) =				or			
31					x (		-		) =				or			
32					x (		-		) =				or			
33					x (		-		) =				or			
34					x (		-		) =				or			

Areas determination

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Summary

Temp.-zone	Area group	Group no.	Area / Length	Unit	Comment	Building assembly overview	Average U-value [W/(m²K)]	Radiation-gains heating season [kWh/a]
	Treated floor area	1	**156,00**	m²	*Treated floor area according to PHPP manual*			7 Months
A	**North windows**	2	**11,04**	m²		**North windows**	**0,768**	**318**
A	**East windows**	3	**0,00**	m²	Results come from the 'Windows' worksheet.	**East windows**		
A	**South windows**	4	**30,42**	m²	Window areas are subtracted from individual opaque areas.	**South windows**	**0,777**	**2373**
A	**West windows**	5	**2,00**	m²	which is displayed in the 'Windows' worksheet.	**West windows**	**0,849**	**79**
A	**Horizontal windows**	6	**0,00**	m²		**Horizontal windows**		
A	**Exterior door**	7	**0,00**	m²	*Please subtract area of door from respective building assembly*	**Exterior door**		
A	**External wall - Ambient**	8	**184,28**	m²	*Temperature zone "A" is ambient air*	**External wall - Ambient**	**0,145**	**37**
B	**External wall - Ground**	9	**0,00**	m²	*Temperature zone "B" is the ground*	**External wall - Ground**		
A	**Roof/Ceiling - Ambient**	10	**83,41**	m²		**Roof/Ceiling - Ambient**	**0,140**	**18**
B	**Floor slab / Basement ceiling**	11	**80,93**	m²		**Floor slab / Basement ceiling**	**0,257**	
		12	**0,00**	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"*			
		13	**0,00**	m²	*Temperature zones "A", "B","P" and "X" may be used. NOT "I"* Factor for X			
X		14	**0,00**	m²	*Temperature zone "X": Please provide user-defined reduction factor (0 < ft < 1):*			
						Thermal bridges - Overview	**Ψ [W/(mK)]**	
A	**Thermal bridges Ambient**	15	**116,85**	m	*Units in m*	**Thermal bridges Ambient**	**-0,030**	
P	**Perimeter thermal bridges**	16	**0,00**	m	*Units in m; temperature zone "P" is perimeter (see 'Ground' worksheet)*	**Perimeter thermal bridges**		
B	**Thermal bridges FS/BC**	17	**11,35**	m	*Units in m*	**Thermal bridges FS/BC**	**0,061**	
I	**Building element towards neigh**	18	**100,90**	m²	*No heat losses, only considered for the heating load calculation*	**Building element towards neighbour**	0,375	
Total thermal envelope			**392,07**	**m²**		**Average therm. envelope**	**0,230**	

Go to building components list

35					x (		-		) =							or			
36					x (		-		) =							or			
37					x (		-		) =							or			
38					x (		-		) =							or			
39					x (		-		) =							or			
40					x (		-		) =							or			
41					x (		-		) =							or			
42					x (		-		) =							or			
43					x (		-		) =							or			
44					x (		-		) =							or			
45					x (		-		) =							or			
46					x (		-		) =							or			
47					x (		-		) =							or			
48					x (		-		) =							or			
49					x (		-		) =							or			
50					x (		-		) =							or			

TBend

Heat losses through the ground

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Building section 1

Ground characteristics			
Thermal conductivity	λ	2,0	W/(mK)
Heat capacity	ρc	2,0	MJ/(m³K)
Periodic penetration depth	δ	3,17	m

Climate data			
Avg indoor temp. winter	T_i	20,0	°C
Avg indoor temp. summer	T_i	25,0	°C
Avg ground surface temperature	$T_{g,ave}$	10,0	°C
Amplitude of $T_{g,ave}$	$T_{g,\wedge}$	8,6	°C
Phase shifting of $T_{e,m}$	τ	1,1	Months
Length of the heating period	n	7,2	Months
Heating degree hours - exterior	G_ι	81,9	kKh/a

Building data							
Area of ground floor slab / basement c	A	80,9	m²	U-value floor slab/basement ceiling	U_f	0,131	W/(m²K)
Perimeter length	P	25,0	m	TBs floor slab / basement ceiling	Ψ_B*l	0,70	W/K
Charact. dimension of floor slab	B'	6,47	m	U-value floor slab / basement ceiling ii	U_f'	0,139	W/(m²K)
				Equivalent thickness floor	d_t	14,34	m

Floor slab type (select only one)

	Slab on grade						
	Perimeter insulation width/depth	D		m	Orientation of perimeter insulation	horizontal	
	Perimeter insulation thickness	d_n		m	(check only one field)	vertical	x
	Conductivity perimeter insulation	λ_n		W/(mK)			
	Heated basement or floor slab completely / partially below ground level						
	Basement wall height below ground le	z		m	U-Value wall below ground	U_{wB}	W/(m²K)
x	**Unheated basement**						
	Height aboveground wall	h	0,00	m	U-Value wall above ground	U_W	0,138 W/(m²K)
	Basement wall height below ground le	z	2,39	m	U-Value wall below ground	U_{WB}	0,600 W/(m²K)
	Air change unheated basement	n	0,20	h^{-1}	U-Value basement floor slab	U_{fB}	0,645 W/(m²K)
	Air volume basement	V	120	m³			
	Suspended floor above a ventilated crawl space (at max. 0.5 m below ground)						
	U-Value crawl space	U_{Crawl}		W/(m²K)	Area of ventilation openings	εP	m²
	Height of crawl space wall	h		m	Wind velocity at 10 m height	v	4,0 m/s
	U-Value crawl space wall	U_W		W/(m²K)	Wind shield factor	f_W	0,05 -

Additional thermal bridge heat losses at perimeter						
				Steady-state fraction	$\Psi_{P,stat}$*l	0,000 W/K
Phase shift	β		Months	Harmonic fraction	$\Psi_{P,harm}$*l	0,000 W/K

Groundwater correction							
Depth of the groundwater table	z_w	3,0	m	Groundwater correction factor	G_w	1,03386917	-
Groundwater flow rate	q_w	0,05	m/d				

Interim results

Phase shift	β	1,20	Months	Steady-state heat flow	Φ_{stat}	93,5	W
Steady-state transmittance	L_S	9,35	W/K	Periodic heat flow	Φ_{harm}	9,9	W
Exterior periodic transmittance	L_{pe}	2,83	W/K	Heat losses during heating period	Q_{tot}	544	kWh
Transmittance building	L_0	11,28	W/K				

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

Month	1	2	3	4	5	6	7	8	9	10	11	12	Avg. value
Winter	10,0	9,6	9,7	10,3	11,4	12,5	13,4	13,8	13,7	13,1	12,0	10,9	11,7
Summer	10,9	10,4	10,6	11,2	12,2	13,3	14,2	14,7	14,6	13,9	12,9	11,8	12,6

Design ground temperature for 'Heating load' worksheet 9,6 **For 'Cooling load' worksheet** 14,7

Reduction factor for 'Annual heating' worksheet 0,59

Total result (all building parts)

Phase shift	β	1,20	Months	Steady-state heat flow	Φ_{stat}	93,5	W
Steady-state transmittance	L_S	9,35	W/K	Periodic heat flow	Φ_{harm}	9,9	W
Exterior periodic transmittance	L_{pe}	2,83	W/K	Heat losses during heating period	Q_{tot}	544	kWh
Transmittance building	L_0	11,28	W/K	Charact. dimension of floor slab	B'	6,47	m

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

Month	1	2	3	4	5	6	7	8	9	10	11	12	Avg. value
Winter	**10,0**	**9,6**	**9,7**	**10,3**	**11,4**	**12,5**	**13,4**	**13,8**	**13,7**	**13,1**	**12,0**	**10,9**	**11,7**
Summer	**10,9**	**10,4**	**10,6**	**11,2**	**12,2**	**13,3**	**14,2**	**14,7**	**14,6**	**13,9**	**12,9**	**11,8**	**12,6**

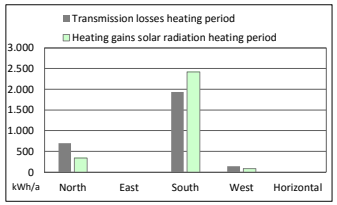
Design ground temperature for 'Heating load' worksheet **9,6** **For 'Cooling load' worksheet** **14,7**

Reduction factor for 'Annual heating' worksheet **0,59**

Windows

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Window area orientation	Global radiation (main orientations)	Shading	Dirt	Non-vertical radiation incidence	Glazing fraction	g-Value	Solar irradiation reduction factor	Window area	Window U-Value	Glazing area	Average global radiation		Transmission losses heating period	Heating gains solar radiation heating period
Standard values →	kWh/(m²a)	0,75	0,95	0,85				m²	W/(m²K)	m²	kWh/(m²a)		kWh/a	kWh/a
North	129	0,86	0,95	0,85	0,67	0,50	0,47	11,04	0,77	7,43	129	North	695	334
East	212	1,00	0,95	0,85	0,00	0,00	0,00	0,00	0,00	0,00	212	East	0	0
South	359	0,83	0,95	0,85	0,66	0,50	0,44	30,42	0,78	19,99	359	South	1936	2416
West	221	0,77	0,95	0,85	0,60	0,50	0,37	2,00	0,85	1,21	221	West	139	83
Horizontal	339	1,00	0,95	0,85	0,00	0,00	0,00	0,00	0,00	0,00	339	Horizontal	0	0
Total or average value for all windows.						0,50	0,45	43,46	0,78	28,64			2771	2833



Recommendation for $U_{w,installed}$ [W/(m²K)]

0,85	1,00	1,10	0,47

Heating degree hours [kKh/a]: 81,9

Go to glazing list Go to window frames list

Quantity	Description	Deviation from north	Angle of inclination from the horizontal	Orientation	Window rough openings: Width	Window rough openings: Height	Installed in: Selection from 'Areas' worksheet	Glazing: Selection from 'Components' worksheet	Frame: Selection from 'Components' worksheet	g-Value: Perpendicular radiation	U-Value: Glazing	U-Value: Frames (avg.)	Ψ Glazing edge: $\Psi_{Glazing\ edge}$ (Avg.)	Installation situation: left	right	bottom	top	$\Psi_{Installation}$ (Avg.)	Results: Window Area	Glazing area	U_w installed	Glazed fraction per window
		°	°		m	m		Sort: AS LIST	Sort: AS LIST	-	W/(m²K)	W/(m²K)	W/(mK)	W/(mK) or 1/0				W/(mK)	m²	m²	W/(m²K)	%
4	S Ground Fl.	180	90	South	1,100	2,120	1-External wall south	02ud-Triple-insulated-Kr12	52ud-PH-FRAME: good thermal quality	0,50	0,58	0,72	0,035	1	0	1	1	0,040	9,3	6,04	0,78	65%
4	S First Fl.	180	90	South	1,140	2,120	1-External wall south	02ud-Triple-insulated-Kr12	52ud-PH-FRAME: good thermal quality	0,50	0,58	0,72	0,035	1	0	1	1	0,040	9,7	6,33	0,78	65%
4	S Second Fl.	180	90	South	1,120	2,550	1-External wall south	02ud-Triple-insulated-Kr12	52ud-PH-FRAME: good thermal quality	0,50	0,58	0,72	0,035	1	0	1	1	0,040	11,4	7,63	0,77	67%
2	N Ground Fl.	0	90	North	1,200	2,300	2-External wall north	02ud-Triple-insulated-Kr12	52ud-PH-FRAME: good thermal quality	0,50	0,58	0,72	0,035	1	0	1	1	0,040	5,5	3,72	0,77	67%
1	West	270	90	West	0,910	2,200	3-External wall west	02ud-Triple-insulated-Kr12	52ud-PH-FRAME: good thermal quality	0,50	0,58	0,72	0,035	1	1	1	1	0,040	2,0	1,21	0,85	60%
2	N First Fl.	0	90	North	1,200	2,300	2-External wall north	02ud-Triple-insulated-Kr12	52ud-PH-FRAME: good thermal quality	0,50	0,58	0,72	0,035	1	0	1	1	0,040	5,5	3,72	0,77	67%

Calculation of shading coefficients

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Latitude: 51,301 °

Orientation	Glazing area [m²]	Reduction factor winter r_v	Reduction factor cooling $r_{v,1}$	Reduction factor cooling load $r_{v,2}$	Solar load [kWh/(m²$_{glazing}$a)]
North	7,43	86%	90%	90%	13
East	0,00	100%	100%	100%	0
South	19,99	83%	40%	35%	10
West	1,21	77%	51%	39%	12
Horizontal	0,00	100%	100%	100%	0

								Horizon		Lateral reveal		Reveal / Overhang						Reduction factors for shading in winter				Reduction factors for shading in summer				
Quan-tity	Description	Deviation from North	Angle of inclination from the horizontal	Orientation	Glazing width	Glazing height	Glazing area	Height of the shading object	Horizontal distance	Window reveal depth	Distance from glazing edge to reveal	Overhang depth	Distance from upper glazing edge to overhang	Additional reduction factor winter shading	Additional reduction factor summer shading	Reduction factor z for temporary sun protection	Regulated / transparent	Horizon	Reveal	Overhang	Total for heating case	Horizon	Reveal	Overhang	Total for cooling case	Total for cooling load
		[Degree]	[Degree]		w_G [m]	h_G [m]	A_G [m²]	h_{Hori} [m]	d_{Hori} [m]	o_{Reveal} [m]	d_{Reveal} [m]	o_{over} [m]	d_{over} [m]	$r_{other,w}$ [%]	$r_{other,s}$ [%]	z [%]		r_H [%]	r_R [%]	r_O [%]	r_S [%]	r_H [%]	r_R [%]	r_O [%]	$r_{S,1}$ [%]	$r_{S,2}$ [%]
4	S Ground Fl.	180	90	South	0,82	1,84	6,0	10,80	42,50	0,16	0,000	0,16	0,00			37%	x	87%	92%	98%	78%	91%	90%	97%	39%	34%
4	S First Fl.	180	90	South	0,86	1,84	6,3	8,30	42,50	0,16	0,000	0,16	0,00			37%	x	92%	92%	98%	83%	93%	90%	97%	40%	35%
4	S Second Fl.	180	90	South	0,84	2,27	7,6	5,80	42,50	0,16	0,000	0,16	0,00			37%	x	96%	92%	98%	87%	95%	90%	98%	42%	36%
2	N Ground Fl.	0	90	North	0,92	2,02	3,7			0,16	0,000	0,16	0,00						90%	95%	86%		91%	99%	90%	90%
1	West	270	90	West	0,63	1,92	1,2			0,16	0,000	0,16	0,00			37%			80%	95%	77%		92%	99%	51%	39%
2	N First Fl.	0	90	North	0,92	2,02	3,7			0,16	0,000	0,16	0,00						90%	95%	86%		91%	99%	90%	90%

Ventilation data

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Treated floor area A_{TFA}	m²	156		*('Areas' worksheet)*
Room height h	m	2,50	2,50	
Volume of ventilated space (A_{TFA}*h) : V_V	m³	390		*(Worksheet 'Annual heating')*

Ventilation type

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

Infiltration air change rate

Wind protection coefficients e and f		
Coefficient e for wind protection class	Several side exposed	One side exposed
No protection	0,10	0,03
Moderate protection	0,07	0,02
High protection	0,04	0,01
Coefficient f	15	20

			For annual demand:	For heating load:				
Wind protection coefficient, e			0,07	0,18				
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	1,00	1,00	480	m³	1,22	m³/(hm²)
			For annual demand:	For heating load:				
Excess extract air		1/h	0,00	0,00				
Infiltration air change rate	$n_{V,Rest}$	1/h	0,086	0,215				

Selection of ventilation input - Results

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

	Ventilation unit / Heat recovery efficiency design		Average air flow rate m³/h	Average air change rate 1/h	Extract air excess (extract air system) 1/h	Effective heat recovery efficiency unit [-]	Humidity recovery efficiency [-]	Specific power input Wh/m³	Heat recovery efficiency SHX [-]
x	Standard design	*('Ventilation' worksheet, see below)*	117	0,30	0,00	82,0%	N/A	0,40	31,3%
	Multiple ventilation units, non-res	*('Addl vent' worksheet)*							

Cooling recovery	Efficiency SHX	
	η^*_{SHX}	93%

Average interior humidity during winter operation

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
34%	34%	39%	44%	-	-	-	-	-	52%	41%	37%

Standard data input for balanced ventilation

Dimensioning of ventilation system with only one ventilation unit

Occupancy	m²/P	53				
Number of occupants	P	2,9				
Supply air per person	m³/(P*h)	30				
Supply air requirement	m³/h	88		Bathroom		
Extract air rooms		Kitchen	Bathroom	(shower only)	WC	
Quantity		1	1	1	1	
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 **152** Recommended: 152 m³/h

Average air change rate calculation

Type of operation	Daily operation times h/d	Factors referenced to maximum	Air flow rate m³/h	Air change rate 1/h
maximum		1,00	152	0,39
Standard	**24,0**	**0,77**	117	0,30
Basic ventilation		**0,54**	82	0,21
Minimum		**0,40**	61	0,16
			Average air flow rate (m³/h)	Average air change rate (1/h)
	Average value	0,77	**117**	**0,30**

Selection of ventilation unit with heat recovery

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

	Go to ventilation units list 1-Sorting: AS LIST	Heat recovery efficiency	Humidity recovery efficiency	Specific efficiency [Wh/m³]	Application [m³/h]	Frost power input
Ventilation unit selection	**01ud-HRV**	0,83	N/A	0,40	N/A	yes
				Implementation of frost protection		2-Elec.
				Limit temperature [°C]		-3
				Useful energy [kWh/a]		52

Conductivity outdoor air duct	Ψ	W/(mK)	0,165
Length of outdoor air duct		m	1,1
Conductivity exhaust air duct	Ψ	W/(mK)	0,226
Length of exhaust air duct		m	1,5
Temperature of mechanical services room		°C	11
(Enter only if the central unit is outside of the thermal envelope)			

Room temperature (°C)		20
Avg. ambient temp. heat. period (°C)		4,9
Avg. ground temp (°C)		10,0

Effective heat recovery efficiency $\eta_{HR,eff}$ **82,0%**

Effective heat recovery efficiency subsoil heat exchanger

SHX efficiency	η^*_{SHX}	**93%**
Heat recovery efficiency SHX	η_{SHX}	31%

Secondary calculation
Ψ-value supply or outdoor air duct

Nominal width	100	mm
Insulation thic	150	mm
Reflective coating?	x	Yes
		No
Thermal conductivity	0,040	W/(mK)
Nominal air flow rate	117	m³/h
Δϑ	15	K
Exterior duct diameter	0,100	m
Exterior diameter	0,400	m
α–Interior	19,02	W/(m²K)
α-Surface	2,07	W/(m²K)
Ψ–value	**0,165**	**W/(mK)**
Surface temperature difference	0,954	K

Secondary calculation
Ψ-value extract or exhaust air duct

Nominal width:	125	mm
Insulation thickness	100	mm
Reflective coating?	x	yes
		no
Thermal conductivity	0,040	W/(mK)
Nominal air flow rate	117	m³/h
Δϑ	15	K
Exterior duct diameter	0,125	m
Exterior diameter	0,325	m
α–Interior	12,73	W/(m²K)
α-Surface	2,31	W/(m²K)
Ψ–value	**0,226**	**W/(mK)**
Surface temperature difference	1,445	K

Specific energy for heating (monthly method)

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

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

Interior temperature:	20	°C
Building type:	Row house	
Treated floor area A_{TFA}:	156,0	m²
Spec. Capacity:	204	Wh/(m²K)

Building assembly	Temperature zone	Area m²		U-Value W/(m²K)		Month. red. fac.		G_t kKh/a		kWh/a	Per m² of treated floor area
External wall - Ambient	A	184,3	*	0,145	*	1,00	*	83	=	2217	14,21
External wall - Ground	B		*		*	1,00	*		=		
Roof/Ceiling - Ambient	A	83,4	*	0,140	*	1,00	*	83	=	968	6,20
Floor slab / Basement ceiling	B	80,9	*	0,257	*	1,00	*	47	=	970	6,22
	A		*		*	1,00	*		=		
	A		*		*	1,00	*		=		
	X		*		*	0,00	*		=		
Windows	A	43,5	*	0,778	*	1,00	*	83	=	2802	17,96
Exterior door	A		*		*	1,00	*		=		
Exterior TB (length/m)	A	116,9	*	-0,030	*	1,00	*	83	=	-289	-1,85
Perimeter TB (length/m)	P		*		*	1,00	*		=		0,00
Ground TB (length/m)	B	11,4	*	0,061	*	1,00	*	47	=	32	0,21
											kWh/(m²a)
Transmission heat losses Q_T									Total	6701	43,0

	A_{TFA} m²		Clear room height m		Effective air volume V_V m³
	156	*	2,50	=	390

	$n_{V,system}$ 1/h		η^*_{SHX}		η_{HR}		$n_{V,Res}$ 1/h		$n_{V,equi,fraction}$ 1/h
Effective air change rate Ambient nV,e	0,300	*(1-	93%	)*(1-	0,82	)+	0,086	=	0,090
Effective air change rate Ground nV,g	0,300	*	93%	*(1-	0,82	)		=	0,050

	V_V m³		$n_{V,equi,fraction}$ 1/h		c_{Air} Wh/(m³K)		G_t kKh/a		kWh/a	kWh/(m²a)
Ventilation losses ambient Q_V	390	*	0,090	*	0,33	*	83	=	959	6,1
Ventilation losses ground $Q_{V,e}$	390	*	0,050	*	0,33	*	51	=	328	2,1
Ventilation heat losses Q_V								Total	1287	8,3

	Q_T kWh/a		Q_V kWh/a		Reduction factor night/weekend saving		kWh/a	kWh/(m²a)
Total heat losses Q_L	(6701	+	1287	) *	1,0	=	7989	**51,2**

Orientation of the area	Reduction factor see 'Windows' worksheet		g-Value (perp. radiation)		Area m²		Global radiation kWh/(m²a)		kWh/a
North	0,47	*	0,50	*	11,0	*	123	=	318
East	0,00	*	0,00	*	0,0	*	203	=	0
South	0,44	*	0,50	*	30,4	*	353	=	2373
West	0,37	*	0,50	*	2,0	*	212	=	79
Horizontal	0,00	*	0,00	*	0,0	*	322	=	0
Sum opaque areas									309
									kWh/(m²a)
Available solar heat gains Q_S								Total	3079	19,7

	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	*	212	*	2,4	*	156,0	=	1921	12,3

			kWh/a	kWh/(m²a)
Free heat Q_F	Q_S + Q_I	=	5001	32,1
Ratio free heat to losses	Q_F / Q_L	=	0,63	
Utilisation factor heat gains h_G		=	96%	
Heat gains Q_G	η_G * Q_F	=	4823	**30,9**

			kWh/a	kWh/(m²a)
Annual heating demand Q_H	Q_L - Q_G	=	3166	**20**

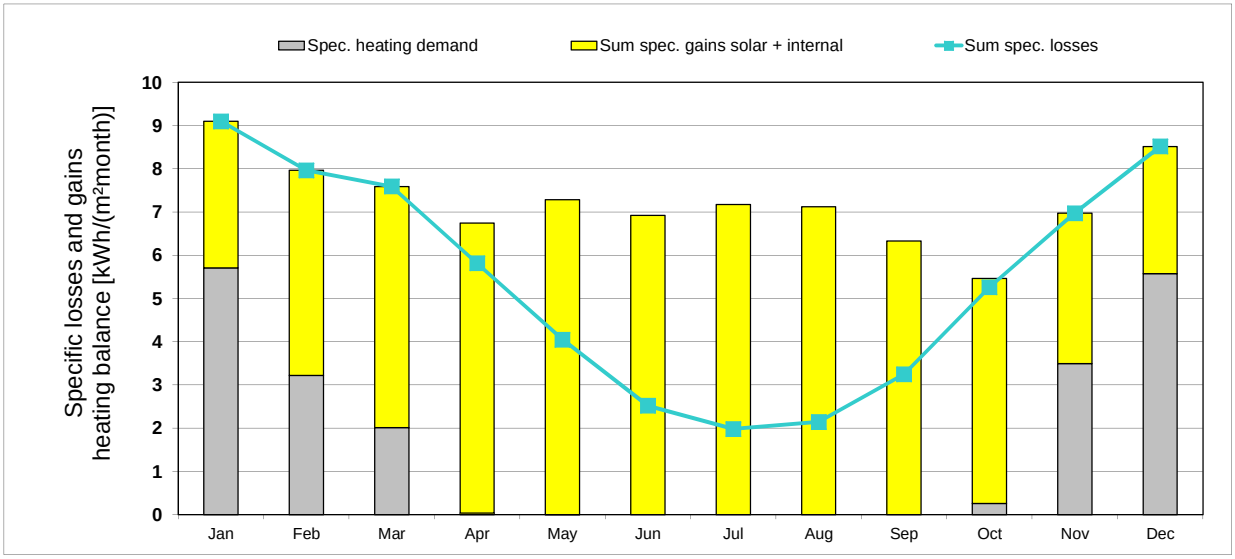
Limiting value	kWh/(m²a)	**Requirement met?**	(Yes/No)
	-		-

Specific energy for heating (monthly method)

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Interior temperature: 20 °C
Building type: Row house
Treated floor area A_{TFA}: 156 m²

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Heating degree hours - Externa	15,1	13,0	12,1	8,9	5,7	3,0	2,1	2,5	4,7	8,2	11,4	14,1	101	kKh
Heating degree hours - Ground	7,4	7,0	7,7	6,9	5,8	4,8	4,3	3,9	3,9	5,2	5,7	6,7	69	kKh
Losses - Exterior	1212	1048	971	711	459	243	169	202	377	662	918	1135	8108	kWh
Losses - Ground	207	194	213	196	172	149	140	133	130	159	169	193	2055	kWh
Sum spec. losses	9,1	8,0	7,6	5,8	4,0	2,5	2,0	2,1	3,2	5,3	7,0	8,5	65,1	kWh/m²
Solar gains - North	26	39	67	96	129	142	142	114	78	47	26	18	923	kWh
Solar gains - East	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Solar gains - South	195	397	444	558	571	511	538	578	538	423	215	141	5108	kWh
Solar gains - West	5	10	16	25	31	30	31	27	21	13	6	4	219	kWh
Solar gains - Horiz.	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Solar gains - Opaque	21	41	62	97	125	125	128	111	80	49	24	15	877	kWh
Internal heat gains	281	254	281	272	281	272	281	281	272	281	272	281	3308	kWh
Sum spec. gains solar + interna	3,4	4,7	5,6	6,7	7,3	6,9	7,2	7,1	6,3	5,2	3,5	2,9	66,9	kWh/m²
Utilisation factor	100%	100%	100%	86%	56%	36%	28%	30%	51%	96%	100%	100%	67%	
Annual heating demand	891	502	314	6	0	0	0	0	0	40	545	869	3166	kWh
Spec. heating demand	**5,7**	**3,2**	**2,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,3**	**3,5**	**5,6**	**20,3**	kWh/m²



Annual heating demand: Comparison

Monthly method	*('Heating')*	3166	kWh/a	20,3	**kWh/(m²a)** reference to treated floor area according to PHPP
Annual method	*('Annual heatin*	3312	kWh/a	21,2	**kWh/(m²a)** reference to treated floor area according to PHPP
		#BEZUG!	kWh/a	#BEZUG!	

Heating load

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Interior temperature: 20 °C
Building type: Row house
Treated floor area A_{TFA}: 156,0 m²

	Design temperature		Radiation:	North	East	South	West	Horizontal	
Weather 1:	-10,6	°C		10	30	90	35	40	W/m²
Weather 2:	-1,2	°C		5	5	10	5	10	W/m²
Ground design temp.	9,6	°C							

Building assembly	Temperature zone	Area m²		U-Value W/(m²K)		Factor always 1 (except "X")		TempDiff 1 K		TempDiff 2 K		PT 1 W		PT 2 W
External wall - Ambient	A	184,3	*	0,145	*	1,00	*	30,6	or	21,2	=	818	or	568
External wall - Ground	B		*		*	1,00	*	10,4	or	10,4	=		or	
Roof/Ceiling - Ambient	A	83,4	*	0,140	*	1,00	*	30,6	or	21,2	=	357	or	248
Floor slab / Basement ceiling	B	80,9	*	0,257	*	1,00	*	10,4	or	10,4	=	217	or	217
	A		*		*	1,00	*	30,6	or	21,2	=		or	
	A		*		*	1,00	*	30,6	or	21,2	=		or	
	X		*		*	0,00	*	30,6	or	21,2	=		or	
Windows	A	43,5	*	0,778	*	1,00	*	30,6	or	21,2	=	1034	or	719
Exterior door	A		*		*	1,00	*	30,6	or	21,2	=		or	
Exterior TB (length/m)	A	116,9	*	-0,030	*	1,00	*	30,6	or	21,2	=	-106	or	-74
Perimeter TB (length/m)	P		*		*	1,00	*	10,4	or	10,4	=		or	
Ground TB (length/m)	B	11,4	*	0,061	*	1,00	*	10,4	or	10,4	=	7	or	7
Building element towards neighbour	I	100,9	*	0,375	*	1,00	*	3,0	or	3,0	=	114	or	114

Transmission heat load P_T

Total = 2439 or 1799

Ventilation system:

Effective air volume, V_V: A_{TFA} 156,0 m² * Clear room height 2,50 m = 390 m³

Heat recovery efficiency of the heat exchanger η_{HR} 82%
Heat recovery efficiency SHX 93%
Heat recovery efficiency SHX $\eta_{SHX\ 1}$ 63% or $\eta_{SHX\ 2}$ 49%

	$n_{V,Res}$ (Heating Load) 1/h		$n_{V,system}$ 1/h		Φ_{HP}		Φ_{HP}		1/h		1/h
Energetically effective air changes n_V	0,215	+	0,300	*(1-	0,93	or	0,91	) =	0,236	or	0,243

Ventilation heat load P_V

V_V m³		n_V 1/h		n_V 1/h		c_{Air} Wh/(m³K)		TempDiff 1 K		TempDiff 2 K		P_V 1 W		P_V 2 W
390,0	*	0,236	or	0,243	*	0,33	*	30,6	or	21,2	=	927	or	664

Total heating load P_L

	PL 1 W		PL 2 W
$P_T + P_V$ =	3366	or	2463

Orientation of the area	Area m²		g-Value (perp. radiation)		Reduction factor (see 'Windows' worksheet)		Radiation 1 W/m²		Radiation 2 W/m²		P_T 1 W		P_T 2 W
North	11,0	*	0,5	*	0,47	*	10	or	5	=	26	or	13
East	0,0	*	0,0	*	0,40	*	30	or	5	=	0	or	0
South	30,4	*	0,5	*	0,44	*	90	or	10	=	605	or	67
West	2,0	*	0,5	*	0,37	*	35	or	5	=	13	or	2
Horizontal	0,0	*	0,0	*	0,40	*	40	or	10	=	0	or	0

Solar heating power P_S

Total = 644 or 82

Internal heating load P_I

Spec. power W/m²		A_{TFA} m²		P_I 1 W		P_I 2 W
1,9	*	156	=	300	or	300

Heating power (gains) P_G

	P_G 1 W		P_G 2 W
$P_T + P_I$ =	943	or	382

$P_L - P_G$ = 2422 or 2081

Heating load P_H = 2422 W

Area specific space heating load P_H / A_{TFA} = 15,5 W/m²

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

Supply air temperature without heating $\vartheta_{Supply,Min}$ 17,9 °C or 18,1 °C

For comparison: heating load transportable by the supply Air $P_{Supply\ Air,Max}$ = 1315 W specific: 8,4 W/m²

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

Summer ventilation

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

			Building type:	Row house	
Building volume:	390	m³	Heat recovery efficiency:	82%	
Max. indoor absolute humidity:	12	g/kg	Humidity recovery efficiency:	0%	
Internal humidity sources:	100	g/(P*h)	Subsoil heat exchanger efficiency:	93%	

Results passive cooling			Results active cooling		
Frequency of overheating:	0,0%	at the overheating limit ϑ_{max} = 25 °C	Useful cooling demand:	0,1	kWh/(m²a)
max. humidity:	11,0	g/kg	Dehumidification demand:	0,0	kWh/(m²a)
Frequency of exceeded humidity:	0,0%		Frequency of exceeded humidity:	0,0%	

Summer basic ventilation to ensure adequate air quality

Air change rate via vent. system with supply air:	0,30	1/h	HRV/ERV in summer (check only one field)	
			None	x
			Automatic bypass, controlled by temperature difference	
			Automatic bypass, controlled by enthalpy difference	
			Always	
Air change rate via extract air system:	0,00	1/h		
			Specific power consumption (for extract air system)	0,00 Wh/m³
Window ventilation air change rate:	0,35	1/h		

Effective air change rate

	$n_{V,system}$ 1/h		η^*_{SHX}		η_{HP}		$n_{V,equi,fraction}$ 1/h
Exterior $n_{V,e}$	0,300	*(1-	93%	)*(1-	0,82	) =	0,004
without HR	0,300	*(1-	93%	)		=	0,021
Ground $n_{L,g}$	0,300	*	93%	*(1-	0,82	) =	0,050
without HR	0,300	*	93%			=	0,279

Ventilation conductance

	V_V m³		$n_{V,equi,fraction}$ 1/h		c_{Air} Wh/(m³K)			
exterior $H_{V,e}$	390	*	0,004	*	0,33	=	0,5	W/K
without HR	390	*	0,021	*	0,33	=	2,7	W/K
ground $H_{V,g}$	390	*	0,050	*	0,33	=	6,5	W/K
without HR	390	*	0,279	*	0,33	=	35,9	W/K
Infiltration, window, extract air system	390	*	0,436	*	0,33	=	56,1	W/K

Additional summer ventilation for cooling

Additional ventilation regulation

Minimum acceptable indoor temp. 22,0 °C

Type of additional ventilation

Window night ventilation, manual	Night ventilation value	0,15	1/h	
	Corresponding air change rate	0,30	1/h	Controlled by (please check)
Mechanical, automatically	during operation, in addition to basic air change			Temperature diff. x
Controlled ventilation	Specific power consumption	0,40	Wh/m³	Humidity diff.

Secondary calculation: Hygienic air change rate through window ventilation

Estimation for window air change rate to ensure sufficient air quality

Description								
	Open duration [h/d]	**3**	**12**					
Climate boundary conditions								
	Temperature diff interior - exterior	**4**	**4**					K
	Wind velocity	**1**	**1**					m/s
Window group 1								
	Quantity	**4**	**6**					
	Clear width	**0,84**	**0,84**					m
	Clear height	**1,92**	**1,92**					m
	Tilting window (check if appropriate)	**x**	**x**					
	Opening width (for tilting windows)	**0,055**	**0,055**					m
Window group 2 (cross ventilation)								
	Quantity							
	Clear width							m
	Clear height							m
	Tilting window (check if appropriate)							
	Opening width (for tilting windows)							m
	Difference in height to window 1							m
							Total	
Result: Air change rate		**0,05**	**0,31**	**0,00**	**0,00**	**0,00**	**0,00**	**0,36** **1/h**

Secondary calculation: Additional night ventilation for cooling

Air change value during additional window night ventilation

Description								
	Reduction factor	**Night**						
		100%						
Climate boundary conditions								
	Temperature diff interior - exterior	1	1	1	1	1	1	K
	Wind velocity	0	0	0	0	0	0	m/s
Window group 1								
	Quantity	**1**						
	Clear width	**0,84**						m
	Clear height	**1,92**						m
	Tilting window (check if appropriate)	**x**						
	Opening width (for tilting windows)	**0,055**						m
Window group 2 (cross ventilation)								
	Quantity	**2**						
	Clear width	**0,84**						m
	Clear height	**1,92**						m
	Tilting window (check if appropriate)	**x**						
	Opening width (for tilting windows)	**0,055**						m
	Difference in height to window 1	**0,00**						m
							Total	
Result: Night ventilation values		**0,15**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,15** **1/h**

Summer: Passive cooling

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Building type:	Row house		Treated floor area A_{TFA}:	156,0	m²
Upper temperature limit:	25	°C	Building volume:	390	m³
Nominal humidity:	12	g/kg	Internal humidity sources:	1,9	g/(m²h)
Spec. capacity:	204	Wh/(m²K)			

Building assembly	Temperature zone	Area m²		U-Value W/(m²K)		Red. factor $f_{T,Summer}$		H_{Summer} heat conductance
External wall - Ambient	A	184,3	*	0,145	*	1,00	=	26,8
External wall - Ground	B		*		*	1,00	=	
Roof/Ceiling - Ambient	A	83,4	*	0,140	*	1,00	=	11,7
Floor slab / Basement ceiling	B	80,9	*	0,257	*	1,00	=	20,8
	A		*		*	1,00	=	
	A		*		*	1,00	=	
	X		*		*	0,00	=	
Windows	A	43,5	*	0,778	*	1,00	=	33,8
Exterior door	A		*		*	1,00	=	
Exterior TB (length/m)	A	116,9	*	-0,030	*	1,00	=	-3,5
Perimeter TB (length/m)	P		*		*	1,00	=	
Ground TB (length/m)	B	11,4	*	0,061	*	1,00	=	0,7

Exterior thermal transmittance, $H_{T,e}$	68,8	W/K
Ground thermal transmittance, $H_{T,g}$	21,5	W/K

Summer ventilation

from 'SummVent' worksheet

Ventilation unit conductance

exterior $H_{V,e}$	0,5	W/K
without HR	2,7	W/K
ground $H_{V,g}$	6,5	W/K
without HR	35,9	W/K

Ventilation conductance, others

exterior	56,1	W/K

Ventilation parameter

Temperature amplitude summer	11,7	K
Minimum acceptable indoor temperature	22,0	°C
Heat capacity air	0,33	Wh/(m³K)
Supply air changes	0,30	1/h
Outdoor air changes	0,44	1/h
Window night ventilation air change rate, manual @ 1K	0,15	1/h
Air change rate due to mech. automatically controlled vent.	0,30	1/h
Specific power consumption for	0,40	Wh/m³
η_{HR}	82%	
η_{ERV}	0%	
η^*_{SHX}	93%	

Summer ventilation regulation

	HRV/ERV
None	x
Controlled by temperature	
Controlled by enthalpy	
Always	

	Additional ventilation
Controlled by temperature	x
Controlled by humidity	

Orientation of the area	Angle factor Summer		Shading factor Summer		Shading dirt		g-Value (perp. radiation)		Area m²		Portion of glazing		**Aperture** m²
North	0,9	*	0,90	*	0,95	*	0,50	*	11,0	*	67%	=	2,9
East	0,9	*	1,00	*	0,95	*	0,00	*	0,0	*	0%	=	0,0
South	0,9	*	0,35	*	0,95	*	0,50	*	30,4	*	66%	=	3,0
West	0,9	*	0,39	*	0,95	*	0,50	*	2,0	*	60%	=	0,2
Horizontal	0,9	*	1,00	*	0,95	*	0,00	*	0,0	*	0%	=	0,0
Sum opaque areas													1,3

Solar aperture	Total	7,4	m²/m² 0,05

	Specif. power q_I W/m²		A_{TFA} m²		W	W/m²
Internal heat gains Q_I	2,4	*	156	=	378	2,4

Frequency of overheating $h_{\vartheta \geq Jmax}$ 0,0% **At the overheating limit ϑ_{max} = 25 °C**

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

Daily internal temperature fluctuation

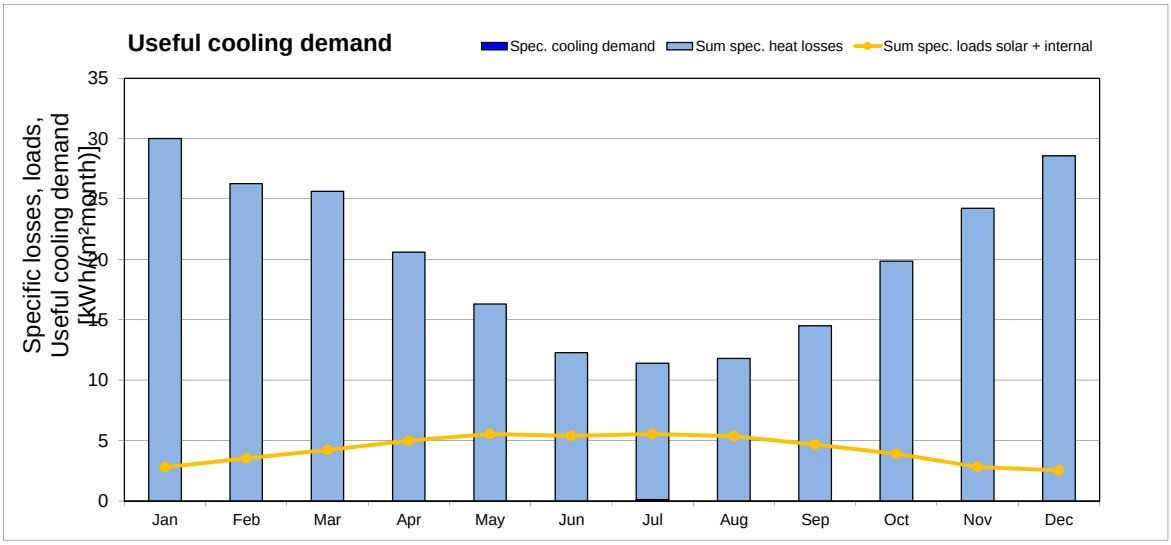
Transmission kWh/d		Ventilation kWh/d		Solar load kWh/d		1/k		Spec. capacity Wh/(m²K)		A_{TFA}: m²		
(9,7	+	10,5	+	29,0	) *	1000	/ (	204	*	156	) =	1,5 K

Cooling: energy value for useful cooling energy

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Interior Temperature: 25 °C
Building type: Row house
Treated Floor Area A_{TFA}: 156 m²

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Heating degree hours - Exterior	18,9	16,5	15,9	12,5	9,5	6,7	5,9	6,3	8,3	12,0	15,1	17,9	145	kKh
Heating degree hours - Ground	11,1	10,4	11,4	10,5	9,5	8,4	8,0	7,7	7,5	8,9	9,3	10,5	113	kKh
Losses - Exterior	2375	2071	1994	1565	1183	828	728	782	1043	1509	1898	2257	18234	kWh
Losses - Ground	640	585	646	615	605	568	573	566	549	592	588	626	7152	kWh
Losses summer ventilation	1668	1443	1361	1033	757	519	463	493	668	997	1295	1574	12272	kWh
Sum spec. heat losses	30,0	26,3	25,6	20,6	16,3	12,3	11,3	11,8	14,5	19,9	24,2	28,6	241,4	kWh/m²
Solar load North	29	43	75	106	143	158	158	126	86	52	29	20	1024	kWh
Solar load East	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Solar load South	100	204	228	287	294	263	277	298	277	218	111	73	2630	kWh
Solar load West	4	7	12	17	22	21	22	19	14	9	4	3	154	kWh
Solar load Horiz.	0	0	0	0	0	0	0	0	0	0	0	0	0	kWh
Solar load Opaque	21	41	62	97	125	125	128	111	80	49	24	15	877	kWh
Internal heat gains	281	254	281	272	281	272	281	281	272	281	272	281	3308	kWh
Sum spec. loads solar + internal	2,8	3,5	4,2	5,0	5,5	5,4	5,5	5,4	4,7	3,9	2,8	2,5	51,2	kWh/m²
Utilisation factor losses	9%	13%	16%	24%	34%	44%	48%	45%	32%	20%	12%	9%	21%	
Useful cooling energy demand	0	0	0	0	0	0	16	0	0	0	0	0	16	kWh
Spec. cooling demand	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,1**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,1**	kWh/m²
Specif. dehumidification demand	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	kWh/m²
Sensible fraction	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	



Cooling: energy value for useful cooling energy

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

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

Building type:	Row house		Treated floor area A_{TFA}:	156,0	m²
Interior temperature summer:	25	°C	Building volume:	390	m³
Nominal humidity:	12	g/kg	Internal humidity sources:	1,9	g/(m²h)
Spec. capacity:	204	Wh/(m²K)			

Building assembly	Temperature zone	Area m²		U-Value W/(m²K)		Mon. red. fac.		G_t kKh/a		kWh/a	per m² treated floor area
External wall - Ambient	A	184,3	*	0,145	*	1,00	*	2	=	62	0,40
External wall - Ground	B		*		*	1,00	*		=		
Roof/Ceiling - Ambient	A	83,4	*	0,140	*	1,00	*	2	=	27	0,17
Floor slab / Basement ceiling	B	80,9	*	0,257	*	1,00	*	4	=	91	0,58
	A		*		*	1,00	*		=		
	A		*		*	1,00	*		=		
	X		*		*	0,00	*		=		
Windows	A	43,5	*	0,778	*	1,00	*	2	=	78	0,50
Exterior door	A		*		*	1,00	*		=		
Exterior TB (length/m)	A	116,9	*	-0,030	*	1,00	*	2	=	-8	-0,05
Perimeter TB (length/m)	P		*		*	1,00	*		=		0,00
Ground TB (length/m)	B	11,4	*	0,061	*	1,00	*	4	=	3	0,02
											kWh/(m²a)
Transmission losses Q_T (negative: heat loads)									Total	253	1,6

Summer ventilation

from 'SummVent' worksheet

Ventilation conductance, vent. unit

exterior $H_{V,e}$	0,5	W/K
without HR	2,7	W/K
ground $H_{V,g}$	6,5	W/K
without HR	35,9	W/K

Ventilation conductance, others

exterior	56,1	W/K

Ventilation parameter

Temperature amplitude summer	11,7	K
Minimum acceptable indoor temperature	22,0	°C
Heat capacity air	0,33	Wh/(m³K)
Supply air changes	0,30	1/h
Outdoor air changes	0,44	1/h
Window night vent. air change rate, manual @ 1K	0,15	1/h
Air changes rate due to mech., autom. controlled vent.	0,30	1/h
Specific power consumption for	0,40	Wh/m³
η_{HR}	82%	
η_{ERV}	0%	
η^*_{SHX}	93%	

Summer ventilation regulation

	HRV/ERV in summer
None	x
Controlled by temp.	
Controlled by enthalpy	
Always	
	Additional ventilation
Controlled by temp.	x
Controlled by humidity	

	$n_{V,system}$ 1/h		η^*_{SHX}		η_{HR} (considers bypass)		$n_{V,Rest}$ 1/h		$n_{V,equi,fraction}$ 1/h
Hygienic air change									
Effective air change rate Ambient $n_{V,e}$	0,300	*(1-	93%	)*(1-	0,00	)+	0,436	=	0,457
Effective air change rate Ground $n_{V,g}$	0,300	*	93%	*(1-	0,00	)		=	0,279

	V_V m³		$n_{V,equi,fraction}$ 1/h		c_{Air} Wh/(m³K)		G_t kKh/a		kWh/a	kWh/(m²a)
Ventilation losses ambient Q_V	390	*	0,457	*	0,33	*	2	=	123	0,8
Ventilation losses ground $Q_{V,e}$	390	*	0,279	*	0,33	*	6	=	220	1,4
Heat losses summer ventilation	390	*	0,468	*	0,33	*	3	=	180	1,2
Ventilation heat losses Q_V								Total	523	3,4

	Q_T kWh/a		Q_V kWh/a		kWh/a	kWh/(m²a)
Total heat losses Q_L	253	+	523	=	776	**5,0**

Orientation of the area	Reduction factor		g-Value (perp. radiation)		Area m²		Global radiation kWh/(m²a)		kWh/a
North	0,52	*	0,50	*	11,0	*	34	=	97
East	0,40	*	0,00	*	0,0	*	55	=	0
South	0,23	*	0,50	*	30,4	*	57	=	198
West	0,26	*	0,50	*	2,0	*	55	=	15
Horizontal	0,40	*	0,00	*	0,0	*	99	=	0
Sum opaque areas									86
									kWh/(m²a)
Available solar heat gains Q_S								Total	396	2,5

	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	*	17	*	2,4	*	156,0	=	154	1,0

			kWh/a	kWh/(m²a)
Sum heat loads Q_F	Q_S + Q_I	=	550	**3,5**
Ratio of losses to free heat gains	Q_L / Q_F	=	1,41	
Utilisation factor heat losses η_G		=	69%	
Useful heat losses $Q_{V,n}$	η_G * Q_L	=	533	**3,4**
Useful cooling demand Q_K	Q_F - $Q_{V,n}$	=	16	**0**

	kWh/(m²*a)	(Yes/No)
Recommended maximum value	15	**Requirement met?** Yes

Compressor - cooling units

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Building type:	Row house		Treated floor area A_{TFA}:	156,0	m²
Interior temperature summer:	25,0	°C	Mechanical cooling:	x	
Nominal humidity:	12,0	g/kg	Air change rate via ventilation system with supply air:	0,3	
Internal humidity sources:	1,9	g/(m²h)			

[x] Supply air cooling
check as appropriate

On/Off mode (check as appropriate)	x	
Max. cooling capacity (sensible + latent)	2,1	kW
Temperature reduction dry	52,8	K
Seasonal energy efficiency ratio	3,2	

[ ] Recirculation cooling
check as appropriate

On/Off mode (check as appropriate)		
Max. cooling capacity (sensible + latent)	0,0	kW
Volume flow rate at nominal power	0,0	m³/h
Temperature reduction dry		K
Variable air volume (check if appropriate)		
Seasonal energy efficiency ratio	1,0	

[x] Additional dehumidification
check as appropriate

Waste heat to room (check if appropriate)	x
Seasonal energy efficiency ratio	2,6

[ ] Panel cooling
check as appropriate

Seasonal energy efficiency ratio	1,0

	Sensible kWh/(m²a)		Latent kWh/(m²a)		COP		Electricity demand (kWh/a) kWh/(m²a)	Sensible fraction
Useful cooling total	0,1		0,0					100%
Cooling contribution by:								
Supply air cooling	(0,1	+	0,0	) /	3,2	=	0,0	93%
Recirculation cooling	(	+		) /	1,0	=		
Dehumidification			0,0	/		=	0,0	0%
Remaining for panel cooling				/	1,0	=		100%
Cooling distribution				/	3,2	=		100%
Total	(**0,1**	+	**0,0**	) /	3,2	=	**0,0**	93%

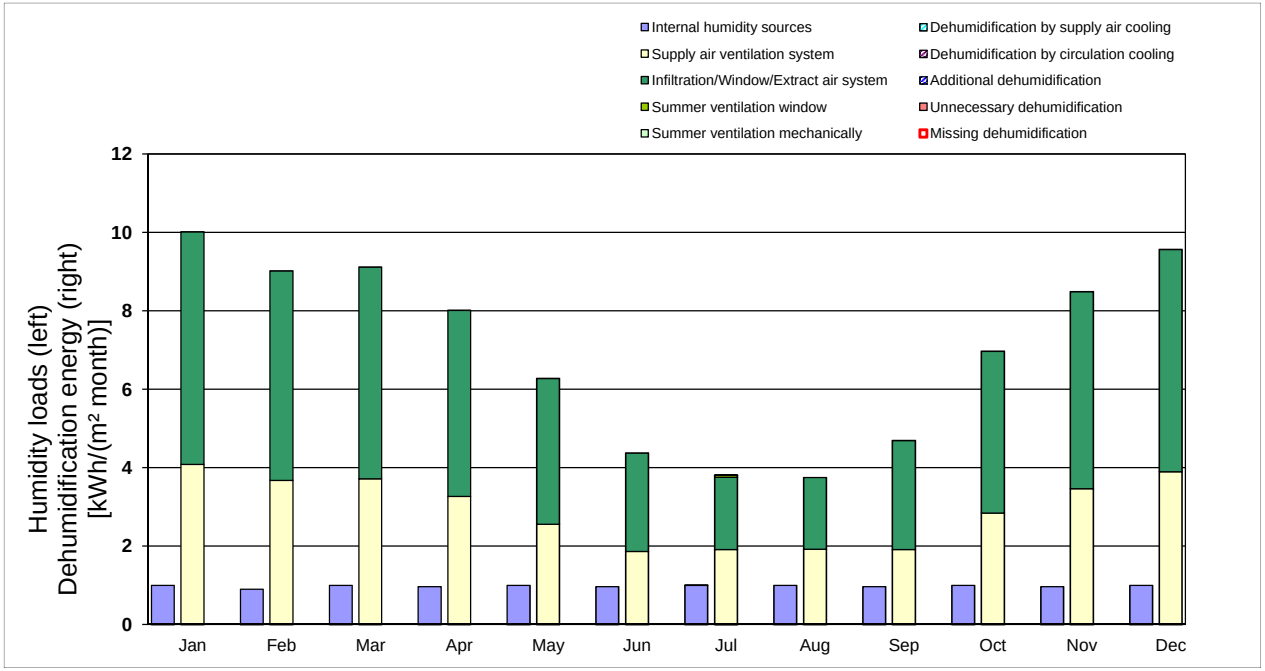
			(Yes/No)
Unsatisfied demand	0,0	0,0	**Cooling demand covered?** **Yes**

Compressor - cooling units

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Humidity loads and humidity removal

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Internal humidity sources	1,0	0,9	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	12	kWh/m²
Infiltration/Window/Extract air system	-5,9	-5,3	-5,4	-4,7	-3,7	-2,5	-1,8	-1,8	-2,8	-4,1	-5,0	-5,7	-49	kWh/m²
Supply air ventilation system	-4,1	-3,7	-3,7	-3,3	-2,6	-1,9	-1,9	-1,9	-1,9	-2,8	-3,5	-3,9	-35	kWh/m²
Summer ventilation window	0,0	0,0	0,0	0,0	0,0	0,0	-0,1	0,0	0,0	0,0	0,0	0,0	0	kWh/m²
Summer ventilation mechanically	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0	kWh/m²
Total humidity load	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0	kWh/m²
Dehumidification by supply air cooling	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0	kWh/m²
Dehumidification by circulation cooling	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0	kWh/m²
Additional dehumidification	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0	kWh/m²
Total dehumidification	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0	
Unnecessary dehumidification	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0	kWh/m²
Missing dehumidification	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0	kWh/m²



Cooling load

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Building type: Row house

Treated floor area A_{TFA}: 156,0 m²
Building volume: 390 m³
Interior temperature: 25 °C

Spec. capacity: 204 Wh/(m²K)
Nominal humidity: 12,0 g/kg
Internal humidity sources: 1,9 g/(m²h)

Temperature:	Outdoor air		Dew point		Sky	
Weather 1:	24,0	°C	15,9	°C	13,1	°C
Weather 2:	24,0	°C	15,9	°C	15,9	°C
Ground design temp.	14,7	°C		SHX	10,0	°C

Radiation:	North	East	South	West	Horizontal	
	100	180	200	180	330	W/m²
	100	180	200	180	330	W/m²

Building assembly	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
External wall - Ambient	A	184,3	*	0,145	*	1,00	*	-1,0	or	-1,0	=	-27	or	-27
External wall - Ground	B		*		*	1,00	*	-10,3	or	-10,3	=		or	
Roof/Ceiling - Ambient	A	83,4	*	0,140	*	1,00	*	-1,0	or	-1,0	=	-12	or	-12
Floor slab / Basement ceiling	B	80,9	*	0,257	*	1,00	*	-10,3	or	-10,3	=	-214	or	-214
	A		*		*	1,00	*	-1,0	or	-1,0	=		or	
	A		*		*	1,00	*	-1,0	or	-1,0	=		or	
	X		*		*	0,00	*	-1,0	or	-1,0	=		or	
Windows	A	43,5	*	0,778	*	1,00	*	-1,0	or	-1,0	=	-34	or	-34
Exterior door	A		*		*	1,00	*	-1,0	or	-1,0	=		or	
Exterior TB (length/m)	A	116,9	*	-0,030	*	1,00	*	-1,0	or	-1,0	=	3	or	3
Perimeter TB (length/m)	P		*		*	1,00	*	-10,3	or	-10,3	=		or	
Ground TB (length/m)	B	11,4	*	0,061	*	1,00	*	-10,3	or	-10,3	=	-7	or	-7
Building element towards neighbour	I	100,9	*	0,375	*	1,00	*	3,0	or	3,0	=	114	or	114
Radiation correction outdoor air				$L_{ambient}$ W/K		-5,5	*	-1,0	or	-1,0	=	5	or	5
Radiation correction sky				L_{Sky} W/K		5,4	*	-11,9	or	-9,1	=	-65	or	-49
Transmission heat load P_T										Total	=	**-236**	or	**-220**

	V_V m³		$n_{V,equi,fraction}$ 1/h		$n_{V,equi,fraction}$ 1/h		c_{Air} Wh/(m³K)		TempDiff 1 K		TempDiff 2 K		P_V 1 W		P_V 2 W
Ventilation load															
Exterior $P_{V,e}$	390	*	0,457	or	0,457	*	0,33	*	-1,0	or	-1,0	=	-59	or	-59
Ground $P_{L,e}$	390	*	0,279	or	0,279	*	0,33	*	-15,0	or	-15,0	=	-539	or	-539
Summer ventilation $P_{L,S}$	390	*	0,317	or	0,317	*	0,33	*	-4,5	or	-4,5	=	-184	or	-184
Ventilation heat load P_V												Total	**-782**	or	**-782**

Orientation of the area	Area m²		g-Value (perp. radiation)		Reduction factor (see 'Windows' worksheet)		Radiation 1 W/m²		Radiation 2 W/m²		P_T 1 W		P_T 2 W
North	11,0	*	0,5	*	0,52	*	100	or	100	=	287	or	287
East	0,0	*	0,0	*	0,40	*	180	or	180	=	0	or	0
South	30,4	*	0,5	*	0,20	*	200	or	200	=	604	or	604
West	2,0	*	0,5	*	0,20	*	180	or	180	=	37	or	37
Horizontal	0,0	*	0,0	*	0,40	*	330	or	330	=	0	or	0
Sum opaque areas											281	or	281
Solar load P_S										Total	**1209**	or	**1209**

	Spec. power W/m²		A_{TFA} m²		P_I 1 W		P_I 2 W
Internal heating load P_I	2,4	*	156	=	**378**	or	**378**

$P_T + P_V + P_S + P_I$	=	**569**	or	**585**
Cooling load P_C	=		**585**	**W**
Area specific cooling load P_C / A_{TFA}	=		**3,7**	**W/m²**

		°C		°C
Please enter the minimum supply air temperature. 3 °C — Supply air temperature without cooling $\vartheta_{Supply,Min}$		11,0		11,0
		W		W
For comparison: cooling load, transportable through the supply air $P_{Supply;Max}$	=	**308**		**308**
		W/m²		W/m²
	specific:	2,0		2,0

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

Daily internal temperature stroke

	Transmission W		Ventilation W		Solar load W		Time h/d		Spec. capacity Wh/(m²K)		A_{TFA} m²		
	(-220,0	+	-782,1	+	1209,0	) *	24	/ (	204	*	156	) =	**0,2** K

Dehumidific. load

from 'Cooling' worksheet

Absolute humidity exterior air	11,3	or	11,3	g/kg	Absolute humid. supply air	8,1	or	8,1	g/kg
Outdoor air mass flow	201	or	201	kg/h	Supply air mass flow	138	or	138	kg/h
Summer vent. air mass flow	152	or	152	kg/h	**Humid. load, supply air**	-532	or	-532	g/h
Humidity load, outdoor air	-240	or	-240	g/h	**Humidity load, internal**	295	or	295	g/h

	Enthalpy of vaporisation Wh/kg		g/kg		Humidity load g/h		Humidity load g/h		P_D 1 W		P_D 2 W
	707,639	/	1000	*	-477	or	-477	=	**0**	or	**0**
Dehumidification load P_T								=		**0**	**W**
Area specific dehumidification load P_T / A_{TFA}								=		**0,0**	**W/m²**

Monthly average values

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Specific cooling demand	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	kWh/m²
Specific dehumidification demand	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	kWh/m²
Sensible fraction	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	

Minimum of sensible cooling load fraction occurred **100%**

Heat distribution and domestic hot water (DHW) system

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Interior temperature:	20	°C	Interior temperature summer:	25	°C
Building type:	Row house				
Treated floor area A_{TFA}:	156	m²			
Occupancy:	2,9	Pers			
Number of dwelling units:	1				
Annual heating demand $q_{Heating}$	3166	kWh/a	Annual useful cooling dem. q_{Cool}	16	kWh/a
Length of heating period:	219	d	Length cooling period:	17	d
Average heating load P_{ave}:	0,6	kW	Average cooling load $P_{Average}$:	0,0	kW
Marginal usability of additional heat gains:	84%		Marginal utility of additional heat losses:	14%	

Space heat distribution

			Inside thermal envelope					Outside thermal envelope					Total values	
			1	2	3	4	5	1	2	3	4	5	Absolute	Specific
Length of distribution pipes	L_H	m	13,5											
Nominal width of pipe		mm	20											
Insulation thickness		mm	40											
Insulation reflective coating?		-												
Thermal conductivity of insulation		W/(mK)	0,035											
Heat loss coefficient per m of insulated pipe		W/(mK)	0,135											
Insulation quality of mountings, pipe suspensions, etc.		-	3 - Good											
Thermal bridge supplement		W/K	0,208											
Total heating loss coefficient per m of pipe	Ψ	W/(mK)	0,150											
Temp. of the room through which the pipes pass	ϑ_X	°C	20	20	20	20	20	11,0	11,0	11,0	11,0	11,0		
Design forward flow temperature	ϑ_V	°C	55,0	55,0	55,0	55,0	55,0	55,0	55,0	55,0	55,0	55,0		
Design system heating load	$P_{heating}$	kW	2,4	2,4	2,4	2,4	2,4	2,4	2,4	2,4	2,4	2,4		
Forward flow temperature control ('x' if appropriate)			x	x	x	x	x	x	x	x	x	x		
Design return flow temperature	ϑ_R	°C	45,0											
Annual heat emission per m of plumbing	q^*_{HL}	kWh/(m·a)	8											
Possible utilisation factor of released heat	η_G	-	84%											
Annual heat losses of heating distribution	Q_{HL}	kWh/a	**18**										kWh/a: **18**	kWh/(m²a): **0,1**
Annual heat losses of heating storage		kWh/a											**0**	**0,0**
Annual heat losses of heating		kWh/a											**18**	**0,1**
Performance ratio of heat distribution	$ea_{,HL}$	-											**101%**	

DHW useful heat

DHW demand for showers, per person and day (with 60°C)		litre/person/d	16,0
DHW demand others, per person and day (with 60°C)		litre/person/d	9,0
Performance of shower drain-water heat recovery		-	0%
Effective DHW demand	V_{DHW}	litre/person/d	25
Average cold water temperature of the supply	ϑ_{TW}	°C	10,0
DHW demand for washing machines and dishwashers non-elec		kWh/a	213
Effective useful heat DHW	Q_{DHW}	kWh/a	1774

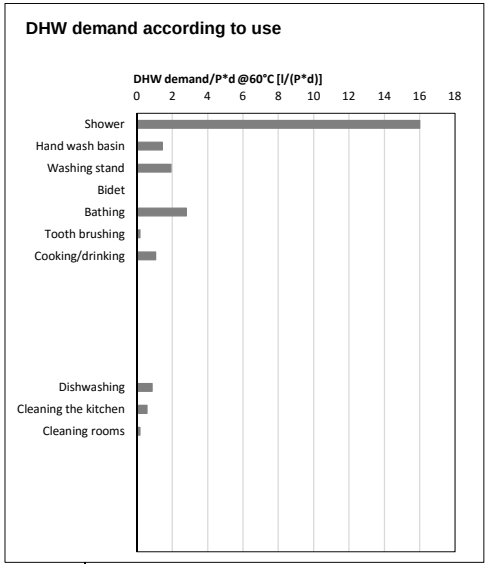
kWh/a	kWh/(m²a)
1774	11,4

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

Days of use per year [d/a]: 365

	l/(P*d) at 60 °C
DHW demand for showering:	16,0
DHW demand for other uses:	9,0

Application		Used?	Single-lever mixer?	Time of use per use	Amount of uses according to type of use	Flow rate	Useful temperature	Equivalent average amount of water @ 60°C	Equivalent average amount of water @ 60°C	Useful heat @ 60°C
		-	-	min	-	l/min	°C	l/(WE*d)	l/(P*d)	kWh/a
Shower	Per person	x	x	5,0	0,7	8,0	38	47	16	1003
Hand wash basin	Per person	x	x	0,3	3,0	4,0	30	4	1	90
Washing stand	Per person	x	x	1,0	0,4	8,0	38	6	2	120
Bidet	Per person		x	1,0	0,1	8,0	38			
Bathing	Per person	x	x	10,0	0,0	15,0	38	8	3	176
Tooth brushing	Per person	x	x	0,1	2,0	4,0	30	0	0	10
Cooking/drinking	Per person	x	x	0,3	1,0	6,0	45	3	1	66
	Per person		N/A							
	Per person		N/A							
	Per person		N/A							
	Per person		N/A							
	Per person		N/A							
Dishwashing	Per time of use	x	x	0,6	1,0	6,0	45	3	1	54
Cleaning the kitchen	Per time of use	x	x	0,5	1,0	6,0	38	2	1	36
Cleaning rooms	Per time of use	x	x	1,0	0,1	6,0	38	0	0	10
	Per time of use		N/A							
	Per time of use		N/A							
	Per time of use		N/A							
	Per time of use		N/A							
	Per time of use		N/A							



Auxiliary calculation - shower drain-water heat recovery

Steady-state operation			1-Sorting: AS LIST		
Selection heat recovery				Heat recovery DHW	
Nominal efficiency of heat exchanger	η_0				
Nominal flow rate		l/min			
Flow rate shower		l/min	**8,0**		
Connexion to DHW			**x**		
Connexion to cold water			**x**		
Forward flow temperature DHW	T_{DHW}	°C	**60**		
Temperature cold water	T_{CW}	°C	**10**		
Room temperature	T_{Room}	°C	**20**		
Temperature DHW use	T_{DW}	°C	40		
Temperature drain water	T_{Drain}	°C	35		
Temperature proportion of heat exchanger			-		
Forward flow temperature after heat exchanger		°C	-		
Steady-state efficiency of the system		-	0%		
Dynamic					
Duration of shower		min	**5,0**		
Eff. time of non-use for HR		s	**0**		
Eff. time of non-use for bathtub shower		s	10		
Drain water pipes for HR					
Horizontal pipe length		m	**0,00**		
Flow velocity		m/s	0,3		
Eff. time of non-use		s	0		
Fresh water pipes after HR			To HW & CW	Only to HW	Only to CW
Length of pipe		m	**1,0**	**1,0**	**1,0**
Exterior pipe diameter		m	**0,030**	**0,030**	**0,030**
Flow rate during non-use time		l/min	8,0	4,0	4,0
Effective time of non-use		s	5	9	9
Total of non-use time until branch of CW/HW		s	15		
Time of non-use CW-HW		s	0,0		
Time of non-use CW-HW		s	0,0		
Dynamic efficiency of system			**0%**		

DHW distribution

			Inside thermal envelope					Outside thermal envelope					Total values	
			1	2	3	4	5	1	2	3	4	5	Absolute	Specific
Temp. of room through which the pipes pass	ϑ_X	°C	20,0	20,0	20,0	20,0	20,0	**11,0**	11,0	11,0	11,0	11,0		
Design forward flow temperature	ϑ_{dist}	°C	**60,0**	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0	60,0		
DHW circulation pipes														
Length of circulation pipes (forward + return flow)	L_{HS}	m	**13,5**					**2,00**						
Nominal width of pipe		mm	**20**					**20**						
Insulation thickness		mm	**40**					**40**						
Insulation reflective coating?		-												
Thermal conductivity of insulation		W/(mK)	**0,035**					**0,035**						
Heat loss coefficient per m of insulated pipe		W/(mK)	0,135					0,135						
Insulation quality of mountings, pipe suspensions, etc.		-	**3 - Good**					**3 - Good**						
Thermal bridge supplement		W/K	0,208					0,150						
Total heating loss coefficient per m of pipe	Ψ	W/(mK)	**0,150**					**0,210**						
Daily circulation period of operation.	td_{Circ}	h/d	**18,0**					**18,0**						
Design return flow temperature	ϑ_R	°C	55					55						
Circulation period of operation per year	t_{Circ}	h/a	6570					6570						
Annual heat released per m of pipe	q^*_Z	kWh/m/a	37					64						
Annual heat loss from circulation lines	QZ	kWh/a	**499**					**128**					kWh/a: **627**	kWh/(m²a): **4,0**
DHW individual pipes														
Exterior pipe diameter	d_{U_Pipe}	m	**0,012**											
Accumulated length per single pipes	L_U	m	**9,00**											
Amount of tapping points in building	$n_{tapping\ poin}$	-	**3,00**											
Average pipe length per tapping point	$L_{U,\ average}$	m	3,0											
Tap openings per person per day		-	**6**											
Utilisation days per year		d	**365**											
Heat loss per tap opening	$q_{Individual}$	'h/tap opening	0,0107											
Amount of tap openings per year and person	n_{Tap}	nings per year	2190											
Annual heat loss of individual pipes	Q_U	kWh/a	**69**										kWh/a: **69**	kWh/(m²a): **0,4**
Total heat losses of DHW distribution	Q_{WL}												kWh/a: **697**	kWh/(m²a): **4,5**
Performance ratio of DHW distribution pipes	$ea_{,HL}$	-											**139%**	

Storage heat losses

		Storage 1	Storage 2	Buffer storage tank (only heating)	Compact unit
Selection of storage tank		1-DHW and heating	0-No storage tank	0-No storage tank	0-No
Storage necessary for HP		x		(x)	
Solar DHW connection		x			
Heat loss rate	W/K	3,0		3,0	
Storage volume	litre	700	0		---
Standby fraction	-	30%			
Location of storage tank, inside or outside of thermal envelope		2-Outside	2-Outside	2-Outside	
Temperature of mechanical room	°C	11,0			
Typical storage tank temperature	°C	60,0			
Manual entry of storage temperature	°C				
Average standby heat losses storage tank	W	44			
Additional heat losses storage tank, solar operation	W	103		---	---
Possibly utilisation factor of heat losses		---	---		---
Annual heat losses DHW storage tank	kWh/a	1288		---	
Annual heat losses buffer storage tank		---	---		---

	kWh/a	kWh/(m²a)
	1288	8,3

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

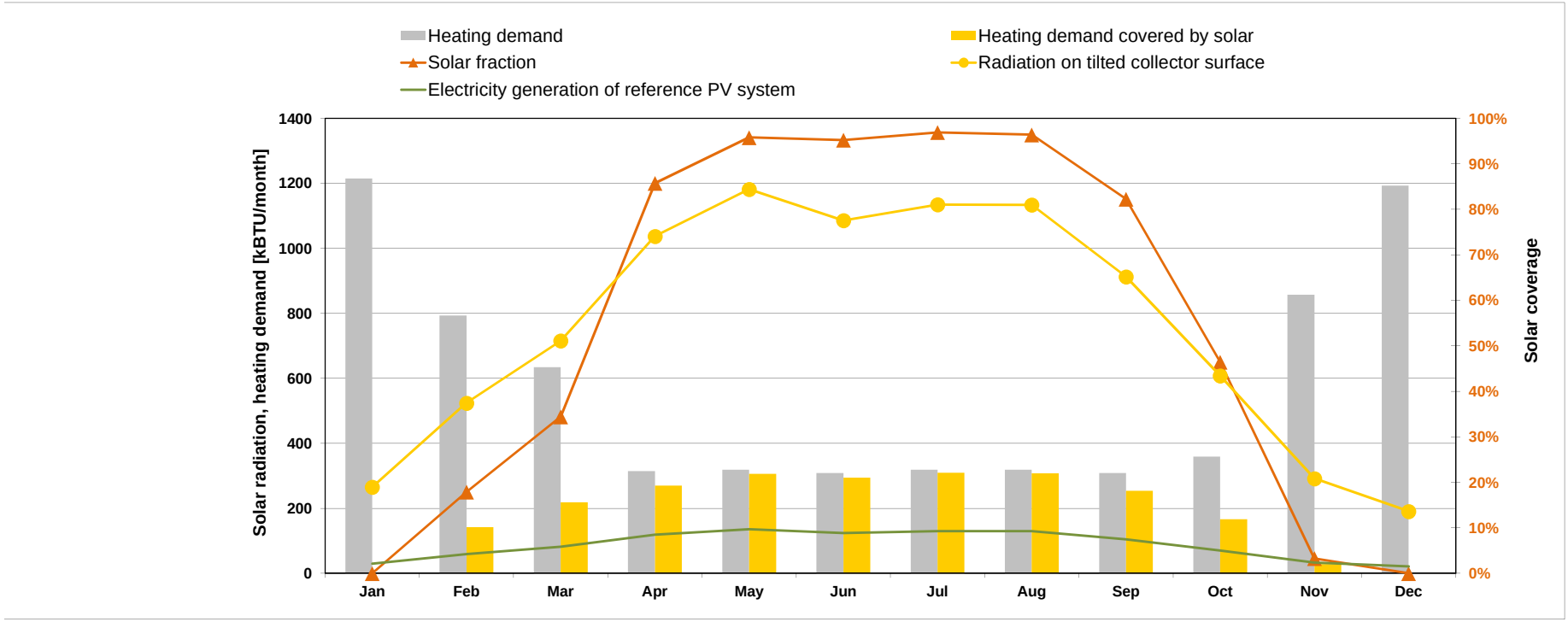
Storage tank volume	Litre	400,0		
ErP classification	-	C	C	C
Maximum permissible standby heat loss	W	108		
Heat loss ratio for PHPP calculation	W/K	2,4		

Total energy demand of domestic hot water

		kWh/a	kWh/(m²a)
Heat losses of DHW distribution and storage	Q_{WL}	1984	12,7
Performance ratio DHW-distribution + storage	$e_{a,WL}$	212%	
Total heating demand of DHW system		kWh/a	kWh/(m²a)
Including storage tank	Q_{gDHW}	3758	24,1

Cooling distribution

			Inside thermal envelope					Outside thermal envelope					Total values	
			1	2	3	4	5	1	2	3	4	5	Absolute	Specific
Length of distribution pipes	L_H	m												
Nominal width of pipe		mm												
Insulation thickness		mm												
Insulation reflective coating?		-												
Thermal conductivity of insulation		W/(mK)												
Heat loss coefficient per m pipe	Ψ	W/(mK)												
Temp. of room through which the pipes pass	ϑ_X	°C	25,0	25,0	25,0	25,0	25,0	**25,0**	25,0	25,0	25,0	25,0		
Design forward flow temperature	ϑ_V	°C												
Dimensioning of cooling load of the system	$P_{cooling}$	kW												
Forward flow temperature control ('x' if appropriate)														
Design return flow temperature	ϑ_R	°C												
Annual heat absorption per m of pipe	q^*_{HL}	kWh/(m·a)												
Possibly utilisation factor of this heat absorption	η_G	-												
Annual heat losses of cooling distribution	Q_{HL}	kWh/a											kWh/a **0**	kWh/(m²a) **0,0**
Performance ratio cold water distribution pipes	$ea_{,HL}$	-											**100%**	



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	
Heating demand DHW-preparation	319	288	319	309	319	309	319	319	309	319	309	319	3758	kWh/month
Space heating demand	896	505	316	6	0	0	0	0	0	40	548	874	3184	kWh/month
Heating demand	1215	793	635	315	319	309	319	319	309	359	857	1193	6942	kWh/month
Radiation on tilted collector surface	266	524	716	1037	1182	1086	1135	1134	913	608	292	191	9084	kWh/month
Please enter: Solar production for DHW													0	kWh/month
Please enter: Solar production for heating													0	kWh/month
DHW heating demand covered by solar	0	7	37	264	306	294	309	308	254	127	0	0	1906	kWh/month
Space heating demand covered by solar	0	134	182	6	0	0	0	0	0	40	28	0	390	kWh/month
Heating demand covered by solar	0	142	219	270	306	294	309	308	254	167	28	0	2297	kWh/month
Solar fraction	0%	18%	34%	86%	96%	95%	97%	96%	82%	46%	3%	0%	33%	-
Electricity generation of reference PV system	30	60	82	119	136	124	130	130	105	70	33	22	1039	kWh/month

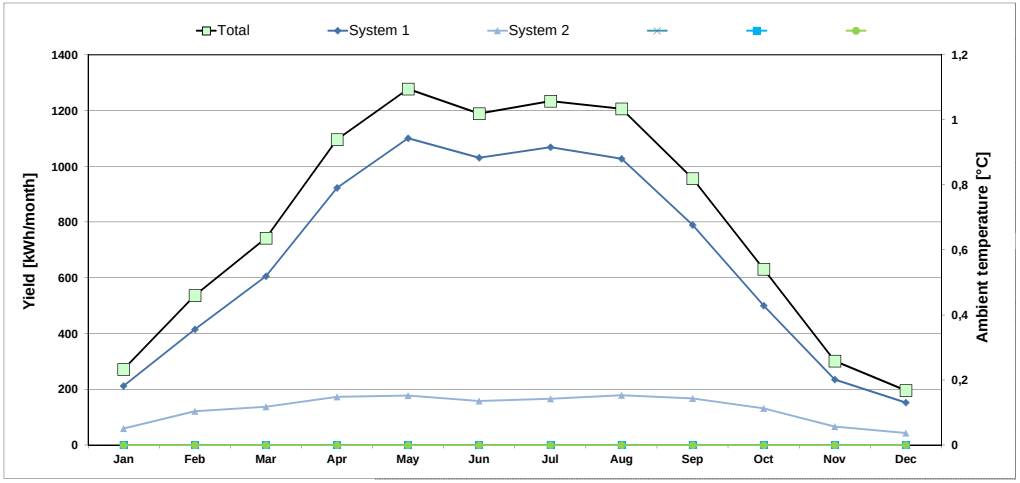
Photovoltaic systems

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Climate data set: DE-9999-PHPP-Standard
Building type: Row house
Projected building footprint: 80,9 m²

		System 1	System 2				Reference PV syst.	
Name of system								
Location: Selection in 'Areas' worksheet		4-Roof	1-External wall south				4-Roof	
Size of selected area		83,4	43,1				83,4	m²
Deviation from North		180	180				180	°
Angle of inclination from horizontal		30	90				45	°
Alternative input: Deviation from North		180						°
Alternative input: Angle of inclination from the horizontal		30						°
Information from the module data sheet								
Technology		4-Mono-Si	5-Poly-Si				4-Mono-Si	
Nominal current	I_{MPP0}	7,71	7,71				7,71	A
Nominal voltage	U_{MPP0}	30,50	30,50				30,50	V
Nominal power	P_n	235	235	0	0	0	235	Wp
Temperature coefficient short-circuit current	α	0,040	0,040				0,040	%/K
Temperature coefficient open-circuit voltage	β	-0,340	-0,340				-0,340	%/K
Module dimensions: Height		1,658	1,658				1,658	m
Module dimensions: Width		0,994	0,994				0,994	m
							1,6	Module area [m²]
Further specifications								
Number of modules	n_M	40	14				4,9	
Height of module array		2,0	3,0				1	m
Height of horizon	h_{hori}		5,0				0	m
Horizontal distance	a_{hori}		20,0				1000,0	m
Additional reduction factor shading	f_{other}	95%	90%					
Efficiency of the inverter	η_{INV}	95%	95%				95%	
Results								
Area of module field		65,9	23,1	0,0	0,0	0,0	8,1	m²
Free area on the selected building element		9,4	20,0				9,4	m²
Allocation to building element		89%	54%				89%	
Annual losses due to shading		424	427				0	kWh

							Total	
Annual electricity yield after the inverter, absolute		8056	1579				1039	9635	kWh/a
Related to projected building footprint area		99,5	19,5				12,8	119	kWh/m²$A_{Projekt}$
CO2-equivalent emissions according to 1-CO2 factors GEMIS (Germany)		1047,3	99,5				135,1	1146,7	kg/a
PE-factor according to 1-PE factors (non-renewable) PHI Certification		0,00	0,00				0,0	0,00	kWh_{prim}/kWh



Electricity demand for residential buildings

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Households	1
Persons	2,9
Living area (m²)	156
Heating demand [kWh/(m²a)]	20,3

PER and PE factors (KWh/kWh)		
Electricity:	1,30	1,8
Non-electric energy carrier for cooking, drying:	1,30	1,8
Energy carrier for heating:	1,19	1,5
Energy carrier for DHW:	0,59	0,5

Solar fraction of DHW Laundry&Dish	30%
Marginal performance ratio DHW	0%
Marginal performance ratio Heating	0%

Column no.	1	2	3			4		5		6			7		8	8a		9		10		11		12		13
Application	Used ? (1/0)	Within the thermal envelope? (1/0)	Norm demand			Utilisation factor		Frequency		Reference quantity			Useful energy (kWh/a)		Electric fraction	Non-electric fraction		**Electricity demand (kWh/a)**		Additional demand		Marginal performance ratio		Solar fraction		Non-electric demand (kWh/a)
Dishwashing	1	1	1,10	kWh/Use		* 1,00	*	65	/(P*a)	* 2,9	P	=	211	*	50%		=	105								
1-DHW connection														*		50%			* (1+	0,30	) *	0,00	*(1-	0,30	) =	0
Clothes washing	1	1	0,95	kWh/Use		* 1,00	*	57	/(P*a)	* 2,9	P	=	160	*	55%		=	88								
1-DHW connection														*		45%			* (1+	0,05	) *	0,00	*(1-	0,30	) =	0
Clothes drying with:	1	0	2,00	kWh/Use	Residual dampness	0,88	*	57	/(P*a)	* 2,9	P	=	0		0%		=	0								
1-Clothes line					0,60							=	0			0%						1,00	*			0
Energy consumed by evaporation	1	0	0,00	kWh/Use		* 0,60	*	57	/(P*a)	* 2,9	P	=	0	*		100%			* (1+	0,00	) *	0,00	*(1-	0,67	) =	0
Refrigerating	1	1	0,28	kWh/d		* 1,00	*	365	d/a	* 1	HH	=	102	*	100%		=	102								
Freezing	1	0	0,55	kWh/d		* 0,90	*	365	d/a	* 1	HH	=	181	*	100%		=	181								
or combination	0	1	0,70	kWh/d		* 1,00	*	365	d/a	* 1	HH	=	0	*	100%		=	0								
Cooking with:	1	1	0,25	kWh/Use		* 1,00	*	500	/(P*a)	* 2,9	P	=	369	*	100%		=	369								
1-Electricity					Average lamp efficiency [lm/W]									*		0%										0
Lighting	1	1	14	W	50	* 1,00	*	2,90	kh/(P*a	* 2,9	P	=	123	*	100%		=	123								
Consumer electronics	1	1	80	W		* 1,00	*	0,55	kh/(P*a	* 2,9	P	=	130	*	100%		=	130								
Small appliances, etc.	1	1	50	kWh		* 1,00	*	1,00	/(P*a)	* 2,9	P	=	147	*	100%		=	147								
Total aux. electricity													646					646								
Other:																										
				kWh/a									0					0								
				kWh/a									0					0								
				kWh/a									0					0								
Total													2069	kWh				1892	kWh			213	kWh			0
																		DHW Non-Electric - Wash&Dish								
Specific demand																		12,1	kWh/(m²a)			1,0	kWh/(m²a)			0,0
																		Non-Renewable Non-Electric DHW Wash&Dish								
Recommended maximum value																		18								

Aux Electricity

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Treated floor area	156	m²
Heating period	219	d
Air volume	390	m³
Dwelling units	1	HH

Heat recovery efficiency ventilation unit	0,82	
Operation vent. system Winter	5,25	kh/a
Operation vent. system Summer	3,51	kh/a
Air change rate	0,30	h⁻¹

Annual space heating demand	20	kWh/(m²a)
Boiler rated power	15	kW
DHW system heating demand	3758	kWh/a
Design forward flow temperature	55	°C

Column no.	1	2	3		4		5		6		7		8		9		10	11
Application	Existing [1/0]	Within the thermal envelope [1/0]	Norm demand		Utilisation factor		Period of operation		Reference size		Electricity demand [kWh/a]		Available as interior heat		Utilisation period [h/a]		Internal heat gains winter [W]	Internal heat gains summer [W]
Ventilation system																		
Winter ventilation	1		0,40	Wh/m³ *	0,30	h⁻¹ *	5,3	kh/a *	390	m³ =	246		considered in heat recovery efficiency					
Defroster HX	1	1	Data entries in 'Ventilation' worksheet or in 'Addl vent'								52	*	0,2	/	5,25	=	2	
Summer ventilation	1	0,55	0,40	Wh/m³ *	0,30	h⁻¹ *	3,5	kh/a *	390	m³ =	164	*	1,0	/	3,51	=		26
																	Internal heat sources ' Additional summer ventilation'	0,1
Additional vent. summer	1	0,55	0,40	Wh/m³ *	0,00	h⁻¹ *	3,5	kh/a *	390	m³ =	1	*	1,0	/	3,51	=		
Heating system				Controlled / non controlled [1/0]														
Enter the rated power of the pump			21	W	1													
Circulator pump heating	1	0	21	W *	0,8	*	5,3	kh/a *	1	=	85	*	1,0	/	5,25	=	0	
Boiler electricity consumption at 30% load				W														
Aux. energy - Heat. boiler	0	0	55	W *	1,00	*	0,00	kh/a *	1	=	0	*	1,0	/	5,25	=	0	
Aux. energy - Wood fired/Pellet boiler	0	0	Data entries in 'Boiler' worksheet. Aux. energy demand including possible drinking water production.								0	*	1,0	/	5,25	=	0	
DHW system																		
Enter average power consumption of pump			6	W														
Circulation pump DHW	1	0	6	W *	1,00	*	4,8	kh/a *	1	=	29	*	1,0	/	8,76	=	0	0
Enter the rated power of the pump				W														
Storage load pump DHW	0		56	W *	1,00	*	0,3	kh/a *	1	=	0	*	1,0	/	8,76	=	0	0
Boiler electricity consumption at 100% load				W														
DHW boiler aux. energy	0	0	165	W *	1,00	*	0,0	kh/a *	1	=	0	*	1,0	/	8,76	=	0	0
Enter the rated power of the solar DHW pump				W														
Solar aux. electricity	1	1	40	W *	1,00	*	1,8	kh/a *	1	=	70	*	1,0	/	8,76	=	8	8
Aux. electricity cooling and dehumidification																		
Aux. electricity cooling	0	0		kWh/a *	1,00	*	1,0	*	1	=	0	*	1,0	/	3,51	=		0
Aux. electricity dehum.	0	0		kWh/a *	1,00	*	1,0	*	1	=	0	*	1,0	/	3,51	=		0
Misc. aux. electricity																		
Misc. aux. electricity	0	0	30	kWh/a *	1,00	*	1,0	*	1	=	0	*	1,0	/	8,76	=	0	0
Total											646						10	34
Specific demand	kWh/(m²a) (treated floor area)										4,1							

Primary Energy Renewable PER

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

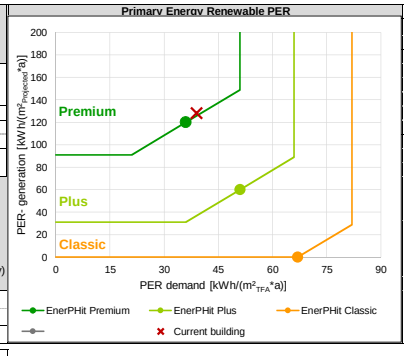
				Building type:	Row house
				Treated floor area A_{TFA}:	156 m²
Selection of heat generation system(s)	**Contribution margin (useful energy)**			Projected building footprint $A_{Projected}$:	81 m²
Primary heat generation type	**Heating**	**DHW**	**Addl. input in following worksheets**	Heating demand incl. distribution & hydr. frost protection	20 kWh/(m²a)
2-Heat pump	100%	100%	HP, possibly HP ground	Cooling energy dem. incl. dehumidification	0 kWh/(m²a)
Secondary heat generation type (optional & different)				DHW demand including distribution:	24 kWh/(m²a)
	0%	0%	-		

Energy demand	**Efficiency**		**Final energy**		**PER**			**PE**		**CO_2**	
Reference: Treated floor area	Calculation	User defined value	Contribution (final energy)	**Final energy demand**	PER factor	Effective PER factor (including biomass	**PER specific value**	PE factor	PE value	CO_2 emissions factor (CO_2-eq)	CO_2eq emissions
	-	-		kWh/(m²a)	kWh/kWh	kWh/kWh	kWh/(m²a)	kWh/kWh	kWh/(m²a)	kg/kWh	kg/(m²a)
								1-PE factors (non-renewable) PHI Certification		1-CO2 factors GEMIS (Germany)	
							38,9		45,9		14,2
Heating			100%			1,19	**17,6**	1,50	**22,1**		**6,6**
Electricity (HP compact unit)					1,80			1,80		0,532	
Electricity (heat pump)	1,82		88%	9,8	1,80	1,28	12,6	1,80	17,7	0,532	5,2
District heating: 1-None					0,85|1,39|1,01					0,000	
Wood and other biomass					1,10			-		-	
Natural gas / RE gas					1,75			1,10		0,250	
Heating oil / RE methanol					2,30			1,10		0,320	
Solar thermal system			12%	2,5	0,25	0,25	0,6	0,00	0,0	0,045	0,1126
Electricity (direct)					1,80			1,80		0,532	
Other			0%								
Aux. electricity (heating, wintertime ventilation)				2,5	1,80	1,80	4,4	1,80	4,4	0,532	1,3
Cooling and dehumidification					1,10		**1,2**		**1,9**		**0,6**
Electricity cooling (heat pump)	3,20			0,0	1,10		0,0	1,80	0,0	0,532	0,0
Auxiliary electricity cooling, ventilation summer				1,1	1,10		1,2	1,80	1,9	0,532	0,6
Electricity dehumidification (heat pump)					1,15			1,80		0,532	
Auxiliary electricity (dehumidification)					1,15			1,80		0,532	
DHW generation			100%			0,59	**9,7**	0,46	**7,5**		**2,8**
Electricity (HP compact unit)					1,30			1,80		0,532	
Electricity (heat pump)	3,35		49%	3,5	1,30	1,30	4,6	1,80	6,4	0,532	1,9
District heating: 1-None					0,85|1,39|1,01					0,000	
Wood and other biomass					1,10			-		-	
Natural gas / RE gas					1,75			1,10		0,250	
Heating oil / Methanol					2,30			1,10		0,320	
Solar thermal system			51%	12,2	0,35	0,35	4,3	0,00	0,0	0,045	0,550
Electricity (direct)					1,30			1,80		0,532	
Other			0%								
Aux. electricity (DHW + solar DHW)				0,6	1,30	1,30	0,8	1,80	1,1	0,532	0,3
Household electricity				8,0		1,30	**10,4**		**14,4**		**4,2**
Electricity (household or non-residential lighting, etc.)				8,0	1,30	1,30	10,4	1,80	14,4	0,532	4,2
Auxiliary electricity (other)					1,30			1,80		0,532	
Gas / RE gas dry/cook				0,0	1,75		**0,0**	1,80	**0,0**	0,270	**0,0**

Energy generation	**Final energy**		**PER**		**PE**		**CO_2**	
Reference: Projected building footprint area	Final energy generation	**Final energy generation**	PER factor	**PER specific value**	PE factor	PE Value	Emission factor (CO_2-eq)	CO_2eq emissions
	kWh/a	**kWh/(m²$A_{Projected}$*a)**	kWh/kWh	kWh/(m²$A_{Projected}$a)	kWh/kWh	kWh/(m²a)	kg/kWh	kg/a
				128,3		**34,1**		**1250,1**
PV electricity	9635	119,1	1,00	119,1	0,00	0,0	0,119	1146,7
Solar thermal system	2297	28,4	0,33	9,3	1,20	34,1	0,045	103,3
		0,0						

PE demand requirement in case of verification through PE (non-renewable) [kWh/(m²a)]	-	**Current building reaches following class**	46	**Requirement met?**	-

Achievable energy standard through the verification of renewable primary energy (assessment of individual aspects)	**Useful energy, performance**				**Airtightness**
	Annual heat. dem.	**Heating load**	**Useful cool. energy**	**Cooling load**	n_{50}
	Treated floor area kWh/(m²a)	Treated floor area W/m²	Treated floor area kWh/(m²a)	Treated floor area W/m²	1/h
Requirement EnerPHit Premium					
Requirement EnerPHit Plus	-		0	-	1,00
Requirement EnerPHit Classic					
Requirement					
Current building reaches following class for aspe	20	16	0	4	1,0
	Premium		Unachieved		Premium



Summary	**Final energy**	**PER specific value**	**PE value**	**CO2eq emissions**	**CO_2eq substitution balance**
Though, from the scientific point of view, not entirely correct, different energy carriers will be added together here. This is done to meet the criteria of other energy standards.			1-PE factors (non-renewable) PHI Certification	1-CO2 factors GEMIS (Germany)	1-CO2 factors GEMIS (Germany)
	MWh/a	MWh/a	MWh/a	kg/a	kg/a
Demand	**6,3**	**6,1**	7,17	2222	2222
Generation	**-11,9**	**-10,4**	-2,76	1250	-4457
Demand, cumulative generation (annual balance)	-5,65	-4,32	4,41	3472	-2235
Demand w/o household electricity	**5,0**	**4,4**	4,93	1559	1559
Demand w/o household electricity, cum. generation	-6,90	-5,94	2,17	2809	-2898

Passive House compact unit with exhaust air heat pump

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

Calculation based on measured values of the laboratory evaluation for component certification

Building type: **Row house**

Treated floor area A_{TFA}: **156** m²

				Including DHW connection for washing machines & dishwa	
Covered fraction of space heating demand	*('PER' worksheet)*	**0%**			
Space heating demand + distribution losses	Q_H+Q_{HL}: *(DHW+Distribution)*	**3184**	kWh		
Solar contribution for space heating	$\eta_{Solar,\ H}$ *('SolarDHW' worksheet)*	**12%**			
Effective annual heating demand	$Q_{H,WI}=Q_H*(1-\eta_{Solar,\ H})$	**0**	kWh		
Covered fraction of DHW demand	*('PER' worksheet)*	**0%**			
Total heating demand of DHW system	Q_{gDHW} *(DHW+Distribution)*	**3546**	kWh	**3758**	kWh
Solar contribution for DHW	$\eta_{Solar,\ DHW}$ *('SolarDHW' worksheet)*	**51%**		**51%**	
Effective DHW demand	$Q_{DHW-WI}=Q_{DHW}*(1-\eta_{Solar,\ DHW})$	**0**	kWh	**0**	kWh

1-Sorting: LIKE LIST

Compact unit selection: Go to list of compact units

Measured values from laboratory test

Ventilation

Effective heat recovery efficiency	η_{eff} *(Test stand)*		
Electric efficiency	*(Test stand)*		Wh/m³

Heating

		Test point 1	*Test point 2*	*Test point 3*	*Test point 4*	
Outdoor air temperature	T_{amb}					°C
Measured thermal power heat pump Heating	$P_{HP,Heating}$					kW
Measured COP Heating	$COP_{Heating}$					-

Domestic hot water

		Test point 1	*Test point 2*	*Test point 3*	*Test point 4*	
Outdoor air temperature	T_{amb}					°C
Measured thermal power DHW storage heating-up	$P_{DHW,Heating-Up}$					kW
Measured thermal power DHW storage reload	$P_{DHW,Reload}$					kW
Measured COP DHW storage heating-up	$COP_{DHW,Heating-Up}$					-
Measured COP DHW storage reload	$COP_{DHW,Reload}$					-

Standby (inputs required only if different from storage reload)

		Test point 1	*Test point 2*	*Test point 3*	*Test point 4*	
Outdoor air temperature	T_{amb}					°C
Measured thermal power heat pump Standby	$P_{HP,Standby}$					kW
Measured COP Standby	$COP_{Standby}$					-

0%

Specific heat loss storage incl. connections	$U * A_{Storage}$ *(Test stand)*		W/K
Average storage temperature in standby mode	$T_{DHW,Standby}$ *(Test stand)*		°C

Heat pump priority: separate heat pumps | DHW priority | Heating priority

Room temperature (°C)	**20**	
Av. ambient temp. Heating P. (°C)	**5**	
Av. Ground temp (°C)	**10**	
Efficiency SHX exhaust air mixing	η^*_{SHX}	
Heat recovery efficiency SHX exhaust air mixing (if applicable)	$\eta_{SHX,add}$ *(Design Value)*	0%
Volume flow rate of added exhaust air (if applicable)	V_{add} *(Test stand)*	m³/h
Hydraulic frost protection		

				Electricity demand	COP		
Heat supplied by direct electricity	$Q_{E,dir}$		kWh/a	#WERT!	1,00		kWh/a
Space heat supplied by HP	$Q_{HP,Heating}$		kWh/a	#WERT!	########		kWh/a
Winter DHW supplied by HP	$Q_{HP,DHW,Winter}$	0	kWh/a	#WERT!	########	0	kWh/a
Winter standby heat supplied by HP	$Q_{HP,Standby,Winter}$		kWh/a	#WERT!	########		kWh/a
Summer DHW supplied by HP	$Q_{HP,DHW,Summer}$	0	kWh/a	#WERT!	########	0	kWh/a
Summer standby heat supplied by HP	$Q_{HP,Standby,Summer}$		kWh/a	#WERT!	########		kWh/a

Performance factor of heat generator, DHW & space heating					
Seasonal performance factor	SPF_{H-3}				
		kWh/a	kWh/(m²a)	kWh/a	kWh/(m²a)
Final energy demand heat generation	Q_{final}				
Annual PE demand (non-renewable primary energy)					
		kg/a	kg/(m²a)	kg/a	kg/(m²a)
Annual CO_2-equivalent emissions					

Heat pump

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 20,3 kWh/(m²a) / Cooling: 0,1 kWh/(m²a) / PER: 38,9 kWh/(m²a)

			Building type:	Row house	
			Treated floor area A_{TFA}:	156	m²
Covered fraction of space heating demand		*('PER' worksheet)*		88%	
Space heating demand + distribution losses		Q_H+Q_{HL}: *(DHW+Distribution)*		3184	kWh/a
Solar fraction for space heat		$\eta_{Solar,\ H}$ *('SolarDHW' worksheet)*		12%	
Effective annual heating demand		$Q_{H,Wi}=Q_H*(1-\eta_{Solar,\ H})$		**2794**	kWh/a
Covered fraction of DHW demand		*('PER' worksheet)*		49%	
Total heating demand of DHW system		Q_{gDHW} *(DHW+Distribution)*		3546	kWh/a
Solar fraction for DHW		$\eta_{Solar,\ DHW}$ *('SolarDHW' worksheet)*		51%	
Effective DHW demand		$Q_{DHW,Wi}=Q_{DHW}*(1-\eta_{Solar,\ DHW})$		**1747**	kWh/a
Number of heat pumps in the system				2	
Functionality				Heating & DHW	
Heating					
Selection of HP:	1-Standard Air/Water heat pump	Heat source:		1-Outdoor air	
Selection of distribution system				3-Supply air heating	
Design distribution temperature		θ_{design} *(DHW+Distribution)*		55,00	°C
Nominal power of distribution system		P_{nom}		2,13	kW
Distribution system (to be completed by experienced users only)					
Nominal power of distribution system		P_{nom}			kW
Radiator exponent		n			
Heat storage tank (buffer storage tank 'DHW+Distribution' worksheet)				0-No	
Specific heat losses storage		U * A $_{Storage}$		3,0	W/K
Storage location in thermal envelope				2-Outside	
Room temperature (storage location: outside of thermal envelope)		*(DHW+Distribution)*			°C
Sink temperature of heat pump for heating		θ_{snk}		55,00	°C
Entries in relation to the domestic hot water system					
Selection of HP:	1-Standard Air/Water heat pump	Heat source:		1-Outdoor air	
DHW temperature		*(DHW+Distribution)*		60,00	°C
Orientation of DHW storage tank ('storage 1' in 'DHW+Distribution' worksheet)				2-Outside	
Specific heat losses storage		U * A $_{Storage}$		3,0	W/K
Room temperature (storage location: outside of thermal envelope)		*(DHW+Distribution)*		11,00	°C
Type of backup heater				1-Elec. Immersion heater	
Δθ of electric continuous flow water heater				5,0	K
Additional options in case of <u>one</u> heat pump for both functions: Heating & DHW					
Same heat pump's sink temperature for Heating and for DHW				1-Yes	
Heat pump priority		*(Manufacturer, tech. data)*		2-Heating priority	
Control strategy					
Heat pump control strategy				1-On/Off	
Heating					
Depth ground water / Ground collector / Ground probe		z		20,0	m
Power of pump for ground heat exchanger		P_{pump}		0,05	kW

Technical References

Project Acronym	EuroPHit
Project Title	Improving the energy performance of step-by-step refurbishment and integration of renewable energies
Project Coordinator	Jan Steiger Passive House Institute, Dr. Wolfgang Feist Rheinstrasse 44/46 D 64283 Darmstadt jan.steiger@passiv.de
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Author(s)	Zeno Bastian
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