

Passive House Verification



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

Year of construction: 2016
 No. of dwelling units: 1
 No. of occupants: 2,9

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

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

Interior temperature winter [°C]: 20,0 Interior temp. summer [°C]: 25,0
 Internal heat gains (IHG) heating case [W/m²]: 2,4 IHG cooling case [W/m²]: 2,4
 Specific capacity [Wh/K per m² TFA]: 204 Mechanical cooling:

Specific building characteristics with reference to the treated floor area

| Criteria | Treated floor area m² | Value | Comparison | Alternative criteria | | Fulfilled? ² |
|--|---|-------|------------|----------------------|----------------------|-------------------------|
| | | | | Criteria | Alternative criteria | |
| Space heating | Heating demand kWh/(m²a) | 13 | ≤ | 15 | - | yes |
| | Heating load W/m² | 10 | ≤ | - | 10 | yes |
| Space cooling | Cooling & dehum. demand kWh/(m²a) | - | ≤ | - | - | - |
| | Cooling load W/m² | - | ≤ | - | - | - |
| | Frequency of overheating (> 25 °C) % | 1 | ≤ | 10 | | yes |
| | Frequency of excessively high humidity (> 12 g/kg) % | 0 | ≤ | 20 | | yes |
| Airtightness | Pressurization test result n ₅₀ 1/h | 0,2 | ≤ | 0,6 | | yes |
| Non-renewable Primary Energy (PE) | PE demand kWh/(m²a) | 40 | ≤ | - | | - |
| Primary Energy Renewable (PER) | PER demand kWh/(m²a) | 32 | ≤ | 30 | 32 | yes |
| | Generation of renewable energy (in relation to projected building footprint area) kWh/(m²a) | 125 | ≥ | 120 | 124 | |

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.

Passive House Premium?

yes

Task: 2-Certifier First name: John Surname: Smith
 Certificate ID: ID-12345 Issued on: 01.07.17 City: Darmstadt

Signature:

Climate data

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 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

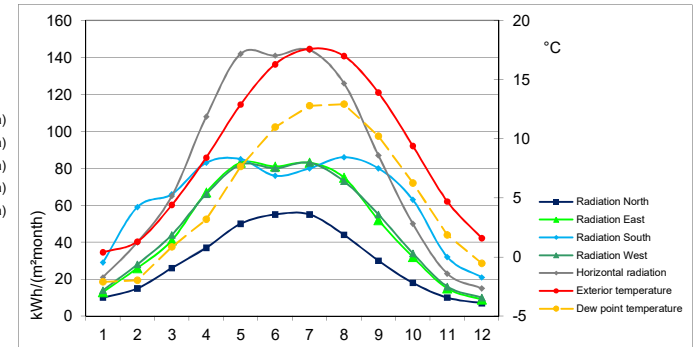
Weather station: m

Building location: m

Result overview

| | | |
|--------------------------|------|------------------------|
| Annual heating demand | 12,5 | kWh/(m ² a) |
| Heating load | 9,8 | W/m ² |
| Frequency of overheating | 1,0 | % |
| Sensible cooling | 0,8 | kWh/(m ² a) |
| Latent cooling | 0,0 | kWh/(m ² a) |
| Cooling load | - | W/m ² |
| PER demand | 31,6 | kWh/(m ² a) |

| | Data for heating | | Data from monthly balance | |
|--------------------------------|------------------|---------|---------------------------|------------------------|
| | Annual method | Heating | Heating | Cooling |
| Heating / cooling period | 219 | 182 | 78 | d/a |
| Heating / cooling degree hours | 82 | 74 | -15 | kKh/a |
| Radiation North | 129 | 86 | 133 | kWh/(m ² a) |
| Radiation East | 212 | 136 | 211 | kWh/(m ² a) |
| Radiation South | 359 | 270 | 219 | kWh/(m ² a) |
| Radiation West | 221 | 146 | 208 | kWh/(m ² a) |
| Horizontal radiation | 339 | 214 | 366 | kWh/(m ² a) |



| | Month | Days | | | | | | | | | | | | Heating load | | Cooling load | | PER factors |
|----------------------------|-----------------------|---|------|-------------|------|--------------|------------------------------------|------|------|------|------|------|--------------------------------|--------------|--------------------------------|--------------|-----------|-------------|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Weather 1 | Weather 2 | Weather 1 | Weather 2 | |
| | DE-9999-PHPP-Standard | Latitude ° | 51,3 | Longitude ° | 9,4 | Altitude [m] | Daily temperature swing Summer [K] | | | | | 11,7 | Radiation: [W/m ²] | | Radiation: [W/m ²] | | | |
| ° 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 |
| kWh/(m ² month) | Radiation North | 10 | 15 | 26 | 37 | 50 | 55 | 55 | 44 | 30 | 18 | 10 | 7 | 10 | 5 | 100 | 100 | 1,30 |
| kWh/(m ² month) | Radiation East | 13 | 26 | 41 | 67 | 83 | 81 | 83 | 75 | 52 | 32 | 15 | 9 | 30 | 5 | 180 | 180 | 1,80 |
| kWh/(m ² month) | Radiation South | 29 | 59 | 66 | 83 | 85 | 76 | 80 | 86 | 80 | 63 | 32 | 21 | 90 | 10 | 200 | 200 | 1,10 |
| kWh/(m ² month) | Radiation West | 14 | 28 | 44 | 66 | 82 | 80 | 83 | 73 | 55 | 34 | 16 | 10 | 35 | 5 | 180 | 180 | 1,15 |
| kWh/(m ² month) | 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 | 11,2 | 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. | | | | | | | | | | | | | | | | |

Household electri
Domestic hot wat
Heating
Cooling
Dehumidification

U-value of building assemblies

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 [m ² K/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 | 1,100 | | | | | 175 |
| Polystyrene | 0,040 | | | | | 275 |
| Exterior Render | 0,800 | | | | | 20 |
| Percentage of sec. 1 | | Percentage of sec. 2 | | Percentage of sec. 3 | | Total |
| 100% | | | | | | 48,5 cm |
| U-value supplement | | W/(m ² K) | | U-value: 0,138 W/(m ² K) | | |

| Assembly no. 02ud | | Building assembly description Roof | | | | Interior insulation? |
|---|------------|---|------------|--|------------|----------------------|
| | | Heat transmission resistance [m ² K/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 | | | 400 |
| Gypsum Plasterboard | 0,700 | | | | | 13 |
| Percentage of sec. 1 | | Percentage of sec. 2 | | Percentage of sec. 3 | | Total |
| 98% | | 2,0% | | | | 46,3 cm |
| U-value supplement | | W/(m ² K) | | U-value: 0,108 W/(m ² K) | | |

| Assembly no. 03ud | | Building assembly description Basement ceiling | | | | Interior insulation? |
|--|------------|---|------------|--|------------|----------------------|
| | | Heat transmission resistance [m ² K/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 | 0,040 | | | | | 250 |
| Plaster Coat | 0,800 | | | | | 10 |
| Percentage of sec. 1 | | Percentage of sec. 2 | | Percentage of sec. 3 | | Total |
| 100% | | | | | | 52,0 cm |
| U-value supplement | | W/(m ² K) | | U-value: 0,131 W/(m ² K) | | |

| | | | | | | | | | |
|---------------------------------|------------|---|------------|---------------------------|------------|----------------------------|--|----------------------|--|
| Assembly no. | | 04ud | | | | Partition wall | | Interior insulation? | |
| | | Heat transmission resistance [m ² K/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 | | Percentage of sec. 2 | | Percentage of sec. 3 | | Total | | | |
| 90% | | 10,0% | | | | 46,0 cm | | | |
| U-value supplement | | | | U-value: | | 0,375 W/(m ² K) | | | |

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|---------------------------------|------------|---|------------|---------------------------|------------|----------------|--|----------------------|--|
| Assembly no. | | 05ud | | | | | | Interior insulation? | |
| | | Heat transmission resistance [m ² K/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] | | | |
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| | | | | | | | | | |
| Percentage of sec. 1 | | Percentage of sec. 2 | | Percentage of sec. 3 | | Total | | | |
| 100% | | | | | | | | | |
| U-value supplement | | | | U-value: | | | | | |

| | | | | | | | | | |
|---------------------------------|------------|---|------------|---------------------------|------------|----------------|--|----------------------|--|
| Assembly no. | | 06ud | | | | | | Interior insulation? | |
| | | Heat transmission resistance [m ² K/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] | | | |
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| | | | | | | | | | |
| Percentage of sec. 1 | | Percentage of sec. 2 | | Percentage of sec. 3 | | Total | | | |
| 100% | | | | | | | | | |
| U-value supplement | | | | U-value: | | | | | |

Areas determination

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

| Summary | | | | | | Building assembly overview | Average U-value [W/(m²K)] | Radiation-gains heating season [kWh/a] | Radiation-load cooling period [kWh/a] |
|-------------------------------|------------------------------------|-----------|---------------|------|---|------------------------------------|---------------------------|--|---------------------------------------|
| Temp.-zone | Area group | Group no. | Area / Length | Unit | Comment | | | | |
| | 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. Window areas are subtracted from individual opaque areas, which is displayed in the 'Windows' worksheet. | North windows | 0,771 | 219 | 373 |
| A | East windows | 3 | 0,00 | m² | | East windows | | | |
| A | South windows | 4 | 30,42 | m² | | South windows | 0,779 | 1816 | 657 |
| A | West windows | 5 | 2,00 | m² | | West windows | 0,795 | 59 | 101 |
| 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 | 0,138 | 10 | 116 |
| 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 | 0,108 | -9 | 126 |
| B | Floor slab / Basement ceiling | 11 | 80,93 | m² | | Floor slab / Basement ceiling | 0,131 | | |
| | | 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" | | | | |
| 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 neighbour | 18 | 100,90 | m² | No heat losses, only considered for the heating load calculation | Building element towards neighbour | 0,375 | | |
| Total thermal envelope | | | | | | Average therm. envelope | 0,194 | | |

[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 | 1 | x (| | x | | + | | - | | - | |) = | | | | | | | | | | |
| 1 | External wall south | 8 | External wall - Ambient | 1 | x (| 7,13 | x | 10,31 | + | | - | | - | 30,4 |) = | 43,1 | 01ud-External wall | 0,138 | 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 | 0,138 | 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 | 0,138 | 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 | 0,108 | 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 | 0,131 | 0 | 180 | Hor | | | | |
| 6 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 7 | Partition wall | 18 | Building element towards neighbour | 1 | x (| 11,35 | x | 8,89 | + | | - | | - | 0,0 |) = | 100,9 | 04ud-Partition wall | 0,375 | 90 | 90 | East | | | | |
| 8 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 9 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 10 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 11 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 12 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 13 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 14 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 15 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 16 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 17 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 18 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 19 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 20 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 21 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 22 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 23 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 24 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 25 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 26 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 27 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 28 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |
| 29 | | | | 1 | x (| | x | | + | | - | | - | 0,0 |) = | | | | | | | | | | |

Areas determination

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

| Summary | | | | | | Building assembly overview | Average U-value [W/(m ² K)] | Radiation-gains heating season [kWh/a] 6 Months |
|-------------------------------|--------------------------------|-----------|---------------|----------------------|--|--|---|---|
| Temp.-zone | Area group | Group no. | Area / Length | Unit | Comment | | | |
| | Treated floor area | 1 | 156,00 | m ² | Treated floor area according to PHPP manual | | | |
| A | North windows | 2 | 11,04 | m ² | Results come from the 'Windows' worksheet. Window areas are subtracted from individual opaque areas, which is displayed in the 'Windows' worksheet. | North windows | 0,771 | 219 |
| A | East windows | 3 | 0,00 | m ² | | East windows | | |
| A | South windows | 4 | 30,42 | m ² | | South windows | 0,779 | 1816 |
| A | West windows | 5 | 2,00 | m ² | | West windows | 0,795 | 59 |
| A | Horizontal windows | 6 | 0,00 | m ² | | Horizontal windows | | |
| A | Exterior door | 7 | 0,00 | m ² | | Please subtract area of door from respective building assembly | Exterior door | |
| A | External wall - Ambient | 8 | 184,28 | m ² | Temperature zone "A" is ambient air | External wall - Ambient | 0,138 | 10 |
| B | External wall - Ground | 9 | 0,00 | m ² | Temperature zone "B" is the ground | External wall - Ground | | |
| A | Roof/Ceiling - Ambient | 10 | 83,41 | m ² | | Roof/Ceiling - Ambient | 0,108 | -9 |
| B | Floor slab / Basement ceiling | 11 | 80,93 | m ² | | Floor slab / Basement ceiling | 0,131 | |
| | | 12 | 0,00 | m ² | Temperature zones "A", "B", "P" and "X" may be used. NOT "I" | | | |
| | | 13 | 0,00 | m ² | Temperature zones "A", "B", "P" and "X" may be used. NOT "I" | Factor for X | | |
| X | | 14 | 0,00 | m ² | 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 | m ² | 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 | 0,194 | |

[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 | | | |

Heat losses through the ground

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

Building section 1

| Ground characteristics | | | |
|----------------------------|-----------|------|-----------------------|
| Thermal conductivity | λ | 2,0 | W/(mK) |
| Heat capacity | ρc | 2,0 | MJ/(m ³ K) |
| 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 $T_{g,ave}$ | $T_{g,\Delta}$ | 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_e | 81,9 | kKh/a |

| Building data | | | |
|--|---------------|----------------|----------------------|
| Area of ground floor slab / basement (A) | 80,9 | m ² | |
| Perimeter length | 25,0 | m | |
| Charact. dimension of floor slab | 6,47 | m | |
| U-value floor slab/basement ceiling | U_f | 0,131 | W/(m ² K) |
| TBs floor slab / basement ceiling | $\Psi_{B,*1}$ | 0,70 | W/K |
| U-value floor slab / basement ceiling ii | U_f' | 0,139 | W/(m ² K) |
| Equivalent thickness floor | d_t | 14,34 | m |

Floor slab type (select only one)

| Slab on grade | | | |
|-------------------------------------|-------------|---|--------|
| Perimeter insulation width/depth | D | | m |
| Perimeter insulation thickness | d_n | | m |
| Conductivity perimeter insulation | λ_n | | W/(mK) |
| Orientation of perimeter insulation | horizontal | | |
| (check only one field) | vertical | x | |

| 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/(m ² K) |

| Unheated basement | | | |
|--|----------|-------|----------------------|
| Height aboveground wall | h | 0,00 | m |
| Basement wall height below ground le Z | | 2,39 | m |
| Air change unheated basement | n | 0,20 | h ⁻¹ |
| Air volume basement | V | 120 | m ³ |
| U-Value wall above ground | U_W | 0,138 | W/(m ² K) |
| U-Value wall below ground | U_{WB} | 0,600 | W/(m ² K) |
| U-Value basement floor slab | U_{fB} | 0,645 | W/(m ² K) |

| Suspended floor above a ventilated crawl space (at max. 0.5 m below ground) | | | |
|---|--------------|------|----------------------|
| U-Value crawl space | U_{Crawl} | | W/(m ² K) |
| Height of crawl space wall | h | | m |
| U-Value crawl space wall | U_W | | W/(m ² K) |
| Area of ventilation openings | ϵP | | m ² |
| Wind velocity at 10 m height | v | 4,0 | m/s |
| Wind shield factor | f_W | 0,05 | - |

| Additional thermal bridge heat losses at perimeter | | | |
|--|--------------------|-------|--------|
| Phase shift | β | | Months |
| Steady-state fraction | $\Psi_{P,stat,*1}$ | 0,000 | W/K |
| Harmonic fraction | $\Psi_{P,harm,*1}$ | 0,000 | W/K |

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

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

Passive House Components

Passive House with PHPP Version 9.6a

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

- Go to: [JAREAS](#) www.passivehouse.com/component-database
[Thermal bridges \(Psi-values\)](#) [Ventilation units](#)
[Glazing](#) [Compact units](#)
[Window frames](#) [Heat recovery DHW](#)

| Building assemblies (U-Values) | | | | | |
|---|------------------|------------------------|-----------------|---------|---------------------|
| Recommended starting values for optimisation: U-values for walls and roofs Floor slabs: 0,15 W/(m²K) 0,29 W/(m²K) | | | | | |
| ID | Building system | 1 Building assembly | Total thickness | U-Value | Interior insulation |
| Summary of the constructions calculated in 'U values' worksheet | | | m | W/(m²K) | - |
| 01ud | External wall | External wall | 0,485 | 0,138 | 0 |
| 02ud | Roof | Roof | 0,463 | 0,108 | 0 |
| 03ud | Basement ceiling | Basement ceiling | 0,520 | 0,131 | 0 |
| 04ud | Partition wall | Partition wall | 0,460 | 0,375 | 0 |
| 05ud | | | | | |
| 06ud | | | | | |
| 07ud | | | | | |
| 08ud | | | | | |
| 09ud | | | | | |
| 10ud | | | | | |

| Glazing | | Glazing | |
|--|-------------------|---------|-----------------------|
| Recommended glazing type to start planning: Triple thermally insulated glazing (Please consider the comfort criterion!) | | | |
| ID | Description | g-Value | U _g -Value |
| | | | W/(m²K) |
| 01ud | Triple-low-e Kr08 | 0,50 | 0,70 |
| 02ud | Triple-low-e Kr12 | 0,50 | 0,58 |
| 03ud | | | |
| 04ud | | | |
| 05ud | | | |
| 06ud | | | |
| 07ud | | | |
| 08ud | | | |
| 09ud | | | |
| 10ud | | | |

| Window frames | | | | | | | | | | Window frames | | | | | | | | | |
|---------------|---------------------|-----------------------|---------|---------|---------|-------------|-------|--------|-------|--------------------------------|---------------------------------|----------------------------------|-------------------------------|--------------------------------|---------------------------------|----------------------------------|-------------------------------|--------------------------------------|--|
| ID | Description | U _f -Value | | | | Frame width | | | | Glazing edge thermal bridge | | | | Installation thermal bridge | | | | Curtain wall facades: | |
| | | left | right | bottom | above | left | right | bottom | above | Ψ _{Glazing edge left} | Ψ _{Glazing edge right} | Ψ _{Glazing edge bottom} | Ψ _{Glazing edge top} | Ψ _{Installation left} | Ψ _{Installation right} | Ψ _{Installation bottom} | Ψ _{Installation top} | X _{GC} -value Glass carrier | |
| | | W/(m²K) | W/(m²K) | W/(m²K) | W/(m²K) | m | m | m | m | W/(mK) | W/(mK) | W/(mK) | W/(mK) | W/(mK) | W/(mK) | W/(mK) | W/(mK) | W/K | |
| 01ud | Standard PU on wood | 0,59 | 0,59 | 0,59 | 0,59 | 0,135 | 0,135 | 0,175 | 0,135 | 0,049 | 0,049 | 0,049 | 0,049 | 0,005 | 0,005 | 0,005 | 0,005 | | |
| 02ud | Junction PU on wood | 0,59 | 0,59 | 0,59 | 0,59 | 0,070 | 0,125 | 0,125 | 0,125 | 0,049 | 0,049 | 0,049 | 0,049 | 0,005 | 0,005 | 0,005 | 0,005 | | |
| 03ud | Wide PU on wood | 0,59 | 0,59 | 0,59 | 0,59 | 0,150 | 0,150 | 0,175 | 0,150 | 0,049 | 0,049 | 0,049 | 0,049 | 0,005 | 0,005 | 0,005 | 0,005 | | |
| 04ud | | | | | | | | | | | | | | | | | | | |
| 05ud | | | | | | | | | | | | | | | | | | | |
| 06ud | | | | | | | | | | | | | | | | | | | |
| 07ud | | | | | | | | | | | | | | | | | | | |
| 08ud | | | | | | | | | | | | | | | | | | | |
| 09ud | | | | | | | | | | | | | | | | | | | |
| 10ud | | | | | | | | | | | | | | | | | | | |

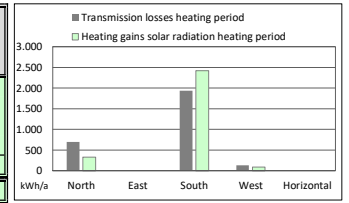
| Ventilation units with heat recovery | | | | | Ventilation units with heat recovery | | | | | | | | |
|--------------------------------------|--------------------|---|------------------------------|---------------------|--------------------------------------|------|-------------------------------|---------------------------|----------------------------|------------------|------------------|-------------------|-----------------|
| ID | Description | Recommended specifications to start planning: Frost protection: Yes; Humidity recovery: Yes | | | Additional Device Data | | | | | | | | |
| | | 75 % | | 0,45 | Application range | | External pressure per section | Fittings $D_{p_{intern}}$ | Frost protection necessary | Noise protection | | | Additional info |
| | | Effective heat recovery efficiency | Humidity recovery efficiency | Electric efficiency | m³/h | m³/h | Pa | Pa | | 35 dB(A) | Supply air dB(A) | Extract air dB(A) | |
| | User defined area | % | % | Wh/m³ | | | | | | | | | |
| 01ud | Heat recovery unit | 83% | | 0,40 | | | | | | yes | | | |
| 02ud | | | | | | | | | | | | | |
| 03ud | | | | | | | | | | | | | |
| 04ud | | | | | | | | | | | | | |
| 05ud | | | | | | | | | | | | | |
| 06ud | | | | | | | | | | | | | |
| 07ud | | | | | | | | | | | | | |
| 08ud | | | | | | | | | | | | | |
| 09ud | | | | | | | | | | | | | |
| 10ud | | | | | | | | | | | | | |

Windows

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

| Window area orientation | Global radiation (main orientations) kWh/(m ² a) | Shading | Dirt | Non-vertical radiation incidence | Glazing fraction | g-Value | Solar irradiation reduction factor | Window area | Window U-Value | Glazing area | Average global radiation |
|---|---|---------|------|----------------------------------|------------------|---------|------------------------------------|----------------|----------------------|----------------|--------------------------|
| Standard values → | | 0,75 | 0,95 | 0,85 | | | | m ² | W/(m ² K) | m ² | kWh/(m ² a) |
| North | 129 | 0,89 | 0,95 | 0,85 | 0,64 | 0,50 | 0,46 | 11,04 | 0,77 | 7,11 | 129 |
| East | 212 | 1,00 | 0,95 | 0,85 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 212 |
| South | 359 | 0,84 | 0,95 | 0,85 | 0,65 | 0,50 | 0,44 | 30,42 | 0,78 | 19,92 | 359 |
| West | 221 | 0,82 | 0,95 | 0,85 | 0,60 | 0,50 | 0,40 | 2,00 | 0,80 | 1,21 | 221 |
| Horizontal | 339 | 1,00 | 0,95 | 0,85 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 339 |
| Total or average value for all windows. | | | | | | 0,50 | 0,45 | 43,46 | 0,78 | 28,24 | |

| Transmission losses heating period | Heating gains solar radiation heating period |
|------------------------------------|--|
| kWh/a | kWh/a |
| 697 | 329 |
| 0 | 0 |
| 1940 | 2418 |
| 130 | 89 |
| 0 | 0 |
| 2768 | 2836 |



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

| | | | |
|------|------|------|------|
| 0,85 | 1,00 | 1,10 | 0,47 |
|------|------|------|------|

Heating degree hours [Kha]: **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 | | Installed in | Glazing | Frame | g-Value | U-Value | | Ψ Glazing edge | Installation situation | | | | Ψ _{Installation} (Avg.) | Results | | | | |
|----------|--------------|----------------------|--|-------------|-----------------------|--------|-----------------------|----------------------------|--------------------------|---------|-------------------------|---------|----------------|------------------------|------|-------|--------|----------------------------------|---------|-------------|--------------|--------------------------|----------------------------|
| | | | | | Width | Height | | | | | Perpendicular radiation | Glazing | | Frames (avg.) | left | right | bottom | | top | Window Area | Glazing area | U _{w,installed} | Glazed fraction per window |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | S Ground Fl. | 180 | 90 | South | 1,100 | 2,120 | 1-External wall south | 01ud-Triple-insulated-Kr08 | 01ud-normal-PU-on-timber | 0,50 | 0,70 | 0,59 | 0,049 | 1 | 0 | 1 | 1 | 0,005 | 9,3 | 6,01 | 0,78 | 64% | |
| 4 | S First Fl. | 180 | 90 | South | 1,140 | 2,120 | 1-External wall south | 01ud-Triple-insulated-Kr08 | 01ud-normal-PU-on-timber | 0,50 | 0,70 | 0,59 | 0,049 | 1 | 0 | 1 | 1 | 0,005 | 9,7 | 6,30 | 0,78 | 65% | |
| 4 | S Second Fl. | 180 | 90 | South | 1,120 | 2,550 | 1-External wall south | 01ud-Triple-insulated-Kr08 | 01ud-normal-PU-on-timber | 0,50 | 0,70 | 0,59 | 0,049 | 1 | 0 | 1 | 1 | 0,005 | 11,4 | 7,62 | 0,78 | 67% | |
| 2 | N Ground Fl. | 0 | 90 | North | 1,200 | 2,300 | 2-External wall north | 01ud-Triple-insulated-Kr08 | 03ud-breit-PU-on-timber | 0,50 | 0,70 | 0,59 | 0,049 | 1 | 0 | 1 | 1 | 0,005 | 5,5 | 3,56 | 0,77 | 64% | |
| 1 | West | 270 | 90 | West | 0,910 | 2,200 | 3-External wall west | 01ud-Triple-insulated-Kr08 | 01ud-normal-PU-on-timber | 0,50 | 0,70 | 0,59 | 0,049 | 1 | 1 | 1 | 1 | 0,005 | 2,0 | 1,21 | 0,80 | 60% | |
| 2 | N First Fl. | 0 | 90 | North | 1,200 | 2,300 | 2-External wall north | 01ud-Triple-insulated-Kr08 | 03ud-breit-PU-on-timber | 0,50 | 0,70 | 0,59 | 0,049 | 1 | 0 | 1 | 1 | 0,005 | 5,5 | 3,56 | 0,77 | 64% | |

Calculation of shading coefficients

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

Latitude: 51,301 °

| Orientation | Glazing area [m²] | Reduction factor winter $r_{f,w}$ | Reduction factor cooling $r_{f,c}$ | Reduction factor cooling load $r_{f,c,l}$ | Solar load [kWh/(m² _{glazing} ·a)] |
|-------------|-------------------|-----------------------------------|------------------------------------|---|---|
| North | 7,11 | 89% | 92% | 92% | 52 |
| East | 0,00 | 100% | 100% | 100% | 0 |
| South | 19,92 | 84% | 35% | 30% | 33 |
| West | 1,21 | 82% | 94% | 94% | 83 |
| Horizontal | 0,00 | 100% | 100% | 100% | 0 |

| Quantity | Description | Deviation from North [Degree] | Angle of inclination from the horizontal [Degree] | Orientation | Glazing width w_g [m] | Glazing height h_g [m] | Glazing area A_g [m²] | Horizon | | Lateral reveal | | Reveal / Overhang | | Additional reduction factor winter shading $f_{other,w}$ [%] | Additional reduction factor summer shading $f_{other,s}$ [%] | Reduction factor z for temporary sun protection z [%] | Regulated / transparent | Reduction factors for shading in winter | | | | Reduction factors for shading in summer | | | | |
|----------|--------------|-------------------------------|---|-------------|-------------------------|--------------------------|-------------------------|---|-----------------------------------|--------------------------------------|--|-------------------------------|---|--|--|---|-------------------------|---|--------|----------|------------------------|---|--------|----------|------------------------|------------------------|
| | | | | | | | | Height of the shading object h_{shad} [m] | Horizontal distance d_{hor} [m] | Window reveal depth d_{reveal} [m] | Distance from glazing edge to reveal d_{hor} [m] | Overhang depth d_{over} [m] | Distance from upper glazing edge to overhang d_{over} [m] | | | | | Horizon | Reveal | Overhang | Total for heating case | Horizon | Reveal | Overhang | Total for cooling case | Total for cooling load |
| 4 | S Ground Fl. | 180 | 90 | South | 0,83 | 1,81 | 6,0 | 10,80 | 42,50 | 0,16 | 0,135 | 0,43 | 0,55 | | | 30% | x | 87% | 94% | 96% | 79% | 91% | 92% | 93% | 34% | 29% |
| 4 | S First Fl. | 180 | 90 | South | 0,87 | 1,81 | 6,3 | 8,30 | 42,50 | 0,16 | 0,098 | 0,43 | 0,55 | | | 30% | x | 92% | 94% | 96% | 83% | 93% | 92% | 93% | 35% | 29% |
| 4 | S Second Fl. | 180 | 90 | South | 0,85 | 2,24 | 7,6 | 5,80 | 42,50 | 0,16 | 0,135 | 0,43 | 0,55 | | | 30% | x | 96% | 94% | 97% | 88% | 95% | 92% | 94% | 36% | 31% |
| 2 | N Ground Fl. | 0 | 90 | North | 0,90 | 1,98 | 3,6 | | | 0,16 | 0,150 | 0,16 | 0,15 | | | | | 92% | 95% | 95% | 89% | 93% | 99% | 92% | 92% | 92% |
| 1 | West | 270 | 90 | West | 0,64 | 1,89 | 1,2 | | | 0,16 | 0,135 | 0,16 | 0,14 | | | | | 86% | 95% | 95% | 82% | 95% | 99% | 95% | 94% | 94% |
| 2 | N First Fl. | 0 | 90 | North | 0,90 | 1,98 | 3,6 | | | 0,16 | 0,150 | 0,16 | 0,15 | | | | | 92% | 95% | 95% | 89% | 93% | 99% | 92% | 92% | 92% |

Ventilation data

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

| | | | |
|---|----------------|------|------------------------------|
| Treated floor area A _{TFA} | m ² | 156 | (Areas' worksheet) |
| Room height h | m | 2,50 | |
| Volume of ventilated space (A _{TFA} ·h) V _V | m ³ | 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 | | |
| Wind protection coefficient, e | | For annual demand: 0,07 | For heating load: 0,18 | | |
| Wind protection coefficient, f | | 15 | 15 | | |
| Air change rate at press. test n ₅₀ | | 1/h 0,22 | 0,22 | Net air volume for press. test V _{n50} m ³ 480 | Air permeability q ₅₀ m ³ /(hm ²) 0,27 |
| Excess extract air | | For annual demand: 1/h 0,00 | For heating load: 0,00 | | |
| Infiltration air change rate n _{V,Rest} | | 1/h 0,019 | 0,047 | | |

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 m ³ /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/m ³ | Heat recovery efficiency SHX [-] |
|--|--|---|-----------------------------|---|---|----------------------------------|--|----------------------------------|
| <input checked="" type="checkbox"/> | Standard design (Ventilation' worksheet, see below) | 117 | 0,30 | 0,00 | 82,4% | N/A | 0,40 | 31,3% |
| <input type="checkbox"/> | 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 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 36% | 36% | 42% | - | - | - | - | - | - | 54% | 44% | 39% |

Standard data input for balanced ventilation

Passive House with PHPP Version 9.6a

Dimensioning of ventilation system with only one ventilation unit

| | | | | | | |
|----------------------------------|-----------------------|-----|------------------------------------|----------|------------------------|----|
| Occupancy | m ³ /P | 53 | | | | |
| Number of occupants | P | 2,9 | | | | |
| Supply air per person | m ³ /(P*h) | 30 | | | | |
| Supply air requirement | m ³ /h | 88 | | | | |
| Extract air rooms | | | Kitchen | Bathroom | Bathroom (shower only) | WC |
| Quantity | | | 1 | 1 | 1 | 1 |
| Extract air requirement per room | m ³ /h | 60 | 40 | 20 | 20 | |
| Total extract air requirement | m ³ /h | 140 | | | | |
| Design air flow rate (maximum) | m ³ /h | 152 | Recommended: 152 m ³ /h | | | |

Average air change rate calculation

| Type of operation | Daily operation times h/d | Factors referenced to maximum | Air flow rate m ³ /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 value | | 0,77 | 117 | 0,30 |

Selection of ventilation unit with heat recovery

Location of ventilation unit **2-Outside of thermal envelope**

| Ventilation unit selection | Heat recovery efficiency | Humidity recovery efficiency | Specific efficiency [Wh/m ³] | Application [m ³ /h] | Frost power input |
|---|--------------------------|------------------------------|--|---------------------------------|-------------------|
| Go to ventilation units list 1-Sorting: AS LIST 01ud-HRV | 0,83 | N/A | 0,40 | N/A | yes |
| Implementation of frost protection | | | | | 2-Elec. |
| Conductivity supply air duct Ψ | W/(mK) | 0,164 | Limit temperature [°C] | | -3 |
| Length of supply air duct | m | 1,1 | Useful energy [kWh/a] | | 52 |
| Conductivity extract air duct Ψ | W/(mK) | 0,223 | Room temperature (°C) | | 20 |
| Length of extract air duct | m | 1,5 | Avg. ambient temp. heat. period (°C) | | 4,9 |
| Temperature of mechanical services room (Enter only if the central unit is outside of the thermal envelope) | °C | 11 | Avg. ground temp (°C) | | 10,0 |

Effective heat recovery efficiency $\eta_{HR,eff}$ **82,4%**

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 m ³ /h |
| $\Delta\theta$ | 9 K |
| Exterior duct diameter | 0,100 m |
| Exterior diameter | 0,400 m |
| α -Interior | 19,02 W/(m ² K) |
| α -Surface | 1,87 W/(m ² K) |
| Ψ -value | 0,164 W/(mK) |
| Surface temperature difference | 0,628 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 m ³ /h |
| $\Delta\theta$ | 9 K |
| Exterior duct diameter | 0,125 m |
| Exterior diameter | 0,325 m |
| α -Interior | 12,73 W/(m ² K) |
| α -Surface | 2,07 W/(m ² K) |
| Ψ -value | 0,223 W/(mK) |
| Surface temperature difference | 0,951 K |

Dimensioning of air quantities

When dimensioning the air quantities, please consider the design recommendations given above.

The operation period of the ventilation can be determined on the basis of daily utilisation hours, including flushing phase if applicable. In addition, time periods with reduced ventilation requirements (operation modes) can be taken into account by means of reduction factors.

| Room no. | Amount a | Room name | Allocation to ventilation unit (No.) | Area A m ² | Clear height h m | Room vol. A x h m ³ | Volume flow per room | | | Air chng. rt. per room n 1/h | Utilisation times | | Duration of holidays d | Reduction factor 1 | Operation red. 1 | Reduction factor 2 | Operation red. 2 | Reduction factor 3 | Operation red. 3 | Annual average value: | | | | |
|---|----------|---------------|--------------------------------------|-----------------------|------------------|--------------------------------|------------------------------------|------------------------------------|--------------------------------------|------------------------------|-------------------|----------|------------------------|--------------------|------------------|--------------------|------------------|--------------------|------------------|------------------------------------|------------------------------------|--------------------------------------|-----------------|------|
| | | | | | | | V _{SUP} m ³ /h | V _{ETA} m ³ /h | V _{TRANS} m ³ /h | | h/d h | d/week d | | | | | | | | V _{SUP} m ³ /h | V _{ETA} m ³ /h | V _{TRANS} m ³ /h | Change rate 1/h | |
| 1 | 1 | Dwelling unit | 1 | 156 | 2,70 | 421 | 152 | 152 | | 0,36 | 24 | 7 | | 77% | 100% | | | | | | 117 | 117 | | 0,28 |
| 2 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 3 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 4 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 5 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 6 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 7 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 8 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 9 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 10 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 11 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 12 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 13 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 14 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 15 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 16 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 17 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 18 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 19 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 20 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 21 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 22 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 23 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 24 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 25 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 26 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 27 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 28 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 29 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| 30 | | | | | | | | | | | | | | 100% | 100% | | | | | | | | | |
| Additional lines: Please mark complete lines above, copy and paste multiple times | | | | | | | | | | | | | | | | | | | | 117 | 117 | --- | 0,28 | |

Ventilation unit selection

Up to 10 different ventilation units are considered. By changing the amount, identical units can be considered. The data from PHI certified ventilation units as well as the entry data lines for user data for other ventilation units can also be found in the worksheet 'Components'. When choosing to use a compact unit the standard design in the 'Ventilation' worksheet has to be used.

[Go to ventilation units list](#)

| Ventilation unit no. | Quantity [-] | Description of ventilation units | Selection of type of ventilation | Design vol. flow per unit m³/h | Application range for volume flow rate | | Electrical efficiency Wh/m³ | Pressure loss calculation | | | Application range per line | | Interior location (x) | Exterior location (x) | Heat recovery efficiency | | Energy recovery efficiency [-] | Frost protection necessary | Subsoil HX | | Frost protection (electr. / hydr.) | | | |
|----------------------|--------------|----------------------------------|----------------------------------|--------------------------------|--|-----|-----------------------------|-------------------------------|-------------------------------|------------------------------------|------------------------------------|-------------------------------------|-----------------------|-----------------------|--------------------------|-----------|--------------------------------|----------------------------|-----------------------------|---------------------------------------|--------------------------------------|----------------------|---------------------|---|
| | | | | | from | to | | ODA-SUP ΔP _{Duct} Pa | ETA-EHA ΔP _{Duct} Pa | Additional ΔP _{Intern} Pa | per line ΔP _{External} Pa | Subtraction ΔP _{Intern} Pa | | | Unit | Effective | | | Efficiency of heat recovery | Effective efficiency of heat recovery | Type | Limit temperature °C | Useful Energy kWh/a | |
| 1 | 1 | Unit 1 | 01ud-HRV | 152 | N/A | N/A | 0,40 | 100 | 100 | | - | - | | x | 0,83 | 82% | N/A | yes | 93% | 31% | 2-Elec. | -3 | 53 | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | 0 | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 8 | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 9 | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| | | | | | | | | | | | | | | | | | | | | | Total (directly electric) | | 53 | |
| | | | | | | | | | | | | | | | | | | | | | Total (hydraulic and heat generator) | | 0 | |

Data entries for duct sections between the ventilation unit and the thermal envelope

The duct sections between the ventilation unit and the thermal envelope should be as short as possible and should be well insulated, whether the ventilation unit is located indoors or outdoors. The dimensions of these duct sections can be entered here. The heat losses of the overlying duct sections will be considered for the effective heat recovery efficiency. One section of a duct entered here may also be used for multiple ventilation units.

If in the section "Ventilation unit - selection" (above) a ventilation unit is selected as multiple units (amount larger than 1 for identical units), then the corresponding duct sections may simply be entered (duct sections for one ventilation unit).

Temperature of installation location: (only enter when at least one unit is installed outside of the thermal envelope)

| Quantity | Round duct ins. diameter mm | Rectangular duct | | Insulation thickness mm | Thermal conductivity W/(m K) | Reflective insulation duct (x) | Duct transmitt. W/(m K) | Length of supply air duct m | Outdoor or supply air duct (1) | Exhaust or extract air duct (1) | Duct type | Design volume rate | Assignment to ventilation unit (enter 1 for the corresponding ventilation unit) | | | | | | | | | | |
|----------|-----------------------------|------------------|-----------|-------------------------|------------------------------|--------------------------------|-------------------------|-----------------------------|--------------------------------|---------------------------------|-----------|--------------------|---|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|--|
| | | Width mm | Height mm | | | | | | | | | | Vent. unit 1 | Vent. unit 2 | Vent. unit 3 | Vent. unit 4 | Vent. unit 5 | Vent. unit 6 | Vent. unit 7 | Vent. unit 8 | Vent. unit 9 | Vent. unit 10 | |
| 1 | 100 | | | 150 | 0,04 | x | 0,164 | 1,1 | 1 | | Supply | 152 | 1 | | | | | | | | | | |
| 1 | 125 | | | 100 | 0,04 | x | 0,223 | 1,5 | | 1 | Extract | 152 | 1 | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |
| | | | | | | | | | | | | 0 | | | | | | | | | | | |

Additional lines: Please mark complete lines above, copy and paste multiple times

Specific energy for heating (annual method)

Passive House with PHPP Version 9.6a

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

Interior temperature: °C
 Building type:
 Treated floor area A_{TFA}: m²

| Building assembly | Temperature zone | Area m ² | U-Value W/(m ² K) | Temp. factor f _t | G _i kWh/a | kWh/a | Per m ² of treated floor area | |
|---|------------------|------------------------|---------------------------------|-----------------------------|-------------------------|-------|--|------|
| External wall - Ambient | A | 184,3 | 0,138 | 1,00 | 81,9 | 2076 | 13,31 | |
| External wall - Ground | B | | | 0,59 | | | | |
| Roof/Ceiling - Ambient | A | 83,4 | 0,108 | 1,00 | 81,9 | 735 | 4,71 | |
| Floor slab / Basement ceiling | B | 80,9 | 0,131 | 0,59 | 81,9 | 510 | 3,27 | |
| | A | | | 1,00 | | | | |
| | A | | | 1,00 | | | | |
| | X | | | 0,00 | | | | |
| Windows | A | 43,5 | 0,777 | 1,00 | 81,9 | 2768 | 17,74 | |
| Exterior door | A | | | 1,00 | | | | |
| Exterior TB (length/m) | A | 116,9 | -0,030 | 1,00 | 81,9 | -285 | -1,83 | |
| Perimeter TB (length/m) | P | | | 0,59 | | | 0,00 | |
| Ground TB (length/m) | B | 11,4 | 0,061 | 0,59 | 81,9 | 34 | 0,21 | |
| Total of all building envelope areas | | 392,1 | | | | | kWh/(m ² a) | |
| Transmission heat losses Q_T | | | | | | Total | 5837 | 37,4 |

| Ventilation system: | Effective air volume, V _V m ³ | A _{TFA} m ² | Clear room height m | m ³ |
|---|--|---|------------------------------------|------------------------------------|
| Effective heat recovery efficiency Efficiency of subsoil heat exchanger Heat recovery efficiency of SHX | <input type="text" value="82%"/> | <input type="text" value="156,0"/> | <input type="text" value="2,50"/> | <input type="text" value="390,0"/> |
| Energetically effective air changes n _V | <input type="text" value="0,300"/> | <input type="text" value="0,88"/> | <input type="text" value="0,019"/> | <input type="text" value="0,055"/> |
| V _V m ³ | n _V 1/h | C _{Air} Wh/(m ² K) | G _i kWh/a | kWh/(m ² a) |
| 390,0 | 0,055 | 0,33 | 81,9 | 583 |
| Ventilation heat losses Q_V | | | | |

| Total heat losses Q _L | Q _T kWh/a | Q _V kWh/a | Reduction factor night/weekend Saving | kWh/a | kWh/(m ² a) |
|----------------------------------|-------------------------|-------------------------|---|-------|------------------------|
| | (5837 + 583) | 1,0 | | 6420 | 41,2 |

| Orientation of the area | Reduction factor See 'Windows' sheet | g-Value (perp. radiation) | Area m ² | Radiation HP kWh/(m ² a) | kWh/a | kWh/(m ² a) | | |
|---|---|------------------------------|------------------------|--|-------|------------------------|------|------|
| North | 0,46 | 0,50 | 11,04 | 129 | 329 | | | |
| East | 0,00 | 0,00 | 0,00 | 212 | 0 | | | |
| South | 0,44 | 0,50 | 30,42 | 359 | 2418 | | | |
| West | 0,40 | 0,50 | 2,00 | 221 | 89 | | | |
| Horizontal | 0,00 | 0,00 | 0,00 | 339 | 0 | | | |
| Available solar heat gains Q_S | | | | | | Total | 2836 | 18,2 |

| Internal heat gains Q _i | Length heating period d/a | Spec. power q _i W/m ² | A _{TFA} m ² | kWh/a | kWh/(m ² a) | |
|--|------------------------------|--|------------------------------------|---|------------------------|------|
| | 0,024 | 219 | 156,0 | 1984 | 12,7 | |
| Free heat Q _F | | | | Q _S + Q _i | 4819 | 30,9 |
| Ratio of free heat to losses | | | | Q _F / Q _V | 0,75 | |
| Utilisation factor heat gains h _G | | | | (1 - (Q _F / Q _L) ⁵) / (1 - (Q _F / Q _L) ⁶) | 93% | |
| Heat gains Q_G | | | | η _G * Q _F | 4470 | 28,7 |

| Annual heating demand Q _H | Q _L - Q _G | kWh/a | kWh/(m ² a) |
|--------------------------------------|---------------------------------|----------------------------------|------------------------|
| | | 1949 | 12 |
| Limiting value | | <input type="text" value="15"/> | |
| Requirement met? | | <input type="text" value="Yes"/> | |

Specific energy for heating (monthly method)

Passive House with PHPP Version 9.6a

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

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

Interior temperature: °C
 Building type:
 Treated floor area A_{TFA}: m²
 Spec. Capacity: Wh/(m²K)

| Building assembly | Temperature zone | Area m ² | U-Value W/(m ² K) | Month. red. fac. | G _t kWh/a | Per m ² of treated floor area kWh/(m ² a) | |
|---|------------------|---------------------|------------------------------|------------------|----------------------|---|-------------|
| External wall - Ambient | A | 184,3 | 0,138 | 1,00 | 74 | 12,03 | |
| External wall - Ground | B | | | 1,00 | | | |
| Roof/Ceiling - Ambient | A | 83,4 | 0,108 | 1,00 | 74 | 4,26 | |
| Floor slab / Basement ceiling | B | 80,9 | 0,131 | 1,00 | 40 | 2,70 | |
| | A | | | 1,00 | | | |
| | A | | | 1,00 | | | |
| | X | | | 0,00 | | | |
| Windows | A | 43,5 | 0,777 | 1,00 | 74 | 16,04 | |
| Exterior door | A | | | 1,00 | | | |
| Exterior TB (length/m) | A | 116,9 | -0,030 | 1,00 | 74 | -1,65 | |
| Perimeter TB (length/m) | P | | | 1,00 | | 0,00 | |
| Ground TB (length/m) | B | 11,4 | 0,061 | 1,00 | 40 | 0,18 | |
| Transmission heat losses Q_T | | | | | | 5234 | 33,6 |

| Effective air change rate Ambient n _{V,e} | Effective air change rate Ground n _{V,g} | Effective air volume V _V m ³ | Clear room height m | Clear room height m ³ | n _{V,system} 1/h | η*SHX | η _{HR} | n _{V,Res} 1/h | n _{V,equi.fraction} 1/h | V _V m ³ | n _{V,equi.fraction} 1/h | C _{Air} Wh/(m ² K) | G _t kWh/a | Q _V kWh/a | Q _{V,e} kWh/(m ² a) | |
|--|---|--|---------------------|----------------------------------|---------------------------|-------|-----------------|------------------------|----------------------------------|-------------------------------|----------------------------------|--|----------------------|----------------------|---|------------|
| 0,300 | 0,300 | 156 | 2,50 | 390 | 0,300 | 93% | 0,82 | 0,019 | 0,023 | 390 | 0,023 | 0,33 | 74 | 216 | 1,4 | |
| | | | | | | | | | 0,049 | 390 | 0,049 | 0,33 | 44 | 277 | 1,8 | |
| Ventilation heat losses Q_V | | | | | | | | | | | | | | | 493 | 3,2 |

| Q _T kWh/a | Q _V kWh/a | Reduction factor night/weekend saving | Q _L kWh/a | Q _L kWh/(m ² a) |
|----------------------|----------------------|---------------------------------------|----------------------|---------------------------------------|
| 5234 | 493 | 1,0 | 5727 | 36,7 |

| Orientation of the area | Reduction factor see 'Windows' worksheet | g-Value (perp. radiation) | Area m ² | Global radiation kWh/(m ² a) | Q _S kWh/a | Q _S kWh/(m ² a) | |
|---|--|---------------------------|---------------------|---|----------------------|---------------------------------------|-------------|
| North | 0,46 | 0,50 | 11,0 | 86 | 219 | | |
| East | 0,00 | 0,00 | 0,0 | 136 | 0 | | |
| South | 0,44 | 0,50 | 30,4 | 270 | 1816 | | |
| West | 0,40 | 0,50 | 2,0 | 146 | 59 | | |
| Horizontal | 0,00 | 0,00 | 0,0 | 214 | 0 | | |
| Sum opaque areas | | | | | 185 | | |
| Available solar heat gains Q_S | | | | | | 2278 | 14,6 |

| Length Heat. Period kh/d | Spec. Power q _i W/m ² | A _{TFA} m ² | Free heat Q _F kWh/a | Free heat Q _F kWh/(m ² a) |
|--|---|---------------------------------|-----------------------------------|---|
| 0,024 | 2,4 | 156,0 | 1649 | 10,6 |
| Internal heat gains Q_I | | | | |
| Free heat Q _F | | | Q _S + Q _I = | 3928 |
| Ratio free heat to losses | | | Q _F / Q _L = | 0,69 |
| Utilisation factor heat gains h _G | | | = | 96% |
| Heat gains Q_G | | | η _G * Q _F = | 3774 |

| | | | |
|--|--|-------------------------|---|
| Annual heating demand Q_H | Q _L - Q _G = | 1953 | 13 |
| Limiting value | <input type="text" value="15"/> kWh/(m ² a) | Requirement met? | <input checked="" type="checkbox"/> Yes |

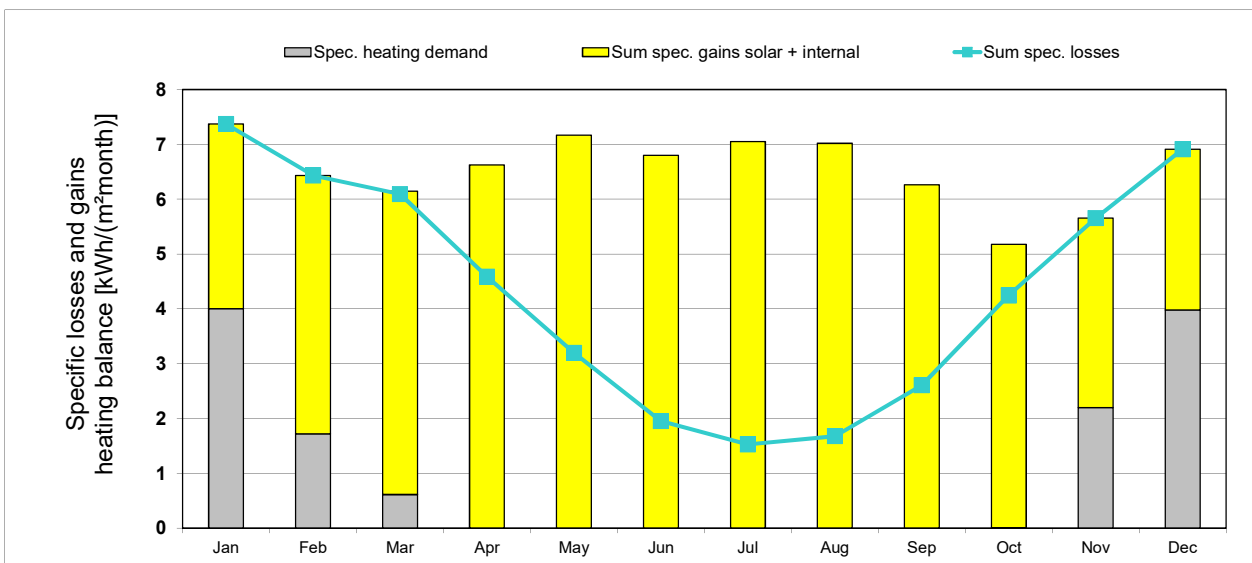
Specific energy for heating (monthly method)

Passive House with PHPP Version 9.6a

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 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 - External | 15,1 | 13,1 | 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 | 6,3 | 5,8 | 4,8 | 4,3 | 3,9 | 3,9 | 5,2 | 5,7 | 6,7 | 69 | kKh |
| Losses - Exterior | 1019 | 882 | 817 | 599 | 386 | 205 | 143 | 170 | 317 | 557 | 772 | 955 | 6822 | kWh |
| Losses - Ground | 131 | 122 | 134 | 117 | 112 | 100 | 95 | 92 | 90 | 105 | 110 | 123 | 1330 | kWh |
| Sum spec. losses | 7,4 | 6,4 | 6,1 | 4,6 | 3,2 | 2,0 | 1,5 | 1,7 | 2,6 | 4,2 | 5,7 | 6,9 | 52,3 | kWh/m ² |
| Solar gains - North | 25 | 38 | 66 | 94 | 127 | 140 | 140 | 112 | 76 | 46 | 25 | 18 | 908 | 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 | 572 | 511 | 538 | 578 | 538 | 424 | 215 | 141 | 5112 | kWh |
| Solar gains - West | 6 | 11 | 18 | 27 | 33 | 32 | 33 | 29 | 22 | 14 | 6 | 4 | 235 | kWh |
| Solar gains - Horiz. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar gains - Opaque | 19 | 36 | 54 | 83 | 106 | 106 | 108 | 94 | 69 | 43 | 21 | 13 | 750 | kWh |
| Internal heat gains | 281 | 254 | 281 | 272 | 281 | 272 | 281 | 281 | 272 | 281 | 272 | 281 | 3308 | kWh |
| Sum spec. gains solar + intern | 3,4 | 4,7 | 5,5 | 6,6 | 7,2 | 6,8 | 7,1 | 7,0 | 6,3 | 5,2 | 3,5 | 2,9 | 66,1 | kWh/m ² |
| Utilisation factor | 100% | 100% | 99% | 69% | 45% | 29% | 22% | 24% | 42% | 82% | 100% | 100% | 60% | |
| Annual heating demand | 624 | 268 | 96 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 343 | 621 | 1953 | kWh |
| Spec. heating demand | 4,0 | 1,7 | 0,6 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 2,2 | 4,0 | 12,5 | kWh/m ² |



Annual heating demand: Comparison

| | | | |
|----------------|---------------------------|-------------------|--|
| Monthly method | (<i>Heating</i>) | 1953 kWh/a | 12,5 kWh/(m ² a) reference to treated floor area according to PHPP |
| Annual method | (<i>Annual heating</i>) | 1949 kWh/a | 12,5 kWh/(m ² a) reference to treated floor area according to PHPP |
| | | 4443 kWh/a | 20,9 kWh/(m ² a) |

Heating load

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

Interior temperature: °C
 Building type:
 Treated floor area A_{TFA}: m²

| Design temperature | Radiation: | North | East | South | West | Horizontal | |
|---|------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|------|
| Weather 1: <input type="text" value="-10,6"/> °C | | <input type="text" value="10"/> | <input type="text" value="30"/> | <input type="text" value="90"/> | <input type="text" value="35"/> | <input type="text" value="40"/> | W/m² |
| Weather 2: <input type="text" value="-1,2"/> °C | | <input type="text" value="5"/> | <input type="text" value="5"/> | <input type="text" value="10"/> | <input type="text" value="5"/> | <input type="text" value="10"/> | W/m² |
| Ground design temp. <input type="text" value="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 | 0,138 | 1,00 | 30,6 | 21,2 | 774 | 538 |
| External wall - Ground | B | | | 1,00 | 10,4 | 10,4 | | |
| Roof/Ceiling - Ambient | A | 83,4 | 0,108 | 1,00 | 30,6 | 21,2 | 274 | 191 |
| Floor slab / Basement ceiling | B | 80,9 | 0,131 | 1,00 | 10,4 | 10,4 | 110 | 110 |
| | A | | | 1,00 | 30,6 | 21,2 | | |
| | X | | | 0,00 | 30,6 | 21,2 | | |
| Windows | A | 43,5 | 0,777 | 1,00 | 30,6 | 21,2 | 1033 | 718 |
| Exterior door | A | | | 1,00 | 30,6 | 21,2 | | |
| Exterior TB (length/m) | A | 116,9 | -0,030 | 1,00 | 30,6 | 21,2 | -106 | -74 |
| Perimeter TB (length/m) | P | | | 1,00 | 10,4 | 10,4 | | |
| Ground TB (length/m) | B | 11,4 | 0,061 | 1,00 | 10,4 | 10,4 | 7 | 7 |
| Building element towards neighbour | I | 100,9 | 0,375 | 1,00 | 3,0 | 3,0 | 114 | 114 |

Transmission heat load P_T

Total = or

| Ventilation system: | A _{TFA} m² | Clear room height m | m³ | Heat recovery efficiency of the heat exchanger η _{HR} | Heat recovery efficiency SHX | Heat recovery efficiency SHX | η _{SHX 1} | η _{SHX 2} |
|--|---------------------------------------|------------------------------------|-----------------------------------|--|----------------------------------|------------------------------------|------------------------------------|--------------------|
| | <input type="text" value="156,0"/> | <input type="text" value="2,50"/> | <input type="text" value="390"/> | <input type="text" value="82%"/> | <input type="text" value="93%"/> | <input type="text" value="63%"/> | <input type="text" value="49%"/> | |
| Energetically effective air changes n _v | n _{v,Res} (Heating Load) 1/h | n _{v,system} 1/h | Φ _{HR} | Φ _{HR} | | | | |
| | <input type="text" value="0,047"/> | <input type="text" value="0,300"/> | <input type="text" value="0,93"/> | <input type="text" value="0,91"/> | <input type="text" value="1/h"/> | <input type="text" value="0,067"/> | <input type="text" value="0,074"/> | |

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 | 0,067 | 0,074 | 0,33 | 30,6 | 21,2 | 264 | 203 |

Total heating load P_L

P_T + P_V = or

| 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 | 0,46 | 10 | 5 | 25 | 13 |
| East | 0,0 | 0,0 | 0,40 | 30 | 5 | 0 | 0 |
| South | 30,4 | 0,5 | 0,44 | 90 | 10 | 605 | 67 |
| West | 2,0 | 0,5 | 0,40 | 35 | 5 | 14 | 2 |
| Horizontal | 0,0 | 0,0 | 0,40 | 40 | 10 | 0 | 0 |

Solar heating power P_S

Total = or

Internal heating load P_I

| Spec. power W/m² | A _{TFA} m² | P _{I 1} W | P _{I 2} W |
|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| <input type="text" value="1,9"/> | <input type="text" value="156"/> | <input type="text" value="300"/> | <input type="text" value="300"/> |

Heating power (gains) P_G

P_T + P_I = or

Heating load P_H

P_L - P_G = or

Area specific space heating load P_H / A_{TFA}

= W/m²

| Input max. supply air temperature °C | Max. supply air temperature θ _{Supply,Max} °C | Supply air temperature without heating °C | θ _{Supply,Min} °C |
|--------------------------------------|--|---|-----------------------------------|
| <input type="text" value="52"/> | <input type="text" value="52"/> | | <input type="text" value="18,0"/> |
| | | | <input type="text" value="18,1"/> |

For comparison: heating load transportable by the supply Air P_{Supply Air,Max}

= W specific: W/m²

Supply air heating: Sufficient? (Yes/No)

Summer ventilation

Passive House with PHPP Version 9.6a

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

| | | | | |
|--------------------------------|----------------------------------|----------------|------------------------------------|--|
| Building volume: | <input type="text" value="390"/> | m ³ | Building type: | <input type="text" value="Row house"/> |
| Max. indoor absolute humidity: | <input type="text" value="12"/> | g/kg | Heat recovery efficiency: | <input type="text" value="82%"/> |
| Internal humidity sources: | <input type="text" value="100"/> | g/(P*h) | Humidity recovery efficiency: | <input type="text" value="0%"/> |
| | | | Subsoil heat exchanger efficiency: | <input type="text" value="93%"/> |

| | | | | | |
|---------------------------------|-----------------------------------|--|---------------------------------|-----------------------------------|------------------------|
| Results passive cooling | | Results active cooling | | | |
| Frequency of overheating: | <input type="text" value="1,0%"/> | at the overheating limit $\vartheta_{max} = 25$ °C | Useful cooling demand: | <input type="text" value="0,8"/> | kWh/(m ² a) |
| max. humidity: | <input type="text" value="12,2"/> | g/kg | Dehumidification demand: | <input type="text" value="0,0"/> | kWh/(m ² a) |
| Frequency of exceeded humidity: | <input type="text" value="0,2%"/> | | Frequency of exceeded humidity: | <input type="text" value="0,3%"/> | |

Summer basic ventilation to ensure adequate air quality

| | | | |
|---|-------------------------------|-----|--|
| Air change rate via vent. system with supply air: | <input type="text" value=""/> | 1/h | HRV/ERV in summer (check only one field) |
| | | | None <input type="text" value=""/> |
| | | | Automatic bypass, controlled by temperature difference <input type="text" value=""/> |
| | | | Automatic bypass, controlled by enthalpy difference <input type="text" value=""/> |
| | | | Always <input type="text" value=""/> |

| | | | | | |
|---|-------------------------------|-----|---|-----------------------------------|-------------------|
| Air change rate via extract air system: | <input type="text" value=""/> | 1/h | Specific power consumption (for extract air system) | <input type="text" value="0,20"/> | Wh/m ³ |
|---|-------------------------------|-----|---|-----------------------------------|-------------------|

| | | |
|-------------------------------------|-----------------------------------|-----|
| Window ventilation air change rate: | <input type="text" value="0,36"/> | 1/h |
|-------------------------------------|-----------------------------------|-----|

Effective air change rate

| | $n_{V,system}$ 1/h | | η_{SHX} | | η_{HP} | | $n_{V,equi.fraction}$ 1/h |
|--------------------|------------------------------------|------|----------------------------------|-------|-----------------------------------|-----|------------------------------------|
| Exterior $n_{V,e}$ | <input type="text" value="0,000"/> | *(1- | <input type="text" value="93%"/> |)*(1- | <input type="text" value="0,82"/> |) = | <input type="text" value="0,000"/> |
| without HR | <input type="text" value="0,000"/> | *(1- | <input type="text" value="93%"/> |)*(1- | <input type="text" value="0,82"/> |) = | <input type="text" value="0,000"/> |
| Ground $n_{L,g}$ | <input type="text" value="0,000"/> | * | <input type="text" value="93%"/> | | | = | <input type="text" value="0,000"/> |
| without HR | <input type="text" value="0,000"/> | * | <input type="text" value="93%"/> | | | = | <input type="text" value="0,000"/> |

Ventilation conductance

| | V_V m ³ | | $n_{V,equi.fraction}$ 1/h | | C_{Air} Wh/(m ³ K) | | |
|--|----------------------------------|---|------------------------------------|---|------------------------------------|---|---------------------------------------|
| exterior $H_{V,e}$ | <input type="text" value="390"/> | * | <input type="text" value="0,000"/> | * | <input type="text" value="0,33"/> | = | <input type="text" value="0,0"/> W/K |
| without HR | <input type="text" value="390"/> | * | <input type="text" value="0,000"/> | * | <input type="text" value="0,33"/> | = | <input type="text" value="0,0"/> W/K |
| ground $H_{V,g}$ | <input type="text" value="390"/> | * | <input type="text" value="0,000"/> | * | <input type="text" value="0,33"/> | = | <input type="text" value="0,0"/> W/K |
| without HR | <input type="text" value="390"/> | * | <input type="text" value="0,000"/> | * | <input type="text" value="0,33"/> | = | <input type="text" value="0,0"/> W/K |
| Infiltration, window, extract air system | <input type="text" value="390"/> | * | <input type="text" value="0,379"/> | * | <input type="text" value="0,33"/> | = | <input type="text" value="48,8"/> W/K |

Additional summer ventilation for cooling

Additional ventilation regulation

Minimum acceptable indoor temp. °C

Type of additional ventilation

| | | | |
|---|--|-----------------------------------|--------------------------------|
| Window night ventilation, manual | Night ventilation value | <input type="text" value="0,15"/> | 1/h |
| Mechanical, automatically Controlled ventilation | Corresponding air change rate during operation, in addition to basic air change | <input type="text" value=""/> | 1/h |
| | Specific power consumption | <input type="text" value=""/> | Wh/m ³ |
| | Controlled by (please check) | Temperature diff. | <input type="text" value=""/> |
| | | Humidity diff. | <input type="text" value="x"/> |

Secondary calculation: Hygienic air change rate through window ventilation

Estimation for window air change rate to ensure sufficient air quality

| | | | | | | | | |
|---|--|---------------|------------------|------|------|------|------|----------|
| Description | | Day GF | 1st floor | | | | | |
| 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 |
| Result: Air change rate | | Total | | | | | | |
| | | 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 | | Night | | | | | | |
| Reduction factor | | 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 |
| Result: Night ventilation values | | Total | | | | | | |
| | | 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: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 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/(m³h) |
| Spec. capacity: 204 Wh/(m²K) | |

| Building assembly | Temperature zone | Area m² | U-Value W/(m²K) | Red. factor f _{T,Summer} | H _{Summer} heat conduction |
|-------------------------------|------------------|---------|-----------------|-----------------------------------|-------------------------------------|
| External wall - Ambient | A | 184,3 | 0,138 | 1,00 | 25,3 |
| External wall - Ground | B | | | 1,00 | |
| Roof/Ceiling - Ambient | A | 83,4 | 0,108 | 1,00 | 9,0 |
| Floor slab / Basement ceiling | B | 80,9 | 0,131 | 1,00 | 10,6 |
| | A | | | 1,00 | |
| | A | | | 1,00 | |
| | X | | | 0,00 | |
| Windows | A | 43,5 | 0,777 | 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} | 64,6 W/K |
| Ground thermal transmittance, H _{T,g} | 11,3 W/K |

Summer ventilation

| | | |
|---|---|---|
| Ventilation unit conductance exterior H _{V,e} 0,0 W/K without HR 0,0 W/K ground H _{V,g} 0,0 W/K without HR 0,0 W/K Ventilation conductance, others exterior 48,8 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 0,00 1/h Outdoor air changes 0,38 1/h Window night ventilation air change rate, manual @ 1K 0,15 1/h Air change rate due to mech. automatically controlled vent. 0,00 1/h Specific power consumption for 0,00 Wh/m³ η _{HR} 82% η _{ERV} 0% η* _{SHX} 93% | Summer ventilation regulation HRV/ERV None Controlled by temperature Controlled by enthalpy Always Controlled by temperature 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 | 0,92 | 0,95 | 0,50 | 11,0 | 64% | 2,8 |
| East | 0,9 | 1,00 | 0,95 | 0,00 | 0,0 | 0% | 0,0 |
| South | 0,9 | 0,30 | 0,95 | 0,50 | 30,4 | 65% | 2,5 |
| West | 0,9 | 0,94 | 0,95 | 0,50 | 2,0 | 60% | 0,5 |
| Horizontal | 0,9 | 1,00 | 0,95 | 0,00 | 0,0 | 0% | 0,0 |
| Sum opaque areas | | | | | | | 1,1 |

Solar aperture Total **6,9** m²/m² **0,04**

| | | | | |
|------------------------------------|--|--------------------------------|--------------|-----------------|
| Internal heat gains Q _i | Specif. power q _i 2,4 W/m² | A _{TFA} 156 m² | W 378 | W/m² 2,4 |
|------------------------------------|--|--------------------------------|--------------|-----------------|

Frequency of overheating h_o ≥ J_{max} **1,0%** **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

$$\left(\frac{9,1}{1000} + \frac{9,9}{1000} + \frac{26,6}{1000} \right) * 1000 / \left(\frac{204}{156} \right) = 1,4 \text{ K}$$

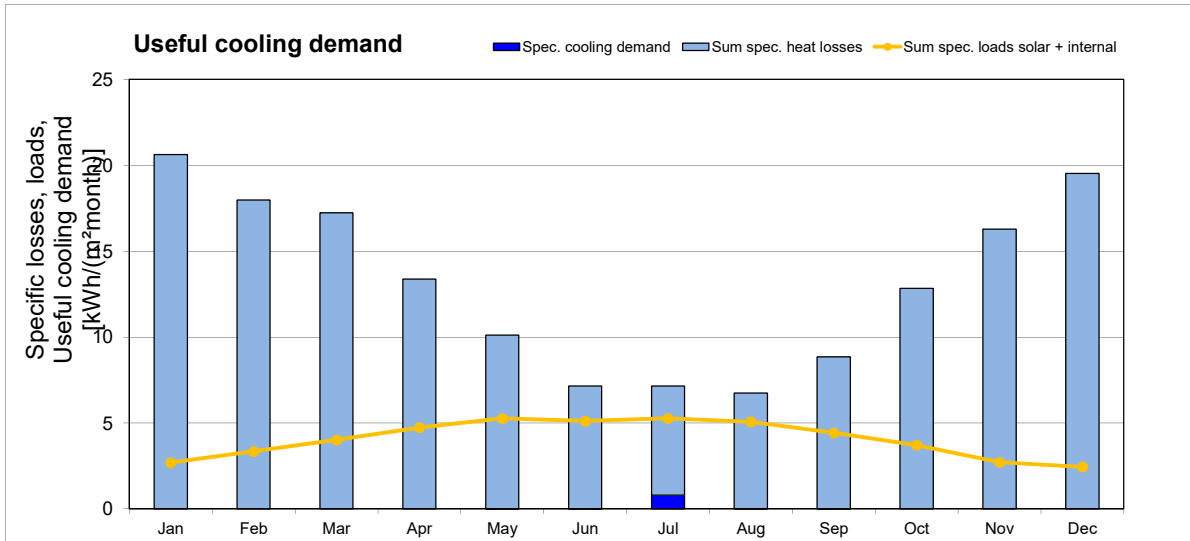
Cooling: energy value for useful cooling energy

Passive House with PHPP Version 9.6a

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 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 | 18,8 | 16,4 | 15,8 | 12,5 | 9,5 | 6,6 | 5,8 | 6,2 | 8,3 | 12,0 | 15,1 | 17,9 | 145 | kKh |
| Heating degree hours - Ground | 11,1 | 10,4 | 11,4 | 9,9 | 9,5 | 8,4 | 8,0 | 7,7 | 7,5 | 8,9 | 9,3 | 10,5 | 113 | kKh |
| Losses - Exterior | 2109 | 1839 | 1771 | 1390 | 1050 | 735 | 646 | 694 | 926 | 1340 | 1685 | 2004 | 16191 | kWh |
| Losses - Ground | 126 | 117 | 129 | 112 | 107 | 95 | 90 | 86 | 85 | 100 | 105 | 118 | 1270 | kWh |
| Losses summer ventilation | 984 | 848 | 788 | 587 | 420 | 285 | 255 | 271 | 370 | 563 | 749 | 924 | 7045 | kWh |
| Sum spec. heat losses | 20,6 | 18,0 | 17,2 | 13,4 | 10,1 | 7,1 | 6,4 | 6,7 | 8,9 | 12,8 | 16,3 | 19,5 | 157,1 | kWh/m ² |
| Solar load North | 28 | 42 | 73 | 104 | 140 | 154 | 154 | 123 | 84 | 51 | 28 | 20 | 1002 | kWh |
| Solar load East | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar load South | 87 | 177 | 198 | 249 | 255 | 228 | 240 | 258 | 240 | 189 | 96 | 63 | 2278 | kWh |
| Solar load West | 7 | 14 | 21 | 32 | 40 | 39 | 40 | 35 | 27 | 16 | 8 | 5 | 283 | kWh |
| Solar load Horiz. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | kWh |
| Solar load Opaque | 19 | 36 | 54 | 83 | 106 | 106 | 108 | 94 | 69 | 43 | 21 | 13 | 750 | kWh |
| Internal heat gains | 281 | 254 | 281 | 272 | 281 | 272 | 281 | 281 | 272 | 281 | 272 | 281 | 3308 | kWh |
| Sum spec. loads solar + internal | 2,7 | 3,3 | 4,0 | 4,7 | 5,3 | 5,1 | 5,3 | 5,1 | 4,4 | 3,7 | 2,7 | 2,4 | 48,9 | kWh/m ² |
| Utilisation factor losses | 13% | 19% | 23% | 35% | 52% | 72% | 70% | 75% | 50% | 29% | 17% | 13% | 31% | |
| Useful cooling energy demand | 0 | 0 | 0 | 0 | 0 | 1 | 126 | 1 | 0 | 0 | 0 | 0 | 128 | kWh |
| Spec. cooling demand | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,8 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,8 | kWh/m ² |
| 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/m ² |
| Sensible fraction | 100% | 100% | 100% | 100% | 100% | 100% | 98% | 100% | 100% | 100% | 100% | 100% | 98% | |



Cooling: energy value for useful cooling energy

Passive House with PHPP Version 9.6a

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 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 m ² |
| Interior temperature summer: | 25 °C | Building volume: | 390 m ³ |
| Nominal humidity: | 12 g/kg | Internal humidity sources: | 1,9 g/(m ² h) |
| Spec. capacity: | 204 Wh/(m ² K) | | |

| Building assembly | Temperature zone | Area m ² | U-Value W/(m ² K) | Mon. red. fac. | G _i kWh/a | kWh/a | per m ² treated floor area |
|-------------------------------|------------------|---------------------|------------------------------|----------------|----------------------|--------------|---------------------------------------|
| External wall - Ambient | A | 184,3 | 0,138 | 1,00 | 15 | 385 | 2,47 |
| External wall - Ground | B | | | 1,00 | | | |
| Roof/Ceiling - Ambient | A | 83,4 | 0,108 | 1,00 | 15 | 136 | 0,87 |
| Floor slab / Basement ceiling | B | 80,9 | 0,131 | 1,00 | 20 | 216 | 1,39 |
| | A | | | 1,00 | | | |
| | A | | | 1,00 | | | |
| | X | | | 0,00 | | | |
| Windows | A | 43,5 | 0,777 | 1,00 | 15 | 513 | 3,29 |
| Exterior door | A | | | 1,00 | | | |
| Exterior TB (length/m) | A | 116,9 | -0,030 | 1,00 | 15 | -53 | -0,34 |
| Perimeter TB (length/m) | P | | | 1,00 | | | 0,00 |
| Ground TB (length/m) | B | 11,4 | 0,061 | 1,00 | 20 | 14 | 0,09 |
| | | | | | | Total | 7,8 |

Transmission losses Q_T (negative: heat loads)

Summer ventilation

| | | |
|---|--|---|
| Ventilation conductance, vent. unit | Ventilation parameter | Summer ventilation regulation |
| exterior H _{v,e} without HR: 0,0 W/K | Temperature amplitude summer: 11,7 K | HRV/ERV in summer: <input type="checkbox"/> |
| ground H _{v,g} without HR: 0,0 W/K | Minimum acceptable indoor temperature: 22,0 °C | Controlled by temp.: <input type="checkbox"/> |
| exterior: 48,8 W/K | Heat capacity air: 0,33 Wh/(m ² K) | Controlled by enthalpy: <input type="checkbox"/> |
| | Supply air changes: 0,00 1/h | Always: <input type="checkbox"/> |
| | Outdoor air changes: 0,38 1/h | Controlled by temp.: <input type="checkbox"/> |
| | Window night vent. air change rate, manual @ 1K: 0,15 1/h | Controlled by humidity: <input checked="" type="checkbox"/> |
| | Air changes rate due to mech., autom. controlled vent.: 0,00 1/h | |
| | Specific power consumption for: 0,00 Wh/m ³ | |
| | η _{HR} : 82% | |
| | η _{ERV} : 0% | |
| | η*SHX: 93% | |

Hygienic air change

| | | | | | |
|--|-------|------------|-------------|---------|---------|
| Effective air change rate Ambient n _{v,e} | 0,000 | *(1 - 93%) | *(1 - 0,82) | + 0,379 | = 0,379 |
| Effective air change rate Ground n _{v,g} | 0,000 | *(1 - 93%) | *(1 - 0,82) | | = 0,000 |

Ventilation losses ambient Q_V

| | | | | | |
|-------------------------------|----------------------------------|--|----------------------|-------|------------------------|
| V _v m ³ | n _{v,equi} fraction 1/h | C _{Air} Wh/(m ² K) | G _i kWh/a | kWh/a | kWh/(m ² a) |
| 390 | 0,379 | 0,33 | 14 | 698 | 4,5 |

Ventilation losses ground Q_{V,g}

| | | | | | |
|-------------------------------|----------------------------------|--|----------------------|-------|------------------------|
| V _v m ³ | n _{v,equi} fraction 1/h | C _{Air} Wh/(m ² K) | G _i kWh/a | kWh/a | kWh/(m ² a) |
| 390 | 0,000 | 0,33 | 0 | 0 | 0,0 |

Heat losses summer ventilation

| | | | | | |
|-------------------------------|----------------------------------|--|----------------------|-------|------------------------|
| V _v m ³ | n _{v,equi} fraction 1/h | C _{Air} Wh/(m ² K) | G _i kWh/a | kWh/a | kWh/(m ² a) |
| 390 | 0,237 | 0,33 | 21 | 655 | 4,2 |

Ventilation heat losses Q_V

| | | |
|--------------|-------------|------------|
| Total | 1353 | 8,7 |
|--------------|-------------|------------|

Total heat losses Q_L

| | | | | | | | | |
|----------------------|------|---|----------------------|------|---|------|-------|-----------------------------|
| Q _T kWh/a | 1212 | + | Q _V kWh/a | 1353 | = | 2565 | kWh/a | 16,4 kWh/(m ² a) |
|----------------------|------|---|----------------------|------|---|------|-------|-----------------------------|

Orientation of the area

| Orientation of the area | Reduction factor | g-Value (perp. radiation) | Area m ² | Global radiation kWh/(m ² a) | kWh/a |
|-------------------------|------------------|---------------------------|---------------------|---|-------------|
| North | 0,51 | 0,50 | 11,0 | 133 | 373 |
| East | 0,40 | 0,00 | 0,0 | 211 | 0 |
| South | 0,20 | 0,50 | 30,4 | 219 | 657 |
| West | 0,48 | 0,50 | 2,0 | 208 | 101 |
| Horizontal | 0,40 | 0,00 | 0,0 | 366 | 0 |
| Sum opaque areas | | | | | 272 |
| Total | | | | | 1403 |

Available solar heat gains Q_S

| | | |
|--------------|-------------|------------|
| Total | 1403 | 9,0 |
|--------------|-------------|------------|

Internal heat gains Q_I

| | | | | | | | | | | | |
|------|-------|-------------------------|----|---|-----|---------------------------------|-------|-------|-----|------------------------|-----|
| kh/d | 0,024 | Length heat. period d/a | 78 | Spec. power q _i W/m ² | 2,4 | A _{TFA} m ² | 156,0 | kWh/a | 707 | kWh/(m ² a) | 4,5 |
|------|-------|-------------------------|----|---|-----|---------------------------------|-------|-------|-----|------------------------|-----|

Sum heat loads Q_F

| | | | | |
|---------------------------------|---|------|-------|-----------------------------|
| Q _S + Q _I | = | 2110 | kWh/a | 13,5 kWh/(m ² a) |
|---------------------------------|---|------|-------|-----------------------------|

Ratio of losses to free heat gains Q_L / Q_F = 1,22

Utilisation factor heat losses η_G = 77%

Useful heat losses Q_{V,n} η_G * Q_L = 1982 kWh/a 12,7 kWh/(m²a)

Useful cooling demand Q_K Q_F - Q_{V,n} = 128 kWh/a 1 kWh/(m²a)

Recommended maximum value 15 kWh/(m²a)

Requirement met? **Yes**

Compressor - cooling units

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

| | | | | |
|------------------------------|-----------|---------------------------------------|---|----------------|
| Building type: | Row house | Treated floor area A _{TFA} : | 156,0 | m ² |
| Interior temperature summer: | 25,0 | °C | Mechanical cooling: | |
| Nominal humidity: | 12,0 | g/kg | Air change rate via ventilation system with supply air: | 0,0 |
| Internal humidity sources: | 1,9 | g/(m ³ h) | | |

Supply air cooling

check as appropriate

| | | |
|---|-----|----|
| On/Off mode (check as appropriate) | x | |
| Max. cooling capacity (sensible + latent) | 1,0 | kW |
| Temperature reduction dry | | K |
| Seasonal energy efficiency ratio | 2,0 | |

Recirculation cooling

check as appropriate

| | | |
|--|-------|-------------------|
| On/Off mode (check as appropriate) | x | |
| Max. cooling capacity (sensible + latent) | 2,0 | kW |
| Volume flow rate at nominal power | 600,0 | m ³ /h |
| Temperature reduction dry | 9,8 | K |
| Variable air volume (check if appropriate) | | |
| Seasonal energy efficiency ratio | 3,2 | |

Additional dehumidification

check as appropriate

| | | |
|---|-----|--|
| Waste heat to room (check if appropriate) | x | |
| Seasonal energy efficiency ratio | 2,0 | |

Panel cooling

check as appropriate

| | | |
|----------------------------------|-----|--|
| Seasonal energy efficiency ratio | 3,0 | |
|----------------------------------|-----|--|

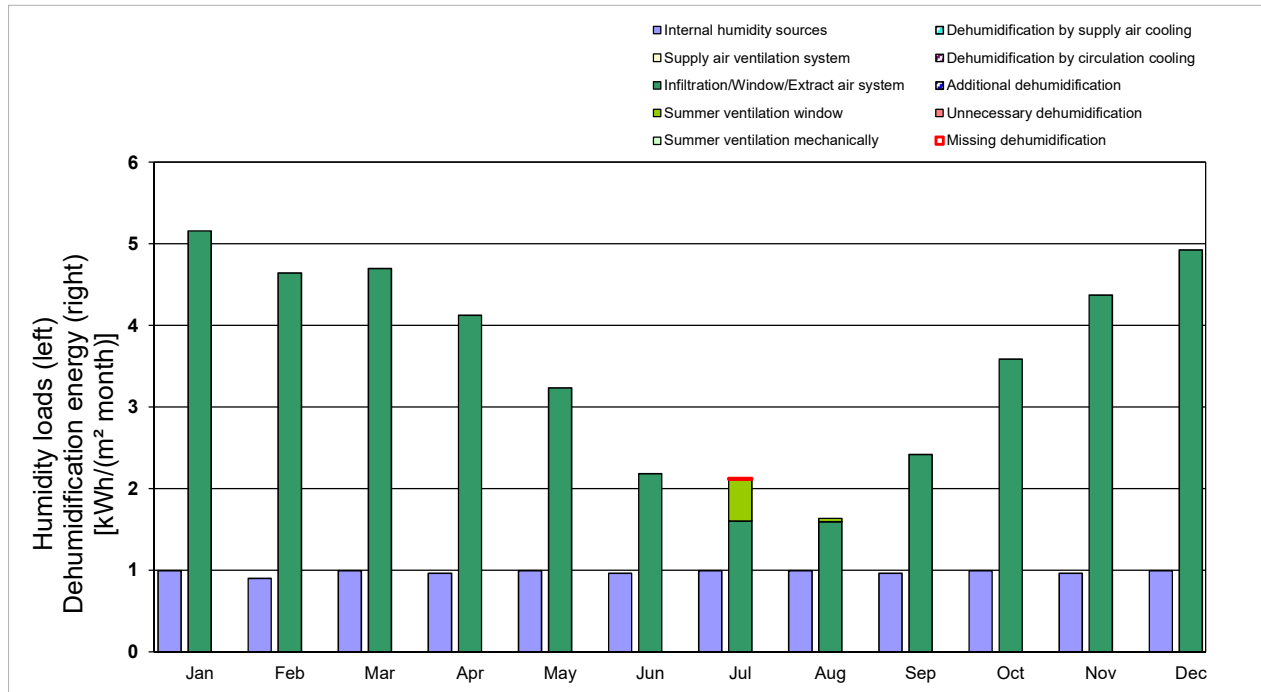
| | Sensible kWh/(m ² a) | Latent kWh/(m ² a) | COP | Electricity demand (kWh/a) kWh/(m ² a) | Sensible fraction |
|------------------------------------|------------------------------------|----------------------------------|-----|--|-------------------|
| Useful cooling total | 0,8 | 0,0 | | | 98% |
| Cooling contribution by: | | | | | |
| Supply air cooling | () + () |) / | 2,0 | = | () |
| Recirculation cooling | () + () |) / | 3,2 | = | () |
| Dehumidification | () |) / | | = | 0% |
| Remaining for panel cooling | () |) / | 3,0 | = | 100% |
| Cooling distribution | () |) / | | = | 100% |
| Total | (0,0 + 0,0) |) / | | = 0,0 | 0% |
| Unsatisfied demand | () | () | | Cooling demand covered? | (Yes/No) () |

Compressor - cooling units

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 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/m ² |
| Infiltration/Window/Extract air system | -5,2 | -4,6 | -4,7 | -4,1 | -3,2 | -2,2 | -1,6 | -1,6 | -2,4 | -3,6 | -4,4 | -4,9 | -43 | kWh/m ² |
| Supply air ventilation system | 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/m ² |
| Summer ventilation window | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | -0,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | -1 | kWh/m ² |
| 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/m ² |
| 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/m ² |
| 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/m ² |
| 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/m ² |
| 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/m ² |
| 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 | kWh/m ² |
| 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/m ² |
| 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/m ² |



Cooling load

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 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** W/(m²·K)
 Nominal humidity: **12,0** g/kg
 Internal humidity sources: **1,9** g/(m²·h)

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
 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 m ² | U-Value W/(m ² K) | Factor always 1 (except "X") | TempDiff 1 K | TempDiff 2 K | P _T 1 W | P _T 2 W |
|------------------------------------|------------------|---------------------|------------------------------|------------------------------|--------------|--------------|--------------------|--------------------|
| External wall - Ambient | A | 184,3 | 0,138 | 1,00 | -1,0 | -1,0 | -25 | -25 |
| External wall - Ground | B | | | 1,00 | -10,3 | -10,3 | | |
| Roof/Ceiling - Ambient | A | 83,4 | 0,108 | 1,00 | -1,0 | -1,0 | -9 | -9 |
| Floor slab / Basement ceiling | B | 80,9 | 0,131 | 1,00 | -10,3 | -10,3 | -109 | -109 |
| | A | | | 1,00 | -1,0 | -1,0 | | |
| | X | | | 0,00 | -1,0 | -1,0 | | |
| Windows | A | 43,5 | 0,777 | 1,00 | -1,0 | -1,0 | -34 | -34 |
| Exterior door | A | | | 1,00 | -1,0 | -1,0 | | |
| Exterior TB (length/m) | A | 116,9 | -0,030 | 1,00 | -1,0 | -1,0 | 3 | 3 |
| Perimeter TB (length/m) | P | | | 1,00 | -10,3 | -10,3 | | |
| Ground TB (length/m) | B | 11,4 | 0,061 | 1,00 | -10,3 | -10,3 | -7 | -7 |
| Building element towards neighbour | I | 100,9 | 0,375 | 1,00 | 3,0 | 3,0 | 114 | 114 |
| Radiation correction outdoor air | | | L _{amb} W/K | -4,7 | -1,0 | -1,0 | 5 | 5 |
| Radiation correction sky | | | L _{sk} W/K | 4,7 | -11,9 | -9,1 | -56 | -42 |

Transmission heat load P_T Total = **-118** or **-105**

| Ventilation load | V _V m ³ | n _{V,eq} fraction 1/h | n _{V,eq} fraction 1/h | C _{air} Wh/(m ³ K) | TempDiff 1 K | TempDiff 2 K | P _V 1 W | P _V 2 W |
|-------------------------------------|-------------------------------|--------------------------------|--------------------------------|--|--------------|--------------|--------------------|--------------------|
| Exterior P _{V,o} | 390 | 0,379 | 0,379 | 0,33 | -1,0 | -1,0 | -49 | -49 |
| Ground P _{V,e} | 390 | 0,000 | 0,000 | 0,33 | -15,0 | -15,0 | 0 | 0 |
| Summer ventilation P _{V,S} | 390 | 0,156 | 0,156 | 0,33 | -4,7 | -4,7 | -95 | -95 |

Ventilation heat load P_V Total = **-144** or **-144**

| Orientation of the area | Area m ² | g-Value (perp. radiation) | Reduction factor (see 'Windows' worksheet) | Radiation 1 W/m ² | Radiation 2 W/m ² | P _T 1 W | P _T 2 W |
|-------------------------|---------------------|---------------------------|--|------------------------------|------------------------------|--------------------|--------------------|
| North | 11,0 | 0,5 | 0,51 | 100 | 100 | 281 | 281 |
| East | 0,0 | 0,0 | 0,40 | 180 | 180 | 0 | 0 |
| South | 30,4 | 0,5 | 0,17 | 200 | 200 | 504 | 504 |
| West | 2,0 | 0,5 | 0,48 | 180 | 180 | 87 | 87 |
| Horizontal | 0,0 | 0,0 | 0,40 | 330 | 330 | 0 | 0 |
| Sum opaque areas | | | | | | 238 | 238 |

Solar load P_S Total = **1110** or **1110**

| Internal heating load P _I | Spec. power W/m ² | A _{TFA} m ² | P _I 1 W | P _I 2 W |
|--------------------------------------|------------------------------|---------------------------------|--------------------|--------------------|
| | 2,4 | 156 | 378 | 378 |

P_T + P_V + P_S + P_I = **1226** or **1239**

Cooling load P_C = **1239** W
Area specific cooling load P_C / A_{TFA} = **7,9** W/m²

Please enter the minimum supply air temperature. **3** °C Supply air temperature without cooling **22,5** °C

For comparison: cooling load, transportable through the supply air P_{Supply;Max} = **0** W
 specific: **0,0** W/m²

Air conditioning over the supply air possible? **No**

Daily internal temperature stroke ((-104,7 + -143,9 + 1110,0) * 24 / (204 * 156)) = **0,6** K

| Absolute humidity exterior air | g/kg | Absolute humid. supply air | g/kg |
|--------------------------------|------|----------------------------|------|
| 11,3 | 11,3 | 8,1 | 8,1 |
| Outdoor air mass flow | 174 | Supply air mass flow | 0 |
| Summer vent. air mass flow | 75 | Humid. load, supply air | 0 |
| Humidity load, outdoor air | -170 | Humidity load, internal | 295 |

Enthalpy of vaporisation 707,639 Wh/kg / 1000 g/kg * Humidity load 125 g/h = **89** W

Dehumidification load P_T = **89** W

Area specific dehumidification load P_T / A_{TFA} = **0,6** 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 | 0,8 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 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 |
| Sensible fraction | 100% | 100% | 100% | 100% | 100% | 100% | 98% | 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: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 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} : | 1953 | kWh/a | Annual useful cooling dem. q _{Cool} : | 128 | kWh/a |
| Length of heating period: | 219 | d | Length cooling period: | 78 | d |
| Average heating load P _{ave} : | 0,4 | kW | Average cooling load P _{Average} : | 0,1 | kW |
| Marginal usability of additional heat gains: | 69% | | Marginal utility of additional heat losses: | 24% | |

Space heat distribution

| | | | | | | | |
|---|------------------------------|-----------|----------|------|------|------|------|
| 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 |
| Design forward flow temperature | ϑ _v | °C | 55,0 | 55,0 | 55,0 | 55,0 | 55,0 |
| Design system heating load | P _{Heating} | kW | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 |
| Forward flow temperature control ('x' if appropriate) | | | 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) | 6 | | | | |
| Possible utilisation factor of released heat | η _G | - | 69% | | | | |
| Annual heat losses of heating distribution | Q _{HL} | kWh/a | 24 | | | | |
| Annual heat losses of heating storage | | kWh/a | | | | | |
| Annual heat losses of heating | | kWh/a | | | | | |
| Performance ratio of heat distribution | ea _{HL} | - | | | | | |

| Inside thermal envelope | | | | | |
|---|----------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 |
| Length of distribution pipes | 13,5 | | | | |
| Nominal width of pipe | 20 | | | | |
| Insulation thickness | 40 | | | | |
| Thermal conductivity of insulation | 0,035 | | | | |
| Heat loss coefficient per m of insulated pipe | 0,135 | | | | |
| Insulation quality of mountings, pipe suspensions, etc. | 3 - Good | | | | |
| Thermal bridge supplement | 0,208 | | | | |
| Total heating loss coefficient per m of pipe | 0,150 | | | | |
| Temp. of the room through which the pipes pass | 20 | 20 | 20 | 20 | 20 |
| Design forward flow temperature | 55,0 | 55,0 | 55,0 | 55,0 | 55,0 |
| Design system heating load | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 |
| Forward flow temperature control ('x' if appropriate) | x | x | x | x | x |
| Design return flow temperature | 45,0 | | | | |
| Annual heat emission per m of plumbing | 6 | | | | |
| Possible utilisation factor of released heat | 69% | | | | |
| Annual heat losses of heating distribution | 24 | | | | |

| Outside thermal envelope | | | | | |
|---|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 |
| Length of distribution pipes | | | | | |
| Nominal width of pipe | | | | | |
| Insulation thickness | | | | | |
| Thermal conductivity of insulation | | | | | |
| Heat loss coefficient per m of insulated pipe | | | | | |
| Insulation quality of mountings, pipe suspensions, etc. | | | | | |
| Thermal bridge supplement | | | | | |
| Total heating loss coefficient per m of pipe | | | | | |
| Temp. of the room through which the pipes pass | 11,0 | 11,0 | 11,0 | 11,0 | 11,0 |
| Design forward flow temperature | 55,0 | 55,0 | 55,0 | 55,0 | 55,0 |
| Design system heating load | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 |
| Forward flow temperature control ('x' if appropriate) | x | x | x | x | x |
| Design return flow temperature | | | | | |
| Annual heat emission per m of plumbing | | | | | |
| Possible utilisation factor of released heat | | | | | |
| Annual heat losses of heating distribution | | | | | |

| Total values | |
|--------------|----------|
| Absolute | Specific |

| | | | |
|-------|------|-----------|-----|
| kWh/a | 24 | kWh/(m²a) | 0,2 |
| | 0 | | 0,0 |
| | 24 | | 0,2 |
| | 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_{FW} °C | 10,0 |
| DHW demand for washing machines and dishwashers non-ele | 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)

DHW distribution

Temp. of room through which the pipes pass ϑ_x °C
 Design forward flow temperature ϑ_{dist} °C

| Inside thermal envelope | | | | |
|-------------------------|------|------|------|------|
| 1 | 2 | 3 | 4 | 5 |
| 20,0 | 20,0 | 20,0 | 20,0 | 20,0 |
| 60,0 | 60,0 | 60,0 | 60,0 | 60,0 |

| Outside thermal envelope | | | | |
|--------------------------|------|------|------|------|
| 1 | 2 | 3 | 4 | 5 |
| 11,0 | 11,0 | 11,0 | 11,0 | 11,0 |
| 60,0 | 60,0 | 60,0 | 60,0 | 60,0 |

| Total values | |
|--------------|----------|
| Absolute | Specific |

DHW circulation pipes

Length of circulation pipes (forward + return flow) L_{HS} m
 Nominal width of pipe mm
 Insulation thickness mm
 Insulative reflective coating? -
 Thermal conductivity of insulation $W/(mK)$
 Heat loss coefficient per m of insulated pipe $W/(mK)$
 Insulation quality of mountings, pipe suspensions, etc. -
 Thermal bridge supplement W/K
 Total heating loss coefficient per m of pipe Ψ $W/(mK)$
 Daily circulation period of operation. t_{dCirc} h/d
 Design return flow temperature ϑ_R °C
 Circulation period of operation per year t_{Circ} h/a
 Annual heat released per m of pipe q^*_z kWh/m/a
 Annual heat loss from circulation lines Q_Z kWh/a

| | | | | |
|----------|--|--|--|--|
| 13,5 | | | | |
| 20 | | | | |
| 40 | | | | |
| - | | | | |
| 0,035 | | | | |
| 0,135 | | | | |
| 3 - Good | | | | |
| 0,208 | | | | |
| 0,150 | | | | |
| 18,0 | | | | |
| 55 | | | | |
| 6570 | | | | |
| 37 | | | | |
| 499 | | | | |

| | | | | |
|----------|--|--|--|--|
| 2,00 | | | | |
| 20 | | | | |
| 40 | | | | |
| - | | | | |
| 0,035 | | | | |
| 0,135 | | | | |
| 3 - Good | | | | |
| 0,150 | | | | |
| 0,210 | | | | |
| 18,0 | | | | |
| 55 | | | | |
| 6570 | | | | |
| 64 | | | | |
| 128 | | | | |

| | |
|-------|-----------|
| kWh/a | kWh/(m²a) |
| 627 | 4,0 |

DHW individual pipes

Exterior pipe diameter d_{U_Pipe} m
 Accumulated length per single pipes L_U m
 Amount of tapping points in building $n_{tapping\ point}$ -
 Average pipe length per tapping point $L_{U_average}$ m
 Tap openings per person per day -
 Utilisation days per year d
 Heat loss per tap opening $q_{individual}$ h/tap opening
 Amount of tap openings per year and person n_{Tap} ings per year
 Annual heat loss of individual pipes Q_U kWh/a

| | | | | |
|--------|--|--|--|--|
| 0,012 | | | | |
| 9,00 | | | | |
| 3,00 | | | | |
| 3,0 | | | | |
| 6 | | | | |
| 365 | | | | |
| 0,0107 | | | | |
| 2190 | | | | |
| 69 | | | | |

| | | | | |
|--|--|--|--|--|
| | | | | |
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| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

| | |
|-------|-----------|
| kWh/a | kWh/(m²a) |
| 69 | 0,4 |

Total heat losses of DHW distribution Q_{WL}

Performance ratio of DHW distribution pipes ea_{+HL} -

| | |
|-------|-----------|
| kWh/a | kWh/(m²a) |
| 697 | 4,5 |

| |
|------|
| 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 400 | 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 | | | | kWh/a 1288 | kWh/(m²a) 8,3 |
| Annual heat losses buffer storage tank | --- | --- | | | | |

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

Total energy demand of domestic hot water

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

Solar thermal system

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

| | | |
|--|-----------|----------------|
| Building type: | Row house | |
| Treated floor area A _{TFA} : | 156,0 | m ² |
| Projected building footprint A _{Projected} : | 80,9 | m ² |
| Latitude (Climate worksheet) | 51,3 | ° |
| DHW demand (DHW+Distribution) | 3758 | kWh/a |
| Heating demand ('Heating' and 'DHW+Distribution' worksheets) | 1976 | kWh/a |
| Occupancy | 2,9 | Persons |

| | | |
|---|--------|----------------|
| Location: Selection in 'Areas' worksheet | 4-Roof | |
| Size of selected area | 83 | m ² |
| Free area (less solar thermal and electrical systems) | 12,1 | m ² |
| Deviation from North | 180 | ° |
| Angle of inclination from the horizontal | 45 | ° |
| Alternative input: Deviation from North | 180 | ° |
| Alternative input: Angle of inclination from the horizontal | 45 | ° |

| | |
|--|---------------------------------|
| Collector | 6-Standard flat plate collector |
| Heating support (check if appropriate) | x |
| DHW priority (check if appropriate) | |

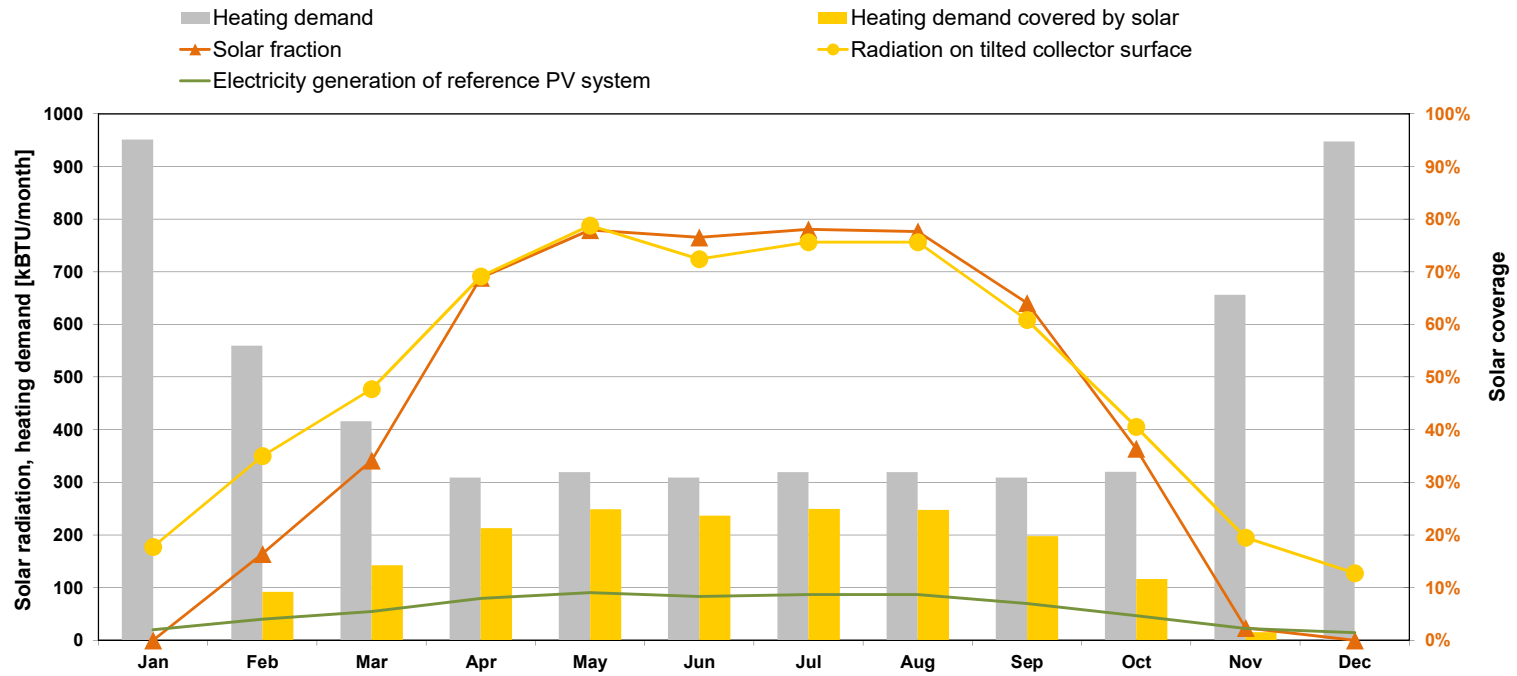
| | | |
|-------------------------------------|--------------------|----------------------|
| Solar collector area | 5,40 | m ² |
| Specific collector area | 1,8 | m ² /Pers |
| Height of the collector field | 1,00 | m |
| Height of horizon | 0,00 | m |
| Horizontal distance | 1000,00 | m |
| Additional reduction factor shading | r _{other} | |

Results

| | footprint area | Absolute |
|-------------------------------------|--|----------|
| | kWh/(m ² _{Projected} ·a) | kWh/a |
| Solar contribution total | 31% | 21,7 |
| Solar contribution to DHW | 42% | 19,5 |
| Solar contribution to space heating | 9% | 2,2 |

| Determination of PER factors | | |
|------------------------------|---|---|
| Yield reference PV syst. | PER _{el} | PER _{sol,therm} |
| kWh _{el} /a | kWh _{prim-el} /kWh _{el} | $\frac{kWh_{sol,therm}}{kWh_{DHW} + kWh_{space}}$ |
| 693 | 1,35 | 0,29 |
| 621,4 | 1,30 | 0,30 |
| 71,6 | 1,80 | 0,22 |

| | kgCO ₂ eq/ kWhFinal | kgCO ₂ eq/ a | kgCO ₂ eq/a |
|-------------------------------|--------------------------------|-------------------------|------------------------|
| 1-CO2 factors GEMIS (Germany) | 0,045 | 1,0 | 79 |



| | 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 | 632 | 271 | 97 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 347 | 628 | 1976 | kWh/month |
| Heating demand | 951 | 559 | 416 | 309 | 319 | 309 | 319 | 319 | 309 | 320 | 656 | 948 | 5735 | kWh/month |
| Radiation on tilted collector surface | 177 | 350 | 477 | 691 | 788 | 724 | 756 | 756 | 609 | 405 | 195 | 127 | 6056 | 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 | 8 | 61 | 213 | 249 | 237 | 249 | 248 | 198 | 116 | 0 | 0 | 1577 | kWh/month |
| Space heating demand covered by solar | 0 | 84 | 82 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 15 | 0 | 182 | kWh/month |
| Heating demand covered by solar | 0 | 92 | 142 | 213 | 249 | 237 | 249 | 248 | 198 | 117 | 15 | 0 | 1759 | kWh/month |
| Solar fraction | 0% | 16% | 34% | 69% | 78% | 77% | 78% | 78% | 64% | 36% | 2% | 0% | 31% | - |
| Electricity generation of reference PV system | 20 | 40 | 55 | 79 | 90 | 83 | 86 | 86 | 70 | 47 | 22 | 14 | 693 | kWh/month |

Photovoltaic systems

Passive House with PHPP Version 9.6a

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,8 kWh/(m²a)

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

Name of system
 Location: Selection in 'Areas' worksheet
 Size of selected area
 Deviation from North
 Angle of inclination from horizontal
 Alternative input: Deviation from North
 Alternative input: Angle of inclination from the horizontal

| System 1 | System 2 | | | | Reference PV syst. |
|----------|-----------------------|--|--|--|--------------------|
| 4-Roof | 1-External wall south | | | | 4-Roof |
| 83,4 | 43,1 | | | | 83,4 |
| 180 | 180 | | | | 180 |
| 30 | 90 | | | | 45 |
| 180 | | | | | |
| 30 | | | | | |

Information from the module data sheet

Technology
 Nominal current
 Nominal voltage
 Nominal power
 Temperature coefficient short-circuit current
 Temperature coefficient open-circuit voltage
 Module dimensions: Height
 Module dimensions: Width

| | 4-Mono-Si | 5-Poly-Si | | | | 4-Mono-Si |
|------------|-----------|-----------|---|---|---|------------------|
| I_{MPP0} | 7,71 | 7,71 | | | | 7,71 |
| U_{MPP0} | 30,50 | 30,50 | | | | 30,50 |
| P_n | 235 | 235 | 0 | 0 | 0 | 235 |
| α | 0,040 | 0,040 | | | | 0,040 |
| β | -0,340 | -0,340 | | | | -0,340 |
| | 1,658 | 1,658 | | | | 1,658 |
| | 0,994 | 0,994 | | | | 0,994 |
| | | | | | | 1,6 |
| | | | | | | Module area [m²] |

Further specifications

Number of modules
 Height of module array
 Height of horizon
 Horizontal distance
 Additional reduction factor shading
 Efficiency of the inverter

| | 40 | 14 | | | | 3,3 |
|-------------------|-----|------|--|--|--|--------|
| n_{M} | 40 | 14 | | | | 3,3 |
| | 2,0 | 3,0 | | | | 1 |
| h_{hor} | | 5,0 | | | | 0 |
| a_{hor} | | 20,0 | | | | 1000,0 |
| r_{other} | 95% | 90% | | | | |
| $\eta_{inverter}$ | 95% | 95% | | | | 95% |

Results

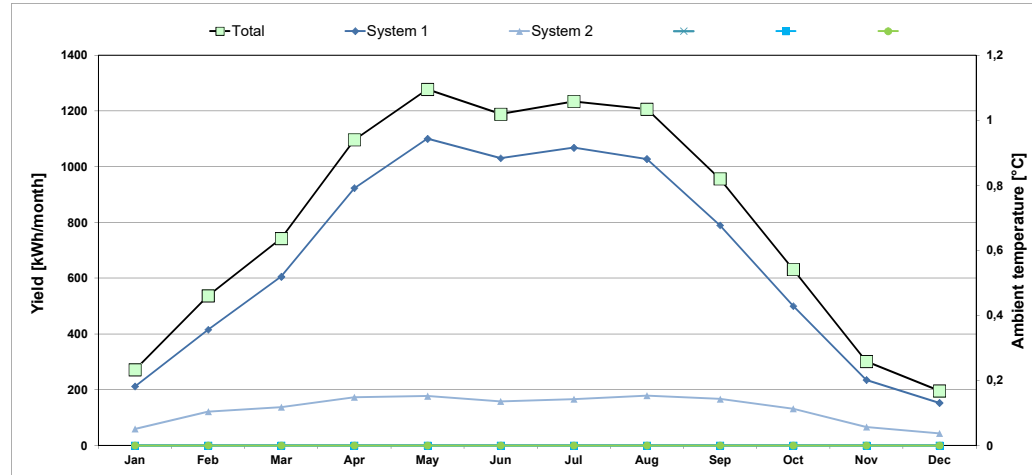
Area of module field
 Free area on the selected building element
 Allocation to building element
 Annual losses due to shading

| | | | | | | |
|--|------|------|-----|-----|-----|------|
| | 65,9 | 23,1 | 0,0 | 0,0 | 0,0 | 5,4 |
| | 12,1 | 20,0 | | | | 12,1 |
| | 86% | 54% | | | | 86% |
| | 424 | 427 | | | | 0 |

Annual electricity yield after the inverter, absolute

Related to projected building footprint area
 CO2-equivalent emissions according to 1-CO2 factors GEMIS (Germany)
 PE-factor according to 1-PE factors (non-renewable) PHI Certification

| | 8056 | 1579 | | | | 693 | 9635 |
|--|--------|------|--|--|--|------|--------|
| | 8056 | 1579 | | | | 693 | 9635 |
| | 99,5 | 19,5 | | | | 8,6 | 119 |
| | 1047,3 | 99,5 | | | | 90,1 | 1146,7 |
| | 0,00 | 0,00 | | | | 0,0 | 0,00 |



Electricity demand for residential buildings

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

| Households | 1 | | | | | | PER and PE factors (KWh/kWh) | | | Electricity: 1,30 1,8 | | | | | | Solar fraction of DHW Laundry&Dish | | | 16% | | |
|---|--------------|------------------------------------|--------------|--------------------|-----------|--------------------|--|-------------------|-----------------------|-----------------------------|-------------------|----------------------------|----------------|-----------------------------|--|------------------------------------|--|--|-----|--|--|
| Persons | 2,9 | | | | | | Non-electric energy carrier for cooking, drying: | | | 1,30 1,8 | | | | | | Marginal performance ratio DHW | | | 56% | | |
| Living area (m ²) | 156 | | | | | | Energy carrier for heating: | | | 1,11 1,6 | | | | | | Marginal performance ratio Heating | | | 61% | | |
| Heating demand [kWh/(m ² a)] | 12,5 | | | | | | Energy carrier for DHW: | | | 0,65 0,6 | | | | | | | | | | | |
| 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% | 50% | 105 | | | | | | | | | | | |
| 1-DHW connection | | | | | | | | | | | | | | | | | | | | | |
| Clothes washing | 1 | 1 | 0,95 kWh/Use | 1,00 | 57 | /(P*a) * 2,9 P | 160 | 55% | 45% | 88 | | | | | | | | | | | |
| 1-DHW connection | | | | | | | | | | | | | | | | | | | | | |
| Clothes drying with: | 1 | 0 | 2,00 kWh/Use | 0,88 | 57 | /(P*a) * 2,9 P | 0 | 0% | 0% | 0 | | | | | | | | | | | |
| 1-Clothes line | | | | | | | | | | | | | | | | | | | | | |
| Energy consumed by evaporation | 1 | 0 | 0,00 kWh/Use | 0,60 | 57 | /(P*a) * 2,9 P | 0 | | 100% | | | | | | | | | | | | |
| 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 | | | | | | | | | | | | | | | | | | | | | |
| Lighting | 1 | 1 | 14 W | 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 | | | | | | | 482 | | | 482 | | | | | | | | | | | |
| Other: | | | | | | | 0 | | | 0 | | | | | | | | | | | |
| | | | | | | | 0 | | | 0 | | | | | | | | | | | |
| | | | | | | | 0 | | | 0 | | | | | | | | | | | |
| Total | | | | | | | 1905 kWh | | | 1727 kWh | | | | | | | | | | | |
| Specific demand | | | | | | | | | | 11,1 kWh/(m ² a) | | | | | | | | | | | |
| Recommended maximum value | | | | | | | | | | 18 | | | | | | | | | | | |

Aux Electricity

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

| | | | | | | | | | | |
|--------------------|-----|----|---|--|------|-----------------|---------------------------------|--|------|-----------|
| Treated floor area | 156 | m² | Heat recovery efficiency ventilation unit | | 0,82 | | Annual space heating demand | | 13 | kWh/(m²a) |
| Heating period | 219 | d | Operation vent. system Winter | | 5,25 | kh/a | Boiler rated power | | 15 | kW |
| Air volume | 390 | m³ | Operation vent. system Summer | | 3,51 | kh/a | DHW system heating demand | | 3758 | kWh/a |
| Dwelling units | 1 | HH | Air change rate | | 0,30 | h ⁻¹ | 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 |
| Defroster HX | 1 | 1 | Data entries in 'Ventilation' worksheet or in 'Addl vent' | | | | 52 | * 0,2 | / 5,25 | = 2 | |
| Summer ventilation | 0 | 0,55 | 0,00 | Wh/m³ | * 0,00 | h ⁻¹ | * 3,5 | kh/a | * 390 | m³ | = 0 |
| | | | | | | | Internal heat sources * Additional summer ventilation' | | 0,0 | | |
| Additional vent. summer | 0 | 0,55 | 0,00 | Wh/m³ | * 0,00 | h ⁻¹ | * 3,5 | kh/a | * 390 | m³ | = 0 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 | |
| Total | | | | | | | 482 | | | 10 | 8 |
| Specific demand | kWh/(m²a) (treated floor area) | | | | | | 3,1 | | | | |

Primary Energy Renewable PER

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

Building type: **Row house**

| | | |
|---|-----|------------------------|
| Treated floor area A _{TFA} : | 156 | m ² |
| Projected building footprint A _{Projected} : | 81 | m ² |
| Heating demand incl. distribution & hydr. frost protection: | 13 | kWh/(m ² a) |
| Cooling energy dem. incl. dehumidification: | | kWh/(m ² a) |
| DHW demand including distribution: | 24 | kWh/(m ² a) |

Selection of heat generation system(s)

Primary heat generation type

2-Heat pump(s)

Secondary heat generation type (optional & different)

-

| Contribution margin (useful energy) | |
|-------------------------------------|------|
| Heating | DHW |
| 100% | 100% |
| 0% | 0% |

Addl. input in following worksheets

HP, possibly HP ground

Heating demand incl. distribution & hydr. frost protection

Cooling energy dem. incl. dehumidification

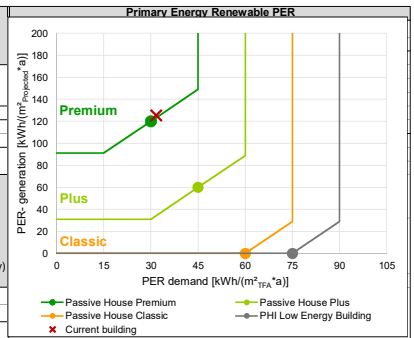
DHW demand including distribution:

| Energy demand Reference: Treated floor area | Efficiency | | Final energy | | PER | | | PE | | CO ₂ | |
|---|--------------|--------------------|-----------------------------|------------------------|------------|--|------------------------|-----------|------------------------|--|------------------------------|
| | Calculati on | 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 ₂ eq emissions |
| | - | - | | kWh/(m ² a) | kWh/kWh | kWh/kWh | kWh/(m ² a) | kWh/kWh | kWh/(m ² a) | kg/kWh | kg/(m ² a) |
| | | | | | | | 31,6 | | 40,1 | | 12,4 |
| 1-PE factors (non-renewable) PHI Certification | | | | | | | | | | | |
| 1-CO2 factors GEMIS (Germany) | | | | | | | | | | | |
| Heating | | | 100% | | | | 1,11 | | 1,59 | | 4,8 |
| Electricity (HP compact unit) | | | | | | | 1,80 | | 1,80 | 0,532 | |
| Electricity (heat pump) | 1,79 | | 91% | 6,4 | | | 1,80 | | 11,5 | 0,532 | 3,4 |
| District heating: 20-Gas CHP (small) 70% CHP | | | | | | | 0,85 1,39 1,01 | | 0,70 | -0,070 | |
| 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 | | | 9% | 1,2 | 0,22 | 0,22 | 0,3 | | 0,00 | 0,045 | 0,0524 |
| Electricity (direct) | | | | | | | 1,80 | | 1,80 | 0,532 | |
| Other | | | | | | | | | | | |
| Aux. electricity (heating, wintertime ventilation) | | | | 2,5 | | | 1,80 | | 4,4 | 0,532 | 1,3 |
| Cooling and dehumidification | | | | | | | | | 0,0 | | 0,0 |
| Electricity cooling (heat pump) | | | | | | | 1,10 | | 1,80 | 0,532 | |
| Auxiliary electricity cooling, ventilation summer | | | | | | | 1,10 | | 1,80 | 0,532 | |
| Electricity dehumidification (heat pump) | | | | | | | 1,15 | | 1,80 | 0,532 | |
| Auxiliary electricity (dehumidification) | | | | | | | 1,15 | | 1,80 | 0,532 | |
| DHW generation | | | 100% | | | | 0,65 | | 0,63 | | 3,3 |
| Electricity (HP compact unit) | | | | | | | 1,30 | | 1,80 | 0,532 | |
| Electricity (heat pump) | 2,91 | | 58% | 4,8 | | | 1,30 | | 8,6 | 0,532 | 2,6 |
| District heating: 20-Gas CHP (small) 70% CHP | | | | | | | 0,85 1,39 1,01 | | 0,70 | -0,070 | |
| 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 | | | 42% | 10,1 | 0,30 | 0,30 | 3,1 | | 0,00 | 0,045 | 0,455 |
| Electricity (direct) | | | | | | | 1,30 | | 1,80 | 0,532 | |
| Other | | | | | | | | | | | |
| Aux. electricity (DHW + solar DHW) | | | | 0,6 | | | 1,30 | | 1,1 | 0,532 | 0,3 |
| Household electricity | | | | 8,0 | | | 1,30 | | 14,4 | | 4,2 |
| Electricity (household or non-residential lighting, etc.) | | | | 8,0 | | | 1,30 | | 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 | 0,270 | 0,0 |

| Energy generation Reference: Projected building footprint area | Final energy | | PER | | PE | | CO ₂ | |
|---|-------------------------|--|------------|--|-----------|------------------------|---------------------------------------|------------------------------|
| | Final energy generation | Final energy generation | PER factor | PER specific value | PE factor | PE Value | Emission factor (CO ₂ -eq) | CO ₂ eq emissions |
| | kWh/a | kWh/(m ² a _{Projected}) | kWh/kWh | kWh/(m ² a _{Projected}) | kWh/kWh | kWh/(m ² a) | kg/kWh | kg/a |
| | | | | 125,4 | | 26,1 | | 1225,9 |
| PV electricity | 9635 | 119,1 | 1,00 | 119,1 | 0,00 | 0,0 | 0,119 | 1146,7 |
| Solar thermal system | 1759 | 21,7 | 0,29 | 6,3 | 1,20 | 26,1 | 0,045 | 79,2 |
| Onshore wind power | | 0,0 | 1,00 | 0,0 | 0,00 | 0,0 | 0,009 | 0,0 |

| | | | | | |
|---|---|--|----|------------------|---|
| PE demand requirement in case of verification through PE (non-renewable) [kWh/(m ² a)] | - | Current building reaches following class | 40 | Requirement met? | - |
|---|---|--|----|------------------|---|

| Achievable energy standard through the verification of renewable primary energy (assessment of individual aspects) | Useful energy, performance | | | | Airtightness n ₅₀ 1/h |
|--|--|--|---|--|--|
| | Annual heat dem. Treated floor area kWh/(m ² a) | Heating load Treated floor area W/m ² | Useful cool. energy Treated floor area kWh/(m ² a) | Cooling load Treated floor area W/m ² | |
| Requirement Passive House Premium | | | | | 0,60 |
| Requirement Passive House Plus | 15 | 10 | - | - | 0,60 |
| Requirement Passive House Classic | | | | | 1,00 |
| Requirement PHI Low Energy Building | 30 | 10 | - | - | 0,2 |
| Current building reaches following class for aspect | 13 | Premium | - | Premium | Premium |



| Summary | Final energy | PER specific value | PE value | CO ₂ eq emissions | CO ₂ eq substitution balance |
|--|--------------|--------------------|--|-------------------------------|---|
| | MWh/a | MWh/a | | kg/a | kg/a |
| 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) |
| | 5,2 | 4,9 | 6,26 | 1929 | 1929 |
| Demand | | | | | |
| Generation | -11,4 | -10,1 | -2,11 | 1226 | -4345 |
| Demand, cumulative generation (annual balance) | -6,16 | -5,21 | 4,15 | 3155 | -2416 |
| Demand w/o household electricity | 4,0 | 3,3 | 4,02 | 1266 | 1266 |
| Demand w/o household electricity, cum. generation | -7,40 | -6,83 | 1,91 | 2492 | -3078 |

Heat pump

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

| | | Building type: | Row house |
|--|--|----------------|--------------------------|
| | Treated floor area A_{TFA} : | | 156 m ² |
| Covered fraction of space heating demand | (<i>PER</i> worksheet) | | 91% |
| Space heating demand + distribution losses | $Q_{H1}+Q_{HL}$ (<i>DHW+Distribution</i>) | | 1976 kWh/a |
| Solar fraction for space heat | $\eta_{Solar, H}$ (<i>SolarDHW</i> worksheet) | | 9% |
| Effective annual heating demand | $Q_{H,W1}=Q_H*(1-\eta_{Solar, H})$ | | 1795 kWh/a |
| Covered fraction of DHW demand | (<i>PER</i> worksheet) | | 58% |
| Total heating demand of DHW system | Q_{gDHW} (<i>DHW+Distribution</i>) | | 3546 kWh/a |
| Solar fraction for DHW | $\eta_{Solar, DHW}$ (<i>SolarDHW</i> worksheet) | | 42% |
| Effective DHW demand | $Q_{DHW,W1}=Q_{DHW}*(1-\eta_{Solar, DHW})$ | | 2058 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} (<i>DHW+Distribution</i>) | | 55,00 °C |
| Nominal power of distribution system | P_{nom} | | 1,39 kW |
| Distribution system (to be completed by experienced users only) | | | |
| Nominal power of distribution system | P_{nom} | | |
| 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) | (<i>DHW+Distribution</i>) | | |
| Sink temperature of heat pump for heating | $\theta_{sнк}$ | | 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 | (<i>DHW+Distribution</i>) | | 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) | (<i>DHW+Distribution</i>) | | 11,00 °C |
| Type of backup heater | | | 1-Elec. Immersion heater |
| $\Delta\theta$ of electric continuous flow water heater | | | 5,0 K |
| Additional options in case of one heat pump for both functions: Heating & DHW | | | |
| Same heat pump's sink temperature for Heating and for DHW | | | 1-Yes |
| Heat pump priority | (<i>Manufacturer, tech. data</i>) | | 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 |

Heating

Heat pump:

Source:

| | θ_{source} °C | θ_{sink} °C | Heating capacity kW | COP |
|---------------|-------------------------|-----------------------|------------------------|-----|
| Test point 1 | -7,0 | 35,0 | 2,2 | 2,7 |
| Test point 2 | 2,0 | 35,0 | 2,6 | 3,1 |
| Test point 3 | 7,0 | 35,0 | 3,1 | 3,7 |
| Test point 4 | 15,0 | 35,0 | 3,8 | 4,3 |
| Test point 5 | 20,0 | 35,0 | 4,1 | 4,9 |
| Test point 6 | -7,0 | 50,0 | 2,0 | 2,0 |
| Test point 7 | 2,0 | 50,0 | 2,5 | 2,3 |
| Test point 8 | 7,0 | 50,0 | 3,0 | 2,8 |
| Test point 9 | 15,0 | 50,0 | 3,7 | 3,3 |
| Test point 10 | 20,0 | 50,0 | 3,9 | 3,5 |
| Test point 11 | | | | |
| Test point 12 | | | | |
| Test point 13 | | | | |
| Test point 14 | | | | |
| Test point 15 | | | | |

Temperature difference in sink $\Delta\theta_{sink}$ K

DHW

Heat pump:

Source:

| | θ_{source} °C | θ_{sink} °C | Heating capacity kW | COP |
|---------------|-------------------------|-----------------------|------------------------|-----|
| Test point 1 | -7,0 | 35,0 | 2,2 | 2,7 |
| Test point 2 | 2,0 | 35,0 | 2,6 | 3,1 |
| Test point 3 | 7,0 | 35,0 | 3,1 | 3,7 |
| Test point 4 | 15,0 | 35,0 | 3,8 | 4,3 |
| Test point 5 | 20,0 | 35,0 | 4,1 | 4,9 |
| Test point 6 | -7,0 | 50,0 | 2,0 | 2,0 |
| Test point 7 | 2,0 | 50,0 | 2,5 | 2,3 |
| Test point 8 | 7,0 | 50,0 | 3,0 | 2,8 |
| Test point 9 | 15,0 | 50,0 | 3,7 | 3,3 |
| Test point 10 | 20,0 | 50,0 | 3,9 | 3,5 |
| Test point 11 | | | | |
| Test point 12 | | | | |
| Test point 13 | | | | |
| Test point 14 | | | | |
| Test point 15 | | | | |

Temperature difference in sink $\Delta\theta_{sink}$ K

- Electr. energy consumption pump (grnd. water / ground)
- Energy by direct electricity
- Space heat supplied by HP
- Winter DHW supplied by HP
- Summer DHW supplied by HP
- Space heating supplied by HP without storage losses
- Winter DHW supplied by HP without storage losses
- Summer DHW supplied by HP without storage losses
- Electrical consumption of HP

- $Q_{EI,Pump}$
- $Q_{EI,dir}$
- $Q_{HP,Heating}$
- $Q_{HP,DHW,Winter}$
- $Q_{HP,DHW,Summer}$
- $Q_{HP,Heating}$
- $Q_{HP,DHW,Winter}$
- $Q_{HP,DHW,Summer}$
- $Q_{EI,HP}$

| | |
|-----------------------------------|-------|
| <input type="text" value="0"/> | kWh/a |
| <input type="text" value="0"/> | kWh/a |
| <input type="text" value="1630"/> | kWh/a |
| <input type="text" value="609"/> | kWh/a |
| <input type="text" value="554"/> | kWh/a |
| <input type="text" value="1630"/> | kWh/a |
| <input type="text" value="388"/> | kWh/a |
| <input type="text" value="28"/> | kWh/a |
| <input type="text" value="1652"/> | kWh/a |

Seasonal performance factor of heat pump

SPF_{H-1}

1. HP: Heating or heating & DHW

kWh/a

2. HP: Domestic hot

kWh/(m²a)

Final electrical energy demand heat generation
Annual primary energy demand

Q_{final}

kg/a

kg/(m²a)

Annual CO₂-equivalent emissions

Heat pump ground (ground collectors / ground probes)

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

Building type: **Row house**
 Treated floor area A_{TFA}: **156** m²

Ground probes

Probe field configuration (HP worksheet)

| | | |
|--|-----------------|--------------------|
| H | A | Individual probe |
| Length of probe | 40 | m |
| Probes spacing/distance | B | 10 m |
| Depth (z=H/2) | z | 20 m |
| Type of probe | A | Double-U |
| Borehole radius | r _b | 0,090 m |
| Inner radius of pipe | r _i | 0,013 m |
| Exterior pipe radius | r _a | 0,016 m |
| Distance between pipes | B _U | 0,070 m |
| Inner radius of pipe casing (only coaxial) | r _{i2} | 0,050 m |
| Exterior radius casing pipe (only coaxial) | r _{a2} | 0,052 m |
| Thermal conductivity of pipe | λ _R | 0,42 W/(mK) |
| Thermal conductivity of back fill | λ _F | 2,00 W/(mK) |
| Probe time constant | t _p | 2058 d |
| Internal borehole resistance | R _b | 0,169 Km/W |
| Borehole resistance | R _o | 0,066 Km/W |

Ground

| | | |
|--------------------------------|-----------------|-----------------------------------|
| Soil type | J | Other soil type |
| Density of the ground | ρ _E | 2000 kg/m ³ |
| Thermal capacity of ground | c _{pE} | 1000 J/(kgK) |
| Thermal conductivity of ground | λ _E | 2,0 W/(mK) |
| Soil temperature conductivity | α _E | 0,000001 m ² /s |
| Ground temperature gradient | ΔT _G | 0,022 K/m |

Brine

| | | |
|---------------------------------|-----------------|-------------------------------|
| Brine (characteristics at 2 °C) | E | Brine |
| Density of the brine | ρ _S | 1036 kg/m ³ |
| dynamic viscosity of the brine | η _S | 0,0052 kg/(ms) |
| Heat capacity brine | c _{pS} | 3815 J/(kgK) |
| Thermal conductivity of brine | λ _S | 0,4405 W/(mK) |
| Brine - mass flow | m _S | 0,6 kg/s |

Operation type

Waste heat from active cooling to ground probe? Please check if appropriate.

Heat pump operation duration h/a

Specific heat extraction rate as an annual average q_{ex} W/m

H/R_b **605** W/K

Ground collectors

| | | |
|------------------------------|-------------------|----------------------------|
| Inner radius of pipe | r _i | 0,013 m |
| Exterior pipe radius | r _a | 0,016 m |
| Thermal conductivity of pipe | λ _R | 0,420 W/(mK) |
| Pipe depth | Z _{pipe} | 20 m |
| Ground water depth | Z _{gw} | <input type="text"/> m |
| Pipe spacing | D | 0,4 m |
| Base area | | 80 m ² |
| Pipe outer surface | | 20,1 m ² |
| Pipe length | L | 200,0 m |

Brine

| | | |
|---------------------------------|-----------------|-------------------------------|
| Brine (characteristics at 2 °C) | E | Brine |
| Density of the brine | ρ _S | 1036 kg/m ³ |
| dynamic viscosity of the brine | η _S | 0,0052 kg/(ms) |
| Heat capacity brine | c _{pS} | 3815 J/(kgK) |
| Thermal conductivity of brine | λ _S | 0,4405 W/(mK) |
| Brine - mass flow | m _S | 0,5 kg/s |

Specific heat extraction rate q_{ex} W/m²

U * A **2361** W/K

Climate

| | | |
|-------------------------------|-----------------|----------------|
| Period duration | | 365 d |
| Average ground surface temp. | T _{mb} | 10,0 °C |
| Surface temperature amplitude | T ₁ | 8,6 °C |
| Phase shifting surface | t ₀₂ | 33 d |

Ground characteristics

| | Thermal conductivity [W/(mK)] | Density [kg/m ³] | Heat capacity [J/(kg K)] | Heat capacity [MJ/(m ³ K)] | Thermal conductivity [10 ⁻⁷ m ² /s] | Source |
|--------------------------|-------------------------------|------------------------------|--------------------------|---------------------------------------|---|-------------|
| A Sand, 9% moisture | 0,980 | 1440 | 1507 | 2,170 | 4,520 | [Neiß 1977] |
| B Sand, 13% moisture | 1,500 | 1600 | 1800 | 2,880 | 5,210 | [Neiß 1977] |
| C Ground, coarse gravel | 0,520 | 2000 | 1840 | 3,680 | 1,410 | [VDI 1984] |
| D Loam, 36% moisture | 2,300 | 1650 | 2847 | 4,700 | 4,900 | [Neiß 1977] |
| E Clay | 1,280 | 1500 | 880 | 1,320 | 9,700 | [VDI 1984] |
| F Clay / Silt | 2,200 | 2550 | 882 | 2,250 | 9,780 | [VDI 2000] |
| G Slate | 2,100 | 2700 | 870 | 2,350 | 8,940 | [VDI 2000] |
| H Silt | 1,500 | 1920 | 2938 | 5,640 | 2,660 | [ISO 13370] |
| I Rock | 3,500 | 2500 | 2500 | 6,250 | 5,600 | [ISO 13370] |
| J Other soil type | 2,000 | 2000 | 1000 | 2,000 | | |

Result ground probe calculation

| Month | Borehole temperature °C |
|-------|-------------------------|
| 1 | 10,4 |
| 2 | 10,4 |
| 3 | 10,4 |
| 4 | 10,4 |
| 5 | 10,4 |
| 6 | 10,4 |
| 7 | 10,4 |
| 8 | 10,4 |
| 9 | 10,4 |
| 10 | 10,4 |
| 11 | 10,4 |
| 12 | 10,4 |

Properties of the brine

| | Temperature [°C] | Density [kg/m ³] | Heat capacity [J/(kg K)] | Thermal conductivity [W/(mK)] | Dynamic viscosity [kg/(ms)] |
|-----------------------|------------------|------------------------------|--------------------------|-------------------------------|-----------------------------|
| A Ethylene glycol 25% | 2 | 1052 | 3950 | 0,480 | 0,0052 |
| B Potassium carbonate | 2 | 1265 | 2941 | 0,544 | 0,0031 |
| C Potassium formate | 2 | 1226 | 3190 | 0,534 | 0,00237 |
| D Water | 2 | 997 | 4190 | 0,590 | 0,001307 |
| E Brine | 2 | 1036 | 3815 | 0,441 | 0,005 |

Boiler (gas, oil and wood)

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

| | |
|---|---------------------------|
| Building type: Row house | |
| Treated floor area A _{TFA} : | 156 m ² |
| Covered fraction of space heating demand (PER' worksheet) | 0% |
| Space heating demand + distribution losses Q _H +Q _{HS} : (DHW+Distribution) | 1976 kWh |
| Solar contribution for space heating η _{Solar, H} (SolarDHW' worksheet) | 9% |
| Effective annual heating demand Q _{H,WI} =Q _H *(1-η _{Solar, H}) | 0 kWh |
| Space heating demand without distribution losses Q _H (Verification' worksheet) | 1953 kWh |
| Covered fraction of DHW demand (PER' worksheet) | 0% |
| Total heating demand of DHW system Q _{DHW} (DHW+Distribution) | 3758 kWh |
| Solar contribution for DHW η _{Solar, DHW} (SolarDHW' worksheet) | 42% |
| Effective DHW demand Q _{DHW,WI} =Q _{DHW} *(1-η _{Solar, DHW}) | 0 kWh |

| | | |
|---|--------------------------------------|--|
| Boiler type | 20-Low temperature boiler gas | |
| Fuel | 30-Natural gas | |
| PER factors (renewable primary energy) (Data' worksheet) | 1,75 | kWh _{PER} /kWh _{Final} |
| PE factor (non-renewable primary energy) (Data' worksheet) | 1,10 | kWh _{PE} /kWh _{Final} |
| CO ₂ emissions factor (CO ₂ -equivalent) (Data' worksheet) | 0,250 | g/kWh |
| Useful heat provided Q _{Use} | | kWh/a |
| Max. heating power required for heating the building P _{BH} (Heating load' worksheet) | 1,53 | kW |
| Length of the heating period t _{HP} | 5253 | h |
| Length of DHW heating period t _{DHW} | 8760 | h |

Use characteristic values entered (check if appropriate)?

| | Project data | Standard values | Input field |
|--|--------------------------|-----------------------------------|--------------------|
| Design output Installation of boiler (Outdoor: 0, Indoor: 1) P_{nom} (Rating plate) | 15 kW 0 | 15 kW 0 | |
| Input values (oil and gas boiler) | Project data | Standard values | Input field |
| Boiler efficiency at 30% load η _{30%} (Manufacturer) | 91% | 91% | 99% |
| Boiler efficiency at nominal output η _{100%} (Manufacturer) | 90% | 90% | 99% |
| Standby heat loss boiler at 70 °C q _{B,70} (Manufacturer) | 1,4% | 1,4% | 2,0% |
| Average return flow temperature measured at 30% load θ _{30%} (Manufacturer) | 40 °C | 40 | |
| Input values (biomass heat generator) | Project data | Standard values | Input field |
| Efficiency of heat generator in basic cycle η _{GZ} (Manufacturer) | | 60% | |
| Efficiency of heat generator in steady-state operation η _{SO} (Manufacturer) | | 70% | |
| Average fraction of heat output released to heating circuit Z _{H,C,m} (Manufacturer) | | 0,4 | |
| Temperature difference betw. power-on and power-off ΔS (Manufacturer) | | 30 K | |
| In case of inside installation: area of installation room A _{Instal} (Project) | | 0 m ² | |
| Useful heat output per basic cycle Q _{N,GZ} (Manufacturer) | | 22,5 kWh | |
| Average power output of the heat generator Q _{N,m} (Manufacturer) | | 15,0 kW | |
| Heat generator with built in conveyor for pellets Unit only with regulation (no fan / no starting aid) | | | x |
| Auxiliary energy demand for a basic cycle Q _{HE,GZ} (Manufacturer) | | 0,32 kWh | |
| Power consumption in steady-state operation P _{el,SB} (Manufacturer) | | 160 W | |
| Utilisation factor of heat generator space heating h _{H,g,K} = f ₁ *h _c | 0% | | |
| Utilisation factor heat generator DHW h _{DW,g,K} = h _{100%}/f_{1,DW}} | 0% | | |
| Utilisation factor heat generator DHW & space heating h _{g,K} | 0% | | |
| Final energy demand space heating Q _{Final,HE} = Q _{H,WI} * e _{H,g,K} | 0 kWh/a | | |
| Final energy demand DHW Q _{Final,TW} = Q _{DHW,WI} * e _{TW,g,K} | 0 kWh/a | | |
| Total final energy demand Q _{Final} = Q _{End,HE} + Q _{End,TW} | 0 kWh/a | 0,0 kWh/(m ² a) | |
| Annual PE demand (non-renewable primary energy) | 0 kg/a | 0,0 kg/(m ² a) | |
| Annual CO₂-equivalent emissions | 0 kg/a | 0,0 kg/(m ² a) | |

District heating and combined heat power (CHP)

Passive House with PHPP Version 9.6a

End-of-terrace Passive House / Climate: PHPP-Standard / TFA: 156 m² / Heating: 12,5 kWh/(m²a) / Freq. overheating: 1 % / PER: 31,6 kWh/(m²a)

| | | |
|--|---|----------------|
| Building type: | Row house | |
| Treated floor area A _{TFA} : | 156 | m ² |
| Covered fraction of space heating demand | (PER worksheet) | 0% |
| Annual heating demand kWh/a | Q _H (DHW+Distribution) | 1976 kWh |
| Solar contribution for space heating | η _{Solar, H} (SolarDHW worksheet) | 9% |
| Effective annual heating demand | Q _{H,WI} = Q _H * (1 - η _{Solar, H}) | 0 kWh |
| Covered fraction of DHW demand | (PER worksheet) | 0% |
| DHW demand | Q _{DHW} (DHW+Distribution) | 3758 kWh |
| Solar contribution for DHW | η _{Solar, DHW} (SolarDHW worksheet) | 42% |
| Effective DHW demand | Q _{DHW,WI} = Q _{DHW} * (1 - η _{Solar, DHW}) | 0 kWh |

| | | |
|---|---------------------------------|-----|
| Definition of heat source for PE factor and CO ₂ emissions | 20-Gas CHP (small) 70% CHP | |
| Definition of heat source for calculation of PER factor | | |
| Heat net | Efficiency district heating net | 80% |
| CHP complex & boiler for peak loads | | |

| | |
|---|--|
| PE factor (non-renewable) | CO ₂ emissions factor (CO ₂ -eq) |
| kWh _{PE} /kWh _{Final} | kg/kWh |
| 0,70 | -0,070 |

| CHP complex & boiler for peak loads | Fraction | Efficiency Electricity | Heat | PER factors | PER factors |
|-------------------------------------|----------|------------------------|------|-------------|-------------|
| CHP complex | 85% | 40% | 50% | 1,10 | 0,85 |
| Boiler for peak loads | 15% | | 96% | 1,80 | 1,39 |
| Total | 100% | | | 1,30 | 1,01 |

| | | |
|--------------------------|------|------|
| Within biomass budget | 1,10 | 0,85 |
| Excess of biomass budget | 1,80 | 1,39 |
| DHW Summer | 1,30 | 1,01 |

| | | | |
|---|---|---------|--------------------------|
| Performance ratio of heat transfer station | h _{a,HX} | 105% | |
| Utilisation factor of heat transfer station | η _{a,SHX} | 95% | |
| Final energy demand heat generation | Q _{Final} = Q _{Use} * e _{a,DH} | 0 kWh/a | 0 kWh/(m ² a) |
| Annual PE demand (non-renewable primary energy) | | 0 kWh/a | 0 kWh/(m ² a) |
| Annual CO ₂ -equivalent emissions | | 0 kg/a | 0 kg/(m ² a) |

| Table of PER and PE factors as well as CO ₂ -equivalent emission factors of different energy carriers and uses from different sources | | | | | |
|--|------------------------------------|---|--------------------------------------|--|------|
| Energy type | Number | Energy carrier | Transfer to 'PER' works | | |
| | | | PER factor | 1-PE factors (non-renewable) PHI Certification | |
| | | | $\frac{kWh_{prim-eel}}{kWh_{Final}}$ | $\frac{kWh_{prim}}{kWh_{Final}}$ | |
| | 10 | None | | | |
| Fuel source | 20 | Heating oil | 2,30 | 1,10 | |
| | 30 | Natural gas | 1,75 | 1,10 | |
| | 31 | LPG | 1,75 | 1,10 | |
| | 41 | Hard coal | 2,30 | 1,10 | |
| | 42 | Brown coal | 2,30 | 1,20 | |
| | 32 | Biogas | 1,10 | 1,10 | |
| | 21 | Pyrolysis oil or bio oil | 1,10 | 1,10 | |
| | 43 | Wood | 1,10 | 0,20 | |
| | 44 | Wood logs | 1,10 | 0,20 | |
| | 50 | Pellets | 1,10 | 0,20 | |
| | 46 | Forest woodchips | 1,10 | 0,20 | |
| | 47 | Poplar woodchips | 1,10 | 0,20 | |
| | 33 | RE-Gas | 1,75 | | |
| | 22 | RE-Methanol | 2,30 | | |
| | 48 | Biomass | 1,10 | | |
| | Electricity | 60 | Electricity-mix | | 1,80 |
| | | 61 | Electricity mix from CHC | | 2,40 |
| 00 | | Primary electricity | 1,00 | | |
| 01 | | Household electricity | 1,30 | 1,80 | |
| 02 | | Electricity for DHW | 1,30 | 1,80 | |
| 03 | | Electricity for heating | 1,80 | 1,80 | |
| 04 | | Electricity for cooling | 1,10 | 1,80 | |
| 05 | | Electricity for dehumidification | 1,15 | 1,80 | |
| 06 | | Platzhalter_EE-Stromanwendung | - | 1,80 | |
| 62 | | Electricity from photovoltaics | 1,00 | 0,00 | |
| 63 | | Monocrystalline photovoltaic electric | 1,00 | 0,00 | |
| 64 | | Polycrystalline photovoltaic electric s | 1,00 | 0,00 | |
| 65 | | Onshore wind power | 1,00 | 0,00 | |
| 66 | Offshore wind power | 1,00 | 0,00 | | |
| 67 | Hydroelectric power station > 10MW | 1,00 | 0,00 | | |
| Environmental energy, solar thermal energy | 71 | Ground heat, geothermal energy | 0,00 | 0,00 | |
| | 72 | Ambient high temperature | 0,00 | 0,00 | |
| | 73 | Ambient low temperature | 0,00 | 0,00 | |
| | 80 | Solar thermal flat plate collector (ger | 1,00 | 0,00 | |
| | 81 | Solar thermal evacuated tube collect | 1,00 | 0,00 | |
| 74 | Waste heat | 0,00 | 0,00 | | |
| User defined energy carrier (for generation, please en | 98 | User determined energy carrier | | | |
| user defined factors for demand in columns N and O | 99 | | | | |
| District heat | 1 | 1-None | | 0,00 | |
| | 10 | 10-Hard coal CHP (large) 70% CHP | | 0,80 | |
| Gas CHP (small) | 11 | 11-Hard coal CHP (large) 35% CHP | | 1,10 | |
| | 12 | 12-Hard coal HP 0% CHP | | 1,50 | |
| | 20 | 20-Gas CHP (small) 70% CHP | Calculation | 0,70 | |
| Heating oil CHP (small) | 21 | 21-Gas CHP (small) 35% CHP | in | 1,10 | |
| | 22 | 22-Gas HP 0% CHP | 'District | 1,50 | |
| | 30 | 30-Oil CHP (small) 70% CHP | heating" | 0,80 | |
| | 31 | 31-Oil CHP (small) 35% CHP | worksheet | 1,10 | |
| | 32 | 32-Oil HP 0% CHP | | 1,50 | |
| District heating: User determined | 40 | 40-User determined: 90% CHP | | 0,80 | |
| District heating combined heat power (CHP) | 13 | Fossil fuel | | 0,70 | |
| District heating from heating plant | 14 | Renewable fuel | | 0,00 | |
| | 15 | Fossil fuel | | 1,30 | |
| | 16 | Renewable fuel | | 0,10 | |

| Heat generator | No. | Type | Fuel ('Comparison' worksheet) | x) Gas will be used | |
|----------------|-----|--|-------------------------------|---------------------|---|
| | 1 | 1-None | | | |
| | 10 | 10-Improved gas condensing boiler | | 1 | x |
| | 11 | 11-Improved oil condensing boiler | | 2 | |
| | 12 | 12-Gas condensing boiler | | 1 | x |
| | 13 | 13-Oil condensing boiler | | 2 | |
| | 20 | 20-Low temperature boiler gas | | 1 | x |
| | 21 | 21-Low temperature boiler oil | | 2 | |
| | 30 | 30-Firewood pieces (direct and indirect heat emission) | | 3 | |
| | 31 | 31-Wood pellets (direct and indirect heat emission) | | 4 | |
| | 32 | 32-Wood pellets (only indirect heat emission) | | 4 | |
| | 40 | 40-Reserve | | | |

| Dishwashers and washing machines |
|----------------------------------|
| 1-DHW connection |
| 2-Cold water connection |

| Clothes drying | Availability electricity | Availability evaporation |
|---------------------------------------|--------------------------|--------------------------|
| 1-Clothes line | 1 | 1 |
| 2-Drying closet (cold) | 1 | 1 |
| 3-Drying closet (cold) in extract air | 0,9 | 0,9 |
| 4-Condensation dryer | 0,7 | 0 |
| 5-Electric exhaust air dryer | 1 | 1 |
| 6-Gas exhaust air dryer | 1 | 1 |

| Cooking | Electric fraction | PE factor | CO ₂ factor | PER-factor |
|---------------|-------------------|-----------|------------------------|------------|
| 1-Electricity | 100% | 1,80 | 0,53 | 1,30 |
| 2-Natural gas | 0% | 1,10 | 0,25 | 1,75 |
| 3-LPG | 0% | 1,10 | 0,27 | 1,75 |