03.02_PH- SUMMER SCHOOL

PH-Calculation - PHPP

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Date: 2008-10-16

CONTENT OF THIS PRESENTATION:

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Source:

The PHPP calculation software

Description

PHPP means Passive House Planning (Design) Package.

The PHPP calculation software calculates energy demand for buildings. It is compatible with international norms (ISO 13790) and well validated with dynamic simulation tools as well as with measured data. It is especially adapted to high-performance buildings and can be used to prove Passive House requirements. The planning package comprises many tools specifically useful for the design of high-performance buildings.

PHPP 2007 PASSIVE HOUSE INSTITUTE Dr. Wolfgang Feist

The PHPP calculation software

Description

The Passive House Planning (Design) Package (PHPP) includes:

- energy calculations (incl. R or U-values)
- design of window specifications
- design of the indoor air quality ventilation system
- sizing of the heating load
- sizing of the cooling load
- forecasting for summer comfort
- sizing of the heating and domestic hot water (DHW) systems
- calculations of auxiliary electricity, primary energy requirements:
  - (circulation pumps, etc.), as well as projection of CO2 emissions
  - verifying calculation proofs of KfW and EnEV (Europe)
  - Climate Data Sheet: Climate regions may be selected from over 200 locations in Europe and North America. User-defined data can also be used.
  - lot of tools useful in the design of passive houses, e.g. a calculation
  - tool to determine internal heat loads, data tables for primary energy factors
  - a comprehensive handbook, not only introducing PHPP use, but also highlights crucial topics to be considered in Passive House design.

Source: http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=549/pagename=alpha_list

The PHPP calculation software

Description

Keywords
energy balance, high-performance houses, passive houses

Validation/Testing
Basis for energy balance: ISO 13790. Tested with dynamic building simulation and with measured data in field project with some 1,000 apartments and additionally with non-residential buildings.

Expertise Required
Experience in building design or building energy consulting. PHPP training is recommended but not prerequisite. Use of manual (included).

Users
1,0000 users worldwide: 500 in the United States

Audience
Architects, engineers, energy consultants, scientists.

Source: http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=549/pagename=alpha_list

The PHPP calculation software

Description

Programming Language
Spreadsheet

Input
Data are entered as numbers or chosen in menus.
Needed:

- surface areas of thermal envelope,
- length of thermal bridges (optional),
- thermal characteristics of materials (thermal conductance) or building components (U-values),
- and of thermal bridges (optional);
- characteristics of ventilation system,
- efficiency of heat recovery,
- location of building.

Characteristics of certified passive house building components are implemented.

Source: http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=549/pagename=alpha_list

The PHPP calculation software

Description

Output

Pre-formatted documentations:

- Overview,
- energy balance,
- heating load,
- cooling load,
- summer comfort (percentage of overheating),
- ventilation,
- energy use/losses for heating system,
- primary energy demand.

Computer Platform

Windows PC with MS Office

Strengths

Energy design and thermal comfort for high performance buildings, esp. passive houses

Source: http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=549/pagename=alpha_list

The PHPP calculation software

Description

Weaknesses

Multizonal dynamic building simulation for buildings with large glazing areas (solar gains) and/or high need of control

Actually available languages

German, English, French, Italian, Dutch, Polish, Russian, Ceska, Slovensko, Magyar, (Albanian)

Contact

Company: Passive House Institute
Address: Rheinstr. 44-46, 64283 Darmstadt Germany
E-mail: mail@passiv.de
Website: http://www.passivhaustagung.de/Passive_House_E/PHPP.html

Source: http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=549/pagename=alpha_list

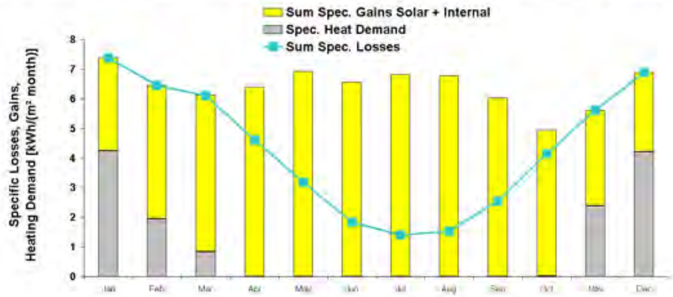
The PHPP calculation software
Description

Some of the sheets with results

PASSIVE HOUSE PLANNING
SPECIFIC ANNUAL HEAT DEMAND
MONTHLY METHOD

Climate: Standard Germany
Building: End-of-Terrace Passive House Kranichstein
Location: Darmstadt Kranichstein
Interior Temperature: 20 °C
Building Type/Use: Terraced House/Dwelling
Treated Floor Area A_{TFA}: 156 m²

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Heating Degree Hours - Exterior	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
Heating Degree Hours - Ground	7.4	7.0	7.6	6.9	6.3	4.7	4.3	3.9	4.5	5.2	5.8	6.8	70
Losses - Exterior	1019	882	817	599	387	205	143	170	317	557	773	955	6824
Losses - Ground	132	124	135	122	112	83	75	69	80	92	103	121	1249
Sum Spec. Losses	7.4	6.5	6.1	4.6	3.2	1.8	1.4	1.5	2.5	4.2	5.6	6.9	51.8
Solar Gains - North	25	38	66	94	127	140	140	112	76	46	25	19	908
Solar Gains - East	0	0	0	0	0	0	0	0	0	0	0	0	0
Solar Gains - South	195	387	444	558	572	511	538	578	538	424	215	141	5112
Solar Gains - West	6	11	18	26	33	32	33	29	22	14	6	4	235
Solar Gains - Horiz.	0	0	0	0	0	0	0	0	0	0	0	0	0
Solar Gains - Opaque	19	36	54	83	105	104	107	94	69	43	21	13	746
Internal Heat Gains	244	220	244	236	244	236	244	244	236	244	236	244	2870
Sum Spec. Gains Solar + Internal	3.1	4.5	5.3	6.4	6.9	6.6	6.8	6.8	6.0	4.9	3.2	2.7	63.3
Utilisation Factor	100%	100%	100%	72%	46%	28%	20%	23%	42%	84%	100%	100%	80%
Annual Heat Demand	663	304	131	0	0	0	0	0	0	2	372	656	2127
Spec. Heat Demand	**4.3**	**2.0**	**0.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.4**	**4.2**	**13.6**



Passive House Verification

PHPP

Building:	End-of-Terrace Passive House Kranichstein
Location and Climate:	Darmstadt Kranichstein — Standard Germany
Street:	
Postcode/City:	D-64289 Darmstadt
Country:	Germany/Hesse
Building Type:	Terraced House/Dwelling
Home Owner(s) / Client(s):	Bauherrengemeinschaft Passivhaus
Street:	
Postcode/City:	D-64289 Darmstadt
Architect:	Prof. Bott/Ridder/Westermeyer
Street:	Jahnstr. 8
Postcode/City:	D-64285 Darmstadt
Mechanical System:	Oeb Dipl.-Ing. Norbert Starz
Street:	Bahnhofstr. 49
Postcode/City:	D-64319 Pfungstadt
Year of Construction:	1991
Number of Dwelling Units:	1
Enclosed Volume V_e:	665.0 m³
Number of Occupants:	4.5
Interior Temperature:	20.0 °C
Internal Heat Gains:	2.1 W/m²

Specific Demands with Reference to the Treated Floor Area

Treated Floor Area: 156.0 m²

	Applied:	Monthly Method	PH Certificate:	Fulfilled?
Specific Space Heat Demand:	14	kWh/(m²a)	15 kWh/(m²a)	Yes
Pressurization Test Result:	0.2	h^{-1}	0.6 h^{-1}	Yes
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	65	kWh/(m²a)	120 kWh/(m²a)	Yes
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	37	kWh/(m²a)		
Specific Primary Energy Demand Energy Conservation by Solar Electricity:		kWh/(m²a)		
Heating Load:	10	W/m²		
Frequency of Overheating:	3	%	over 25 °C	
Specific Useful Cooling Energy Demand:		kWh/(m²a)	15 kWh/(m²a)	
Cooling Load:	9	W/m²		

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

Issued on:

signed:

Source: http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=549/pagename=alpha_list

Working with PHPP

Manual

The manual for PHPP is available in German and English.

This presentation is focused on the most important points. For all the details, please use the manual.

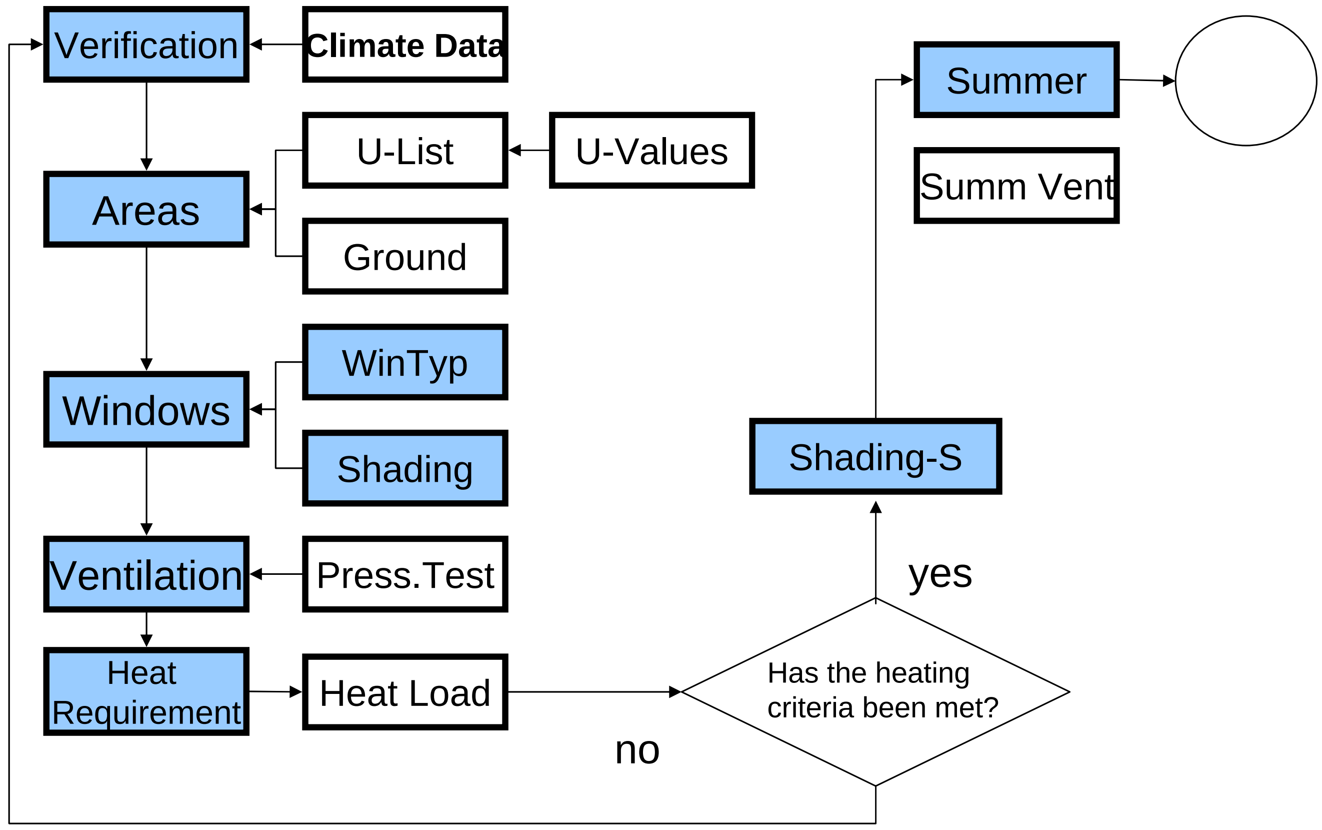
Working with PHPP

Inputs to PHPP

- Start> F0 Verification (Climate Data, Occupants)
- F0-F1 Calculate the U-values
- F1-F2 Input of the areas (Note: use external dimensions for walls)
- F2-F3 Sheet WinTyp and Windows. Pay attention to the orientation
  Enter the windows individually if they have different shading.
  Enter a separate line for fixed glazing, take glazed outside-doors as windows
- F3-F4 Input the shading variables for each window
- F4-F5 Ventilation sheet
- F5-F6 Input thermal bridges, prioritise the psi-value of the windows
- F6-F7 Input summer cooling system and summer shading

Working with PHPP

Inputs to PHPP



Working with PHPP

Inputs to PHPP - Excel sheet verification

passive house Freundorfer	
Oberbayern	Garmisch-P.
Martin Greif Straße 20	
83080 Oberaudorf	
bavaria	
one familiy residence	
Josefa und Franz Freundorfer	
Martin Greif Straße 20	
83080 Oberaudorf	
Dipl. Ing. Elke Kneißl	
Morellstraße 27	
86159 Augsburg	
B.Tec Dr. Harald Krause	
Sonnenfeld 9	
83122 Samerberg	

no standard climate

2006				
1		Interior Temperature:	20,0	°C
742,0	m^3	Internal Heat Sources:	2,1	W/m²
5,0				

Internal Heat Sources

Building Type: Residence

Standard Values used? Standard

Planned Number of Occupants:

5 Planning

Working with PHPP

Inputs to PHPP - Choose the climate region

Passive House Planning

CLIMATE DATA

Standard/Regional Climate: Select Here.

Regional Climate Data ▼

Germany (DIN 4108-6) ▼

Choose the regional climate here:

Garmisch-P. ▼

Climate Data for Heat Load

Heat Load Data Already Assigned ▼

No Choice/Heat Load Data Assigned ▼

Use Regional Data?	Yes
Climate Building	**Garmisch-P.**
Chosen Method Heat Requirement:	**Annual Method**
Monthly Data:	Garmisch-P. (Region
Annual Data:	0
Use Annual Climate Data Set	No

Annual Climate Data — **Carried over into Annual Method**

H_T	**261**
G_t	**107**
East	**428**
South	**693**
West	**416**
North	**227**
Horizontal	**635**

Source:

Working with PHPP

Inputs to PHPP - Areas and volume

Calculation of the TFA (treated floor area)

- The calculation rule was simplified in some points and was adapted to the demands of the energy balancing. Heated secondary rooms are included within this operation.
- For calculating the TFA at first the thermal envelope has to be defined. It is shaped by the external surfaces of the insulated external components. The thermal envelope includes all heated rooms. At the same time it marks the balance limit for the energy balance. The TFA consists of all areas inside the thermal envelope.
- The TFA of an apartment or house is the sum of the TFAs all the living rooms inside the apartment. Living rooms are defined as rooms inside an apartment that either are situated aboveground or that offer a window area of at least 10% as measured by the base area. Stairs with more than three steps, landings and elvators are not added to the living room.

Working with PHPP

Inputs to PHPP - Areas and volume

Calculation of the TFA (treated floor area)

- Basement and engineering room etc. inside the thermal envelope, that are no living rooms, are taken into account by 60%.

- Calculating the base area:
  4.1 The base area of a room is identified by dimension of the shell. Plaster etc. is not to be abstracted.
  4.2 The dimensions of the shell are the inside widths between the walls without regarding any wall arrangements, baseboards, ovens, radiators etc.

- Chimneys, columns etc. measuring less than 0,1 m² of base area are not abstracted from the energy reference area

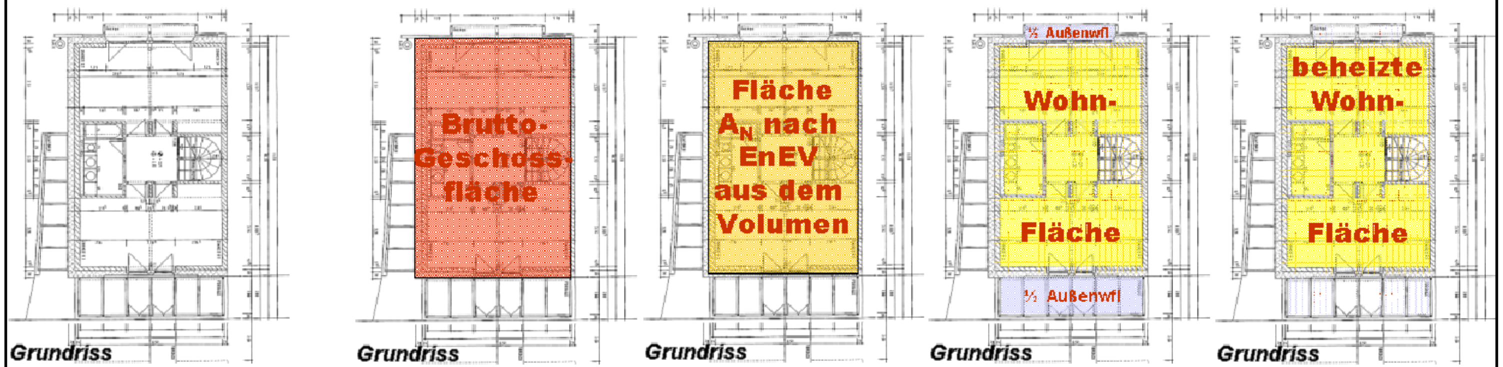
- Door- and window recesses are not regarded

- Bevels:
  7.1 Areas of the room with a clear height of at least 2 meters are calculated completely.
  7.2 Areas of the room with a clear height of at least 1 meter and less than 2 meters are calculated on half.

Working with PHPP

Inputs to PHPP - Areas and volume

Other methods for the calculation of the floor area with other results !!!

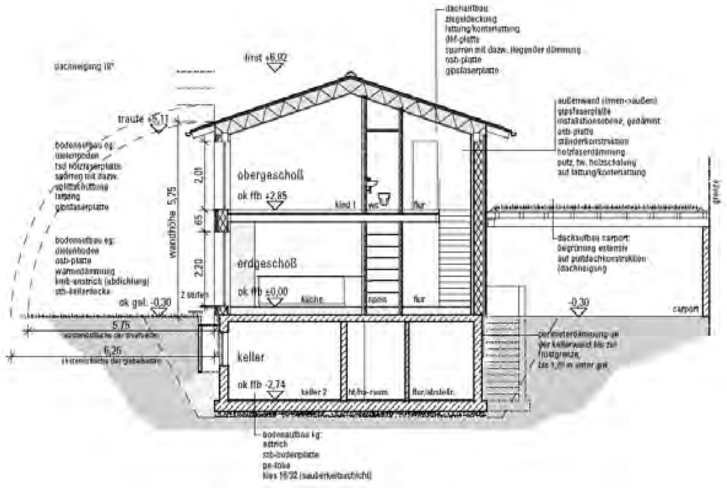


Gross floor area	**212 m²**
Area A_N of the EnEV	**207 m²**
Living area. incl. external surfaces	**183 m²**
Heated living area	**156 m²**
TFA - Treated floor area	157 m²

Source:

Working with PHPP

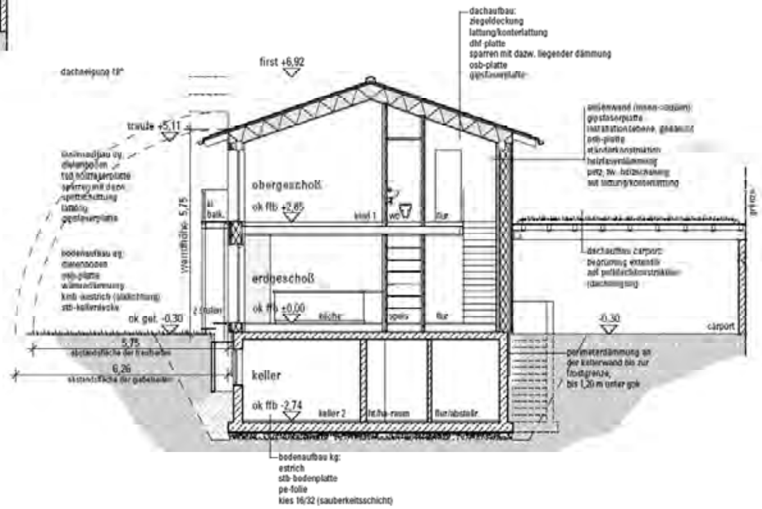
Inputs to PHPP - Areas and volume (House F.)



Roof width L + R 4.43m

Heights of the wall L+R 5.94m
ridge 7.11m mean value 6.53m
´

Timber wall up to 2.75m



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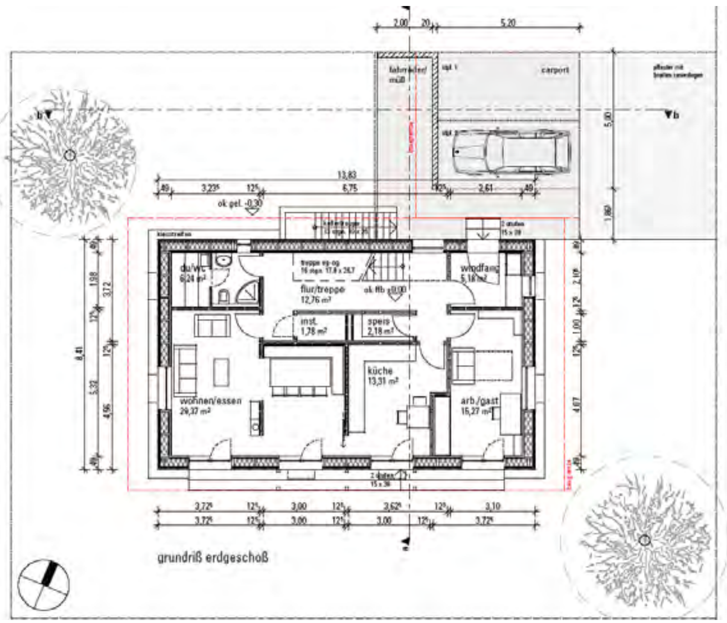
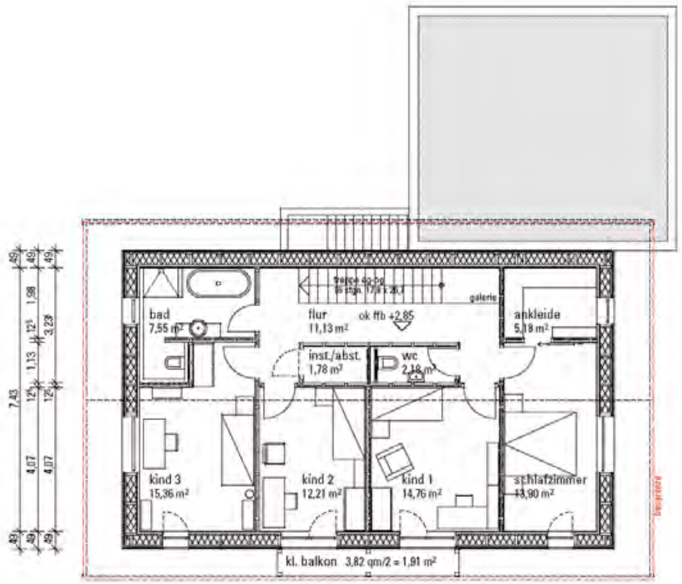
Working with PHPP

Inputs to PHPP - Areas and volume (House F.)



Foot point 13.83m x 8.41m

Treated Floor Area 165,23 m²



U-value wall = 0.11 W/m²K,

Ceiling and roof = 0.10 W/m²K

Working with PHPP

Inputs to PHPP - Areas and volume (House F.)

Facade east

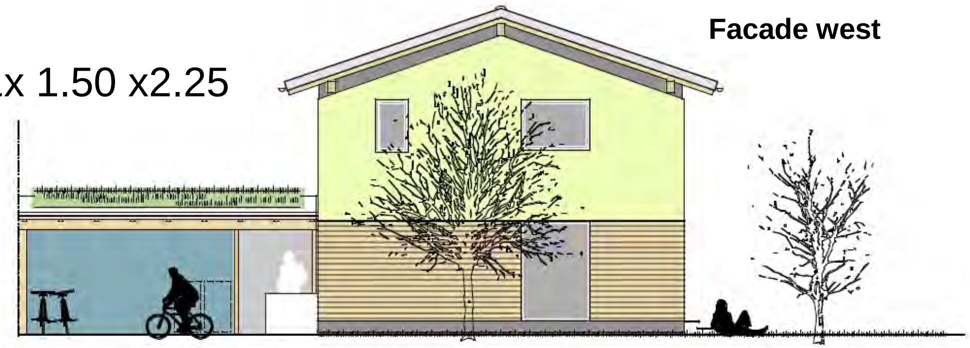
ostansicht

Fixed window first floor 1x 0.75x2.25
1x 1.50x 2.25
Normal window top floor 1x 0.75x 1.45
1x 1.50 x1.45

Normal window top floor 1x 0.75 x1.45
1x 1.50 x1.45

Fixed window first floor 1x 1.50 x2.25

Facade west



Working with PHPP

Inputs to PHPP - Areas and volume (House F.)

Facade south

French door 2x 0.925x 2.25
6x 1.85 x 2.25

U_g-value = 0.60 W/m²K

g -value = 52%

U_D-value = 0.65 W/m²K

Facade east

Outdoor I	1.13 x2.20
Tilt window	0.925 x2.25
Outdoor II	1.13 x 2.20

Source:

Working with PHPP

Inputs to PHPP - Areas and volume (House F.)

Area Nr.	Building Element Description	Group Nr.	Assigned to Group	Quantity	x (	a [m]	x	b [m]	+	User-Determined [m²]
	Treated Floor Area	1	Treated Floor Area	1	x (		x		+	165,23
	East Windows	2	East Windows	Please complete in Windows w						
	South Windows	3	South Windows							
	West Windows	4	West Windows							
	North Windows	5	North Windows							
	Horizontal Windows	6	Horizontal Windows							
	Exterior Door	7	Exterior Door	2	x (	1,13	x	2,20	+	
1	wall east 1.floor	8	Exterior Wall - Ambient Air	1	x (	8,41	x	2,75	+	
2	wall west 1.floor	8	Exterior Wall - Ambient Air	1	x (	8,41	x	2,75	+	
3	wall south 1.floor	8	Exterior Wall - Ambient Air	1	x (	13,830	x	2,750	+	
4	wall north 1.floor	8	Exterior Wall - Ambient Air	1	x (	13,830	x	2,750	+	
5	ceiling basement	9	Exterior Wall - Ground	1	x (	13,830	x	8,410	+	
6	roof	10	Roof/Ceiling - Exterior Air	2	x (	13,830	x	4,430	+	
7	wall east 2.floor	8	Exterior Wall - Ambient Air	1	x (	8,41	x	3,78	+	
8	wall west 2.floor	8	Exterior Wall - Ambient Air	1	x (	8,41	x	3,78	+	
9	wall south 2.floor	8	Exterior Wall - Ambient Air	1	x (	13,830	x	3,190	+	
10	wall north 2.floor	8	Exterior Wall - Ambient Air	1	x (	13,830	x	3,190	+	
11					x (		x		+	

Choose Group Nr. from sheet area A 14 till 17

Source:

Working with PHPP

Inputs to PHPP - Calculation of U-Values (House F.)

Assembly No.	Building Assembly Description
1	wall plastered

Heat Transfer Resistance [m²K/W] interior R_{si}: 0,13
exterior R_{se}: 0,04

	Area of Section 1	λ [W/(mK)]	Area of Section 2 (optional)	λ [W/(mK)]	Area of Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.	plaster board	0,800					12
2.	fiber board	0,040	lightwood	0,130			60
3.	OSB board	0,170					15
4.	cellulose	0,040			timber frame	0,130	340
5.							
6.	fiber board inthermo	0,050					60
7.	outside plaster	0,600					5
8.							

Percentage of Sec. 2: 7,0%
Percentage of Sec. 3: 17,0%
Total: 49,2 cm

U-Value: 0,107 W/(m²K)

Working with PHPP

Inputs to PHPP - Calculation of U-Values (House F.)

Excel sheet U- list

Passive House Plann

U - L I S T

Sheet with compilation of calculated assemblies from U-Values worksheet and further assemblies from data banks

	Type						
Assembly Nr.	Assembly Description	Total Thickness	U-Value	Thickness of Insulation Layer	Thermal Conductivity of Insulation Layer	Spec. Capacity C_{eff}	Min. Moisture Diffusion
		m	$W/(m^2K)$	m	W/(mK)	kJ/m²/K	sd_{min} m
1	- none -						
2	wall plastered	0,492	0,11				
3	wall timber	0,462	0,11				
4	ceiling to the basement	0,544	0,10				
5	roof	0,491	0,10				
6							
7							
8							
9							

Source:

Working with PHPP

Inputs to PHPP - Areas and volume (House F.)

Connect the areas with the U-Values

subtract the outdoors

User-Determined [m²]	-	User Deduction [m²]	-	Deducted Window Areas [m²]	) =	Area [m²]	Selection of the corresponding building elements	Nr.
165,23	-				) =	165,2		
						0,0	Values from Windows worksheet	
						0,0	Values from Windows worksheet	
						0,0	Values from Windows worksheet	
						0,0	Values from Windows worksheet	
						0,0	Values from Windows worksheet	
	-	5,00	) -		=	-5,0	outdoor	6
	-		) -	0,0	=	0,0	wall plastered	2
	-		) -	0,0	=	0,0	wall plastered	2
	-		) -	0,0	=	41,1	wall plastered	2
	-		) -	0,0	=	41,1	wall plastered	2
	-		) -	0,0	=	116,3	ceiling to the basement	4
	-		) -	0,0	=	122,5	roof	5
	-		) -	0,0	=	0,0	wall timber	3
	-		) -	0,0	=	0,0	wall plastered	2
	-		) -	0,0	=	41,1	wall timber	3
	-		) -	0,0	=	41,1	wall timber	3

Working with PHPP

Inputs to PHPP – Input of thermal bridges (House F.)

Thermal bridges entries in "Areas"

Nr. of Thermal Bridge	Thermal Bridge Description	Group Nr.	Assigned to Group	Quantity
1	Edge outside wall	15	Exterior Air Thermal Bridges	4
2	Outside wall-roof	15	Exterior Air Thermal Bridges	1
3	Outside wall basement	16	Perimeter Thermal Bridges	1
4	Top of the roofs	15	Exterior Air Thermal Bridges	1
5	insode wall roof	15	Exterior Air Thermal Bridges	1
6	inside wall outside wall	15	Exterior Air Thermal Bridges	1

Working with PHPP

Inputs to PHPP - Calculation of U_g and g-Values (House F.)

Excel sheet WinTyp

To the frames from row: 64

	Type			
Assembly Nr.	Glazing	g-Value	U_g-Value	
			$W/(m^2K)$	
1	Triple glass Unitop	0,520	0,600	
2				
3				

Source:

Working with PHPP

Inputs to PHPP - Calculation of Ug and g-Values (House F.)

Excel sheet WinTyp

FRAME TYPE IN ACCORDANCE WITH

To the glazings from row: 2

Type	U_w-Value	Frame Measurements				Thermal Bridge	Thermal Bridge
Frame	Frame	Width - Left	Width - Right	Width - Below	Width - Above	$\Psi_{glass\ edge}$	$\Psi_{Installation}$
	W/(m²K)	m	m	m	m	W/(mK)	W/(mK)
Double wood normal	0,950	0,118	0,118	0,118	0,118	0,050	0,014
Double wood fixed	0,950	0,068	0,068	0,068	0,068	0,050	0,014

this value comes out of a finite element calculation and not out of the telephone

Source:

Working with PHPP

Inputs to PHPP - Areas and types of windows (House F.)

Excel sheet Window

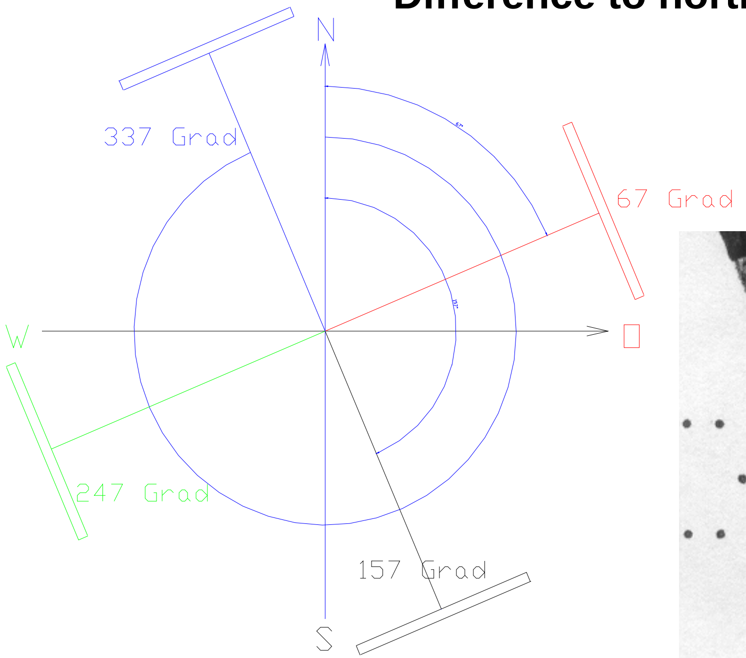
Quantity	Description	Deviation from North	Angle of Inclination Against Horizontal	Orientation	Window Rough Openings: Width	Window Rough Openings: Height	Installed: in Area in the Areas worksheet	Nr.	Glazing: Select glazing from the WinTyp worksheet	Nr.	Window Frar: Select window from the WinTyp worksheet
		Degree	Degree		m	m	Select:		Select:		Select:
1	tilt stair 1	337	90	North	0,925	2,250	wall north 1.floor	4	Triple glass Unito	1	Double wood nor
								0		0	
1	sleeping 2.f	67	90	East	1,500	1,450	wall east 2.floor	7	Triple glass Unito	1	Double wood nor
1	clothing 2.f	67	90	East	0,750	1,450	wall east 2.floor	7	Triple glass Unito	1	Double wood nor
1	fixed office	67	90	East	1,500	2,250	wall east 1.floor	1	Triple glass Unito	1	Double wood fixe
1	fixed entran	67	90	East	0,750	2,250	wall east 1.floor	1	Triple glass Unito	1	Double wood fixe
2	door sep.2.f	157	90	South	0,925	2,250	wall south 2.floor	9	Triple glass Unito	1	Double wood nor
2	door to fixe	157	90	South	0,925	2,250	wall south 2.floor	9	Triple glass Unito	1	Double wood nor
2	fixed 2.floo	157	90	South	0,925	2,250	wall south 2.floor	9	Triple glass Unito	1	Double wood fixe
2	door middle	157	90	South	0,925	2,250	wall south 1.floor	3	Triple glass Unito	1	Double wood nor
2	fixed middle	157	90	South	0,925	2,250	wall south 1.floor	3	Triple glass Unito	1	Double wood fixe
2	door l+r 1.f	157	90	South	0,925	2,250	wall south 1.floor	3	Triple glass Unito	1	Double wood nor
2	fixed l+r 1.	157	90	South	0,925	2,250	wall south 1.floor	3	Triple glass Unito	1	Double wood fixe
1	living fixed	247	90	West	1,500	2,250	wall west 1.floor	2	Triple glass Unito	1	Double wood fixe
1	children 2.f	247	90	West	1,500	1,450	wall west 2.floor	8	Triple glass Unito	1	Double wood nor
1	bathroom 2.f	247	90	West	0,750	1,450	wall east 2.floor	7	Triple glass Unito	1	Double wood nor

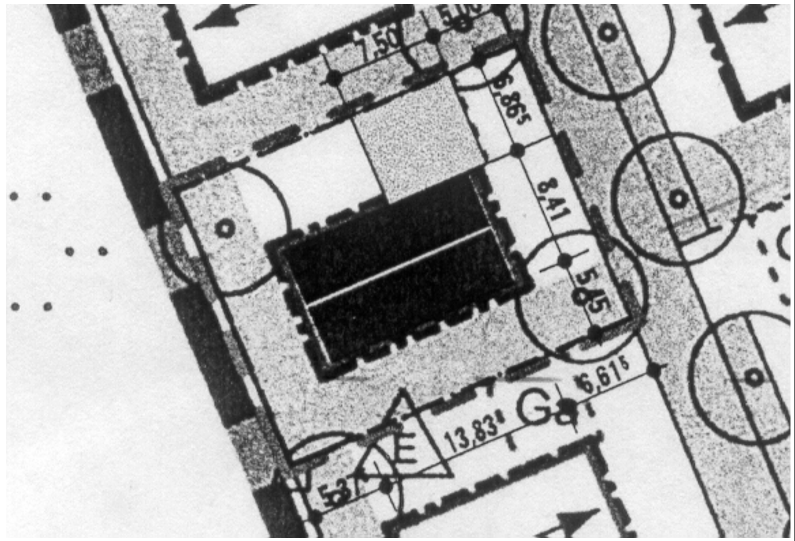
Source:

Working with PHPP

Inputs to PHPP - Orientation of windows (House F.)

Difference to northern orientation





Working with PHPP

Inputs to PHPP - Shading of windows

Working with PHPP

Inputs to PHPP - Shading of windows

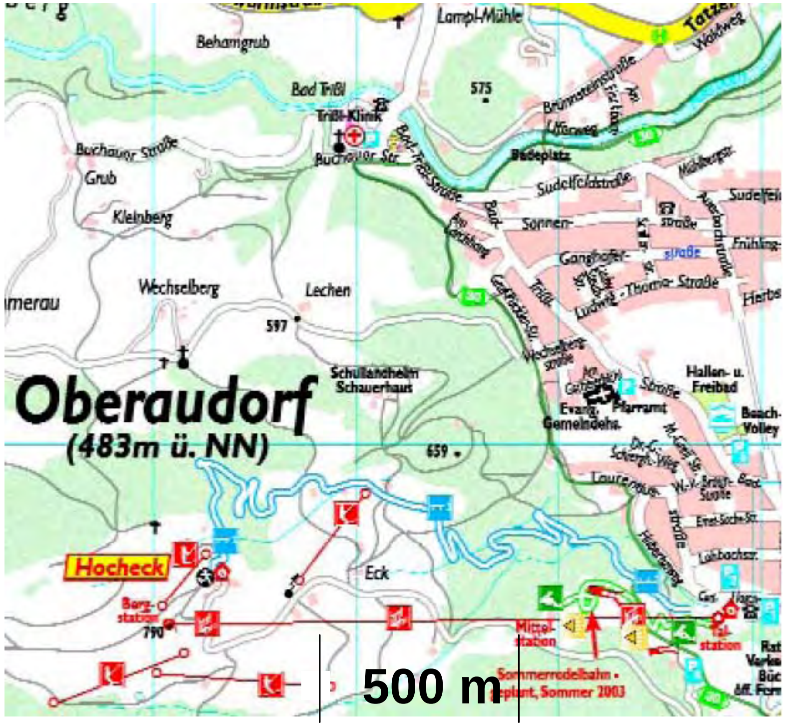
We are looking out of every window and add the values to the PHPP in three cases

- Trees, houses, mountains ......
- Reveal
- Overhang: roof, balcony...

Working with PHPP

Inputs to PHPP - Shading of windows

Plan of surrounding area for the shading of mountains



Working with PHPP

Inputs to PHPP - Shading of windows (House F.)

The input of the mountains

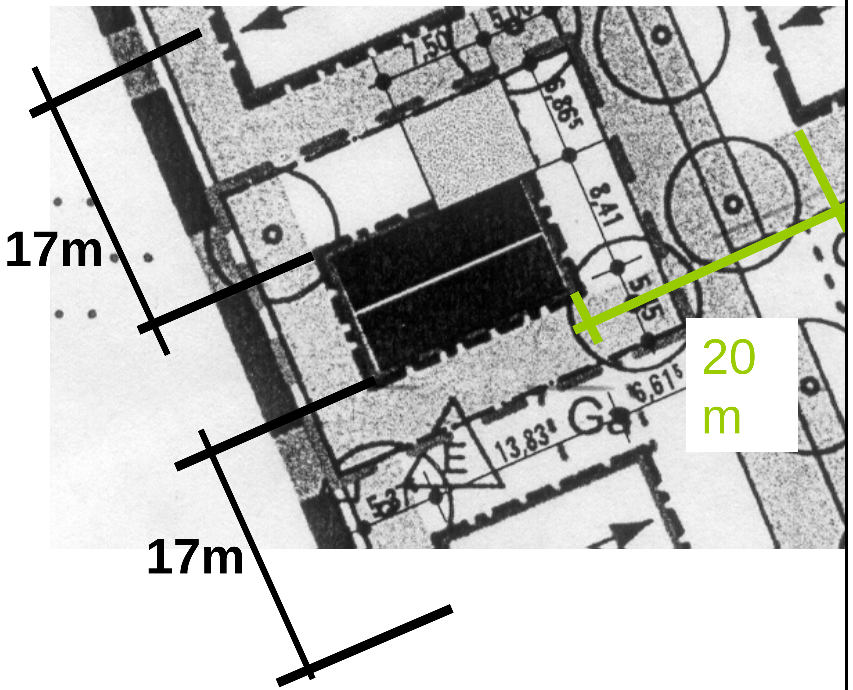
Height of the Shading Object	Horizontal Distance	Window Reveal Depth	Distance from Glazing Edge to Reveal	Overhang Depth	Distance from Upper Glazing Edge to Overhang	Additional Shading Reduction Factor	Horizontal Shading Reduction Factor	Reveal Shading Reduction Factor
m	m	m	m	m	m	%	%	%
h_{Hori}	a_{Hori}	o_{Reveal}	d_{Reveal}	o_{over}	d_{over}	r_{ot}	r_H	r_R
7,00	17,00	0,10	0,00	0,10	0,00	100%	72%	86%
0,00	0,00	0,10	0,05	0,80	1,40	100%	100%	95%
3,25	20,00	0,10	0,05	0,80	1,20	100%	87%	84%
0,00	0,00	0,10	0,00	0,10	0,00	100%	100%	95%
7,00	20,00	0,10	0,00	0,10	0,00	100%	74%	84%
4,25	17,00	0,10	0,05	0,80	0,25	100%	87%	94%
4,25	17,00	0,10	0,05	0,80	0,25	100%	87%	94%
4,25	17,00	0,00	0,00	0,80	0,25	100%	87%	100%
7,00	17,00	0,10	0,05	0,80	0,25	100%	72%	94%
7,00	17,00	0,00	0,00	0,80	0,25	100%	72%	100%
7,00	17,00	0,10	0,05	0,80	0,25	100%	72%	94%
7,00	17,00	0,00	0,00	0,80	0,25	100%	72%	100%
175,00	500,00	0,10	0,00	0,10	0,00	100%	76%	96%
175,00	500,00	0,10	0,05	0,80	1,40	100%	76%	96%
175,00	500,00	0,10	0,05	0,80	1,20	100%	76%	88%

Source:

Working with PHPP

Inputs to PHPP - Shading of windows (House F.)

Position plan is needed for the input of the shading



Working with PHPP

Inputs to PHPP - Shading of windows (House F.)

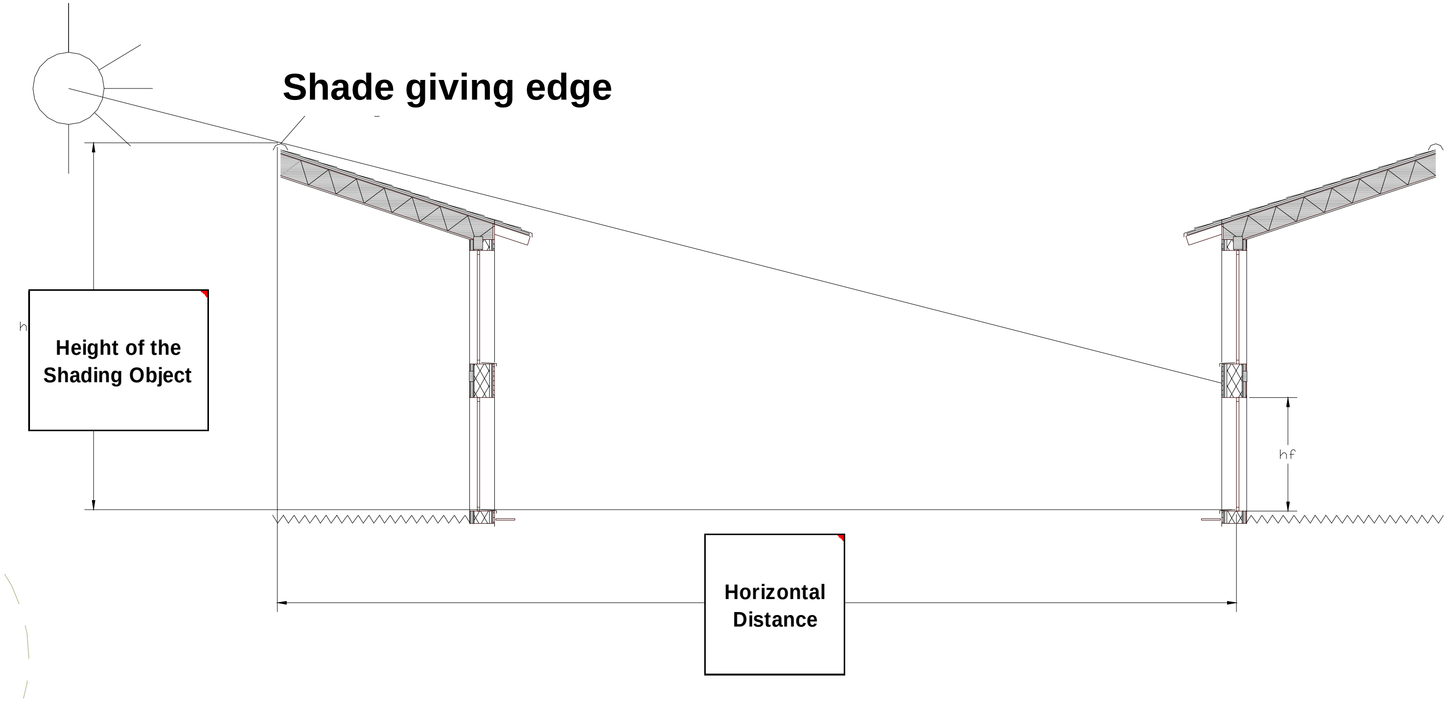
The input of the neighbour houses

	Height of the Shading Object	Horizontal Distance	Window Reveal Depth	Distance from Glazing Edge to Reveal	Overhang Depth	Distance from Upper Glazing Edge to Overhang	Additional Shading Reduction Factor	Horizontal Shading Reduction Factor	Reveal Shading Reduction Factor
	m	m	m	m	m	m	%	%	%
	h_{Hori}	a_{Hori}	o_{Reveal}	d_{Reveal}	o_{over}	d_{over}	r_{ot}	r_H	r_R
North	7,00	17,00	0,10	0,00	0,10	0,00	100%	72%	86%
East	0,00	0,00	0,10	0,05	0,80	1,40	100%	100%	95%
East	3,25	20,00	0,10	0,05	0,80	1,20	100%	87%	84%
East	0,00	0,00	0,10	0,00	0,10	0,00	100%	100%	95%
East	7,00	20,00	0,10	0,00	0,10	0,00	100%	74%	84%
South	4,25	17,00	0,10	0,05	0,80	0,25	100%	87%	94%
South	4,25	17,00	0,10	0,05	0,80	0,25	100%	87%	94%
South	4,25	17,00	0,00	0,00	0,80	0,25	100%	87%	100%
South	7,00	17,00	0,10	0,05	0,80	0,25	100%	72%	94%
South	7,00	17,00	0,00	0,00	0,80	0,25	100%	72%	100%
South	7,00	17,00	0,10	0,05	0,80	0,25	100%	72%	94%
South	7,00	17,00	0,00	0,00	0,80	0,25	100%	72%	100%
West	175,00	500,00	0,10	0,00	0,10	0,00	100%	76%	96%
West	175,00	500,00	0,10	0,05	0,80	1,40	100%	76%	96%
West	175,00	500,00	0,10	0,05	0,80	1,20	100%	76%	88%

Working with PHPP

Inputs to PHPP - Shading of windows

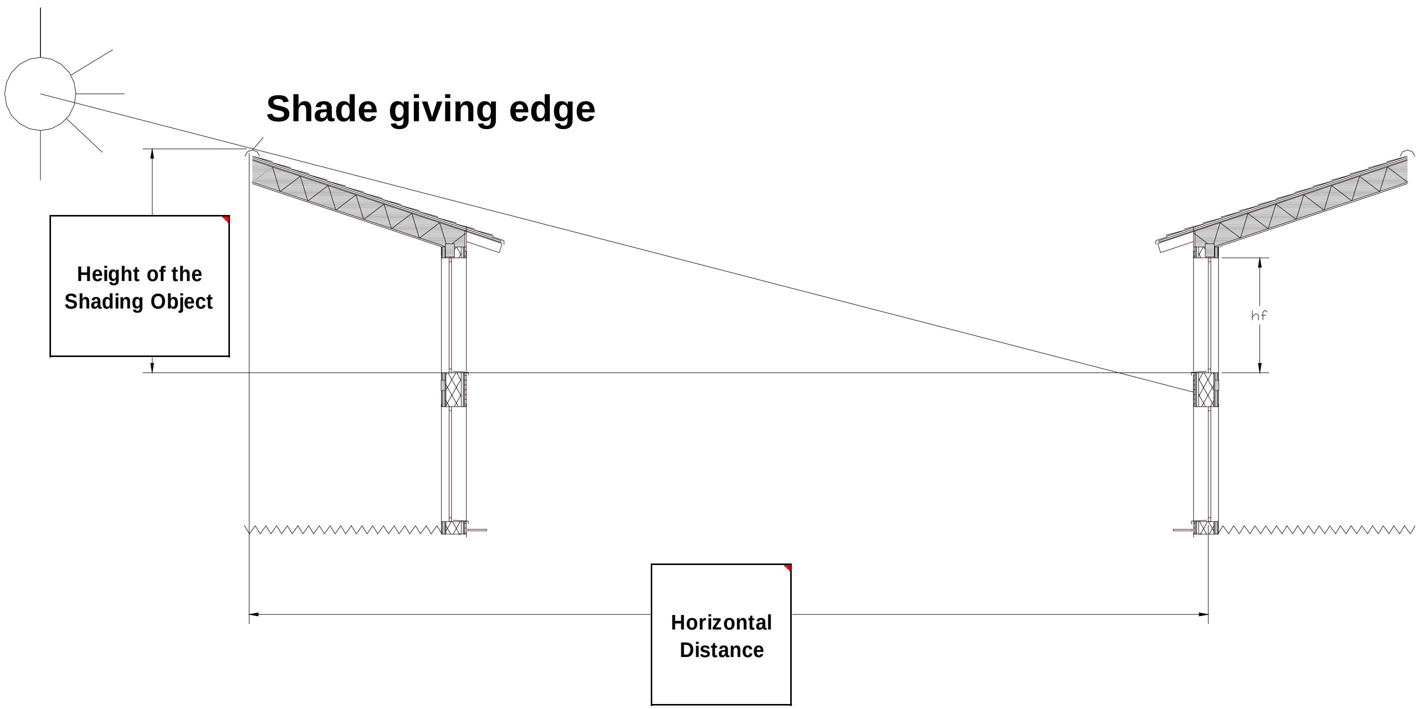
Shading of a house by a window on the first floor



Working with PHPP

Inputs to PHPP - Shading of windows

Shading of a house by a window on the second floor



Working with PHPP

Inputs to PHPP - Shading of windows (House F.)

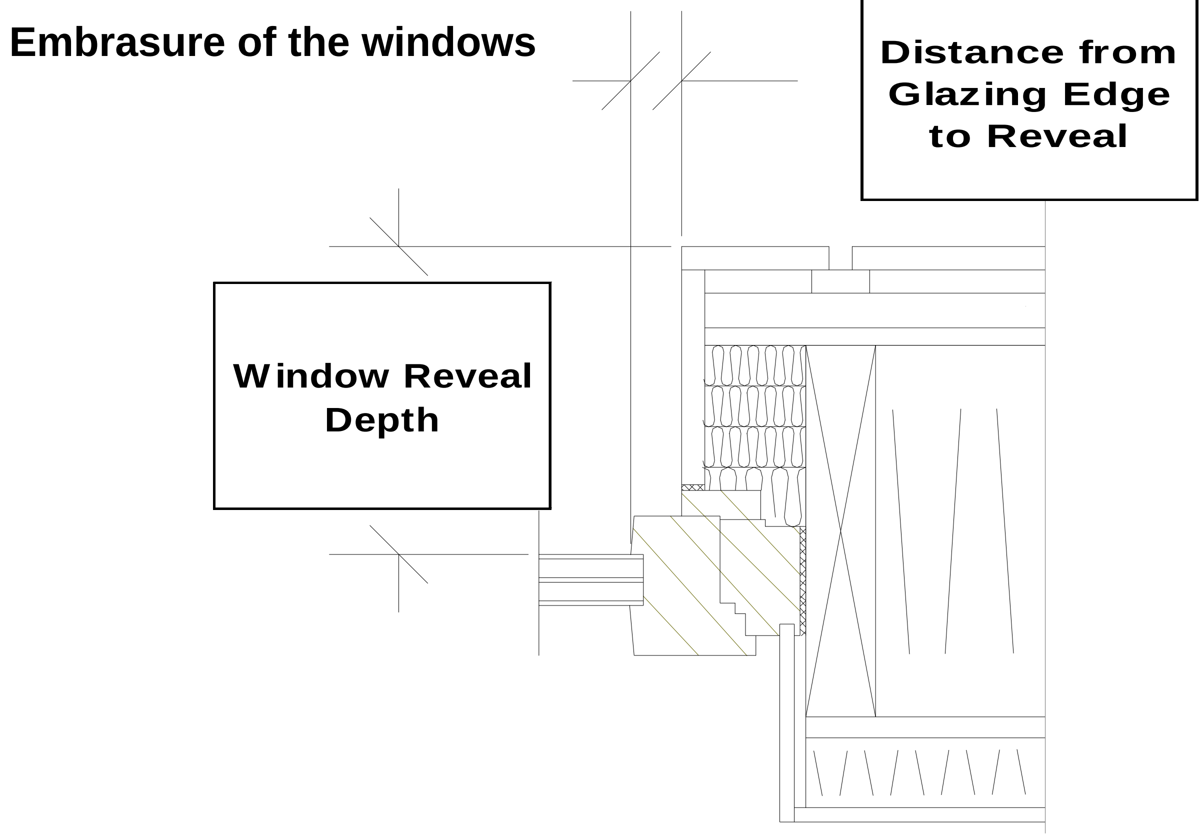
The input of the window reveal

	Height of the Shading Object	Horizontal Distance	Window Reveal Depth	Distance from Glazing Edge to Reveal	Overhang Depth	Distance from Upper Glazing Edge to Overhang	Additional Shading Reduction Factor	Horizontal Shading Reduction Factor	Reveal Shading Reduction Factor
	m	m	m	m	m	m	%	%	%
	h_{Hori}	a_{Hori}	o_{Reveal}	d_{Reveal}	o_{over}	d_{over}	r_{ot}	r_H	r_R
North	7,00	17,00	0,10	0,00	0,10	0,00	100%	72%	86%
East	0,00	0,00	0,10	0,05	0,80	1,40	100%	100%	95%
East	3,25	20,00	0,10	0,05	0,80	1,20	100%	87%	84%
East	0,00	0,00	0,10	0,00	0,10	0,00	100%	100%	95%
East	7,00	20,00	0,10	0,00	0,10	0,00	100%	74%	84%
South	4,25	17,00	0,10	0,05	0,80	0,25	100%	87%	94%
South	4,25	17,00	0,10	0,05	0,80	0,25	100%	87%	94%
South	4,25	17,00	0,00	0,00	0,80	0,25	100%	87%	100%
South	7,00	17,00	0,10	0,05	0,80	0,25	100%	72%	94%
South	7,00	17,00	0,00	0,00	0,80	0,25	100%	72%	100%
South	7,00	17,00	0,10	0,05	0,80	0,25	100%	72%	94%
South	7,00	17,00	0,00	0,00	0,80	0,25	100%	72%	100%
West	175,00	500,00	0,10	0,00	0,10	0,00	100%	76%	96%
West	175,00	500,00	0,10	0,05	0,80	1,40	100%	76%	96%
West	175,00	500,00	0,10	0,05	0,80	1,20	100%	76%	88%

Source:

Working with PHPP

Inputs to PHPP - Shading of windows

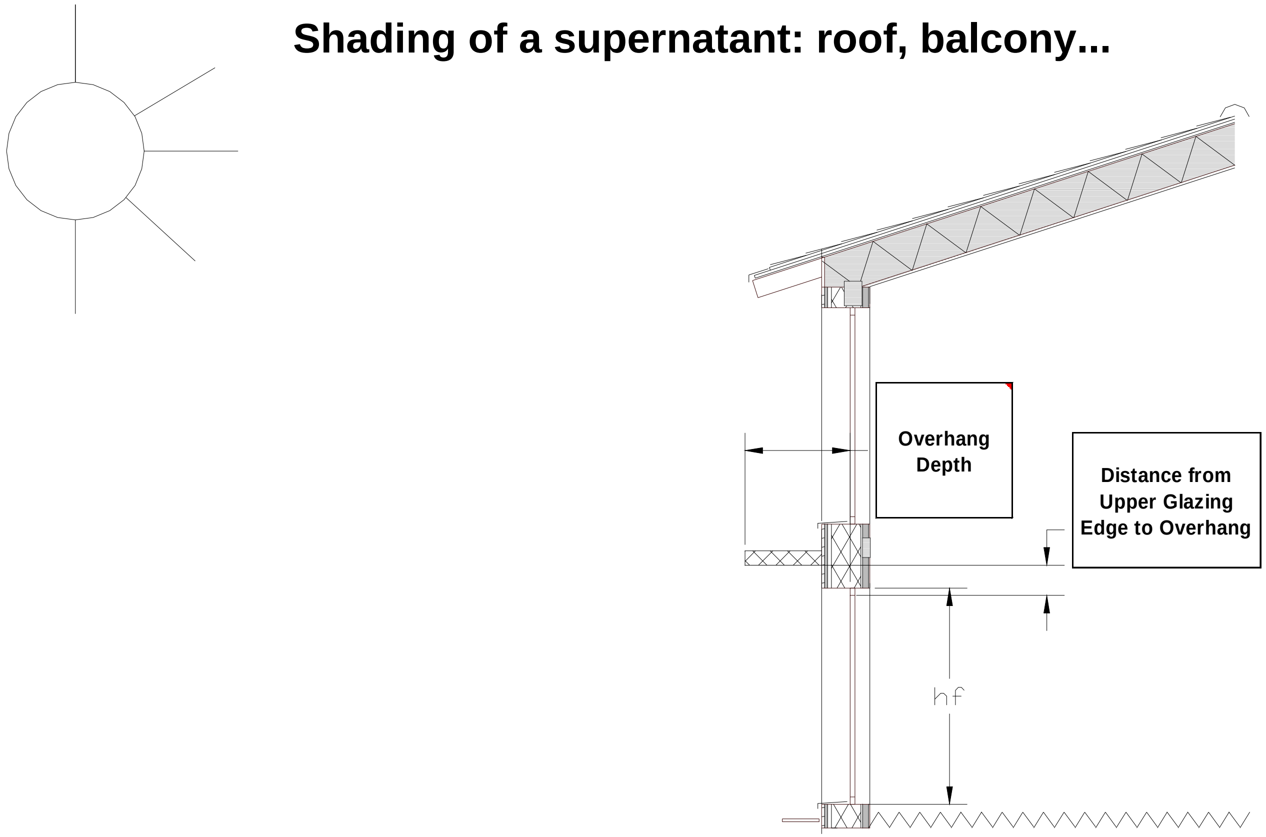


Source:

Working with PHPP

Inputs to PHPP - Shading of windows

Shading of a supernatant: roof, balcony...



Working with PHPP

Inputs to PHPP - Shading of windows (House F.)

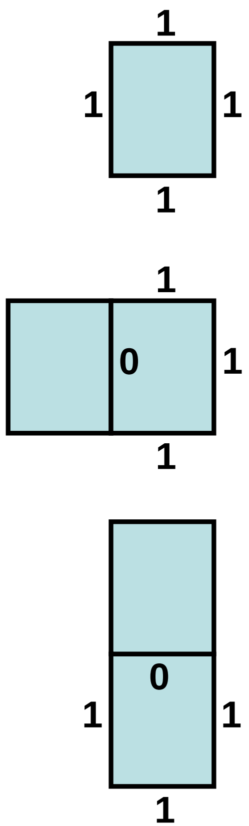
The input of the overhangs

	Height of the Shading Object	Horizontal Distance	Window Reveal Depth	Distance from Glazing Edge to Reveal	Overhang Depth	Distance from Upper Glazing Edge to Overhang	Additional Shading Reduction Factor	Horizontal Shading Reduction Factor	Reveal Shading Reduction Factor
	m	m	m	m	m	m	%	%	%
	h_{Hori}	a_{Hori}	o_{Reveal}	d_{Reveal}	o_{over}	d_{over}	r_{ot}	r_H	r_R
North	7,00	17,00	0,10	0,00	0,10	0,00	100%	72%	86%
East	0,00	0,00	0,10	0,05	0,80	1,40	100%	100%	95%
East	3,25	20,00	0,10	0,05	0,80	1,20	100%	87%	84%
East	0,00	0,00	0,10	0,00	0,10	0,00	100%	100%	95%
East	7,00	20,00	0,10	0,00	0,10	0,00	100%	74%	84%
South	4,25	17,00	0,10	0,05	0,80	0,25	100%	87%	94%
South	4,25	17,00	0,10	0,05	0,80	0,25	100%	87%	94%
South								%	100%
South								%	94%
South	7,00	17,00	0,00	0,00	0,80	0,25	100%	72%	100%
South	7,00	17,00	0,10	0,05	0,80	0,25	100%	72%	94%
South	7,00	17,00	0,00	0,00	0,80	0,25	100%	72%	100%
West	175,00	500,00	0,10	0,00	0,10	0,00	100%	76%	96%
West	175,00	500,00	0,10	0,05	0,80	1,40	100%	76%	96%
West	175,00	500,00	0,10	0,05	0,80	1,20	100%	76%	88%

If there is no overhang put in the „reveal on the top!

Working with PHPP

Inputs to PHPP - Installation of windows (House F.)



Window: installation and result

Installation				Ψ–Value		Results			
Left 1/0	Right 1/0	Para-pet 1/0	Lintel 1/0	Ψ_{Spacer}	$\Psi_{Installation}$	Window Area	Glazing Area	U-Value Window	Glass Per Window
				W/(mK)	W/(mK)	m^2	m^2	$W/(m^2K)$	%
1	1	1	1	0,05	0,01	2,1	1,39	0,89	0,67
				#NV	#NV				
1	1	1	1	0,05	0,01	2,2	1,53	0,85	0,71
1	1	1	1	0,05	0,01	1,1	0,62	0,96	0,57
1	1	1	1	0,05	0,01	3,4	2,88	0,79	0,85
1	1	1	1	0,05	0,01	1,7	1,30	0,89	0,77
1	1	1	1	0,05	0,01	4,2	2,78	0,89	0,67
1	0	1	1	0,05	0,01	4,2	2,78	0,87	0,67
0	1	1	1	0,05	0,01	4,2	3,34	0,84	0,80
1	0	1	1	0,05	0,01	4,2	2,78	0,87	0,67
0	1	1	1	0,05	0,01	4,2	3,34	0,84	0,80
1	0	1	1	0,05	0,01	4,2	2,78	0,87	0,67
0	1	1	1	0,05	0,01	4,2	3,34	0,84	0,80
1	1	1	1	0,05	0,01	3,4	2,88	0,79	0,85
1	1	1	1	0,05	0,01	2,2	1,53	0,85	0,71
1	1	1	1	0,05	0,01	1,1	0,62	0,96	0,57

Source:

Working with PHPP

Inputs to PHPP – Results of windows (House F.)

Solar heat gain with average shading

g-Value	Reduction Factor for Solar Radiation	Window Areas	Window U-Values	Glazing Area	Average Global Radiation
		m^2	$W/(m^2K)$	m^2	$kWh/(m^2a)$
0,52	0,46	8,33	0,85	6,3	337
0,52	0,44	29,14	0,86	21,1	669
0,52	0,46	6,64	0,84	5,0	519
0,52	0,40	2,08	0,89	1,4	240
0,00	0,00	0,00	0,00	0,0	635
0,52	0,44	46,18	0,86	33,9	

107,2	
Transmission Losses	Heat Gains Solar Radiation
kWh/a	kWh/a
757	672
2686	4447
596	824
198	105
0	0
4237	6048

Working with PHPP

Inputs to PHPP – Input of ventilation (House F.)

Building: passive house Freundorfer

Treated Floor Area A_{TFA}	m²	165	(Areas worksheet)
Room Height, h	m	2,5	(Annual Heat Requirement worksheet)
Room Ventilation Volume (A_{TFA}*h) = V_{RAX}	m³	413	(Annual Heat Requirement worksheet)

Ventilation System Layout - Standard Operation

Occupancy	m²/P	33				
Number of Occupants	P	5,0				
Supply Air per Person	m³/(P*h)	30				
Supply Air Requirement	m³/h	150				
Extract Air Rooms		Kitchen	Bathroom	Shower	WC	thing,wasch
Quantity		1	1	1	1	1
Extract Air Requirement per Room	m³/h	60	40	20	20	25
Total Extract Air Requirement	m³/h	165				

Design Air Flow Rate (Maximum) m³/h 165

Average Air Change Rate Calculation

Type of Operation	Daily Operation Times h/d	Factors Referenced to Maximum	Air Flow Rate m³/h	Air Change Rate 1/h
Maximum	0,0	1,00	165	0,40
Standard	24,0	0,77	127	0,31
Basic	0,0	0,54	89	0,22
Minimum		0,40	66	0,16
x Residential Building	**Average Value**	0,77	Average Airflow Volume (m³/h): 127	Average Air Change Rate: 0,31

Working with PHPP

Inputs to PHPP – Input of ventilation (House F.)

Infiltration Air Change Rate Following DIN EN 832.

Wind Protection Coefficients, e and f, in Accordance With EN 832.		
Coefficient e for Screening Class	Several Sides Exposed	One Side Exposed
No screening	0,10	0,03
Moderate Screening	0,07	0,02
High Screening	0,04	0,01
Coefficient f	15	20

			for Ann. Reqment:	for Heat Load:	Net Air Volume for Press. Test
Wind Protection Coefficient, e			0,07	0,18	
Wind Protection Coefficient, f			15	15	
Air change rate at Press. Test	n_{50}	1/h	0,40	0,40	413

Type of Ventilation System

				for Ann. Reqment:	for Heat Load:
x	Balanced PH Ventilation	*Please check.*			
	Pure Extract Air				
	Excess Extract Air		1/h	0,00	0,00
	Infiltration Air Change Rate	$n_{V,Res}$	1/h	0,028	0,070

Actual efficiency of the ventilation system with heat recovery

	Central unit within the thermal envelope.
x	Central unit outside of the thermal envelope.

Efficiency of Heat Recovery	$\eta_{eff,HR}$		92%	
Conductance Supply Air Duct	Ψ	W/(mK)	0,337	Calculation see Secondary Calculati
Supply Air Duct Length		m	2	
Conductance Extract Air Duct	Ψ	W/(mK)	0,337	Calculation see Secondary Calculati
Extract Air Duct Length		m	2	Room Temperatur
Temperature of Mechanical Service Room		°C	12	Average Exterior T
(Enter only if the central unit is outside of the thermal envelope.)				

Actual Efficiency of Heat Recovery	$\eta_{HR,eff}$	91%
Efficiency of Heat Recovery of Subsoil Heat Exchanger	η_{SHX}	20%

Secondary Calculation:

Ψ-Value Supply or Outdoor Air Duct

Nominal Width	160	mm
Insul. Thickness:	60	mm

Reflecting surface? Please mark with an "x"!

	Yes
x	No

Thermal Conductivity	0,035	W/(mK)
Nominal Air Flow Rate	127	m³/h
Δϑ	8	K
Interior Duct Diameter	0,160	m
Exterior Duct Diameter	0,160	m
Exterior Diameter	0,280	m
α–Interior	8,71	W/(m²K)
α–Surface Area	5,77	W/(m²K)
Ψ-Value	**0,337**	**W/(mK)**
Surface temperature difference	1,145	K

Source:

Working with PHPP

Inputs to PHPP – Summer ventilation (House F.)

Exterior Heat Flow Coefficient, $H_{T,e}$	68,4	W/K
Ground Heat Flow Coefficient, $H_{T,g}$	10,6	W/K

Efficiency of Heat Recovery of the plate heat exchanger η_{HR} 91%

effective Air Volume V_V: A_{TFA} (m²) 165,2 * Room Clearance (m) 2,50 = 413 m³

Mark with 'x':

	Free Ventilation (Windows + Cracks):	**Summer Air Change Rate: 1/h**	**0,40**
	Mech. Exhaust Only	0,40	1/h
	Supply and Exhaust Air as During Winter Operation, With HR.		
x	**Supply/Exh. w/o HR**	0,20	η_{SHX} **Subsoil Heat Excha**

Energetically Effective Air Exchange n_V: 0,000 + 0,400 (1/h) * (1 - 0,000 (η_{HR})) + 0,028 ($n_{V,Rest}$, 1/h)

	V_V (m³)		$n_{V,equi\ Portion}$ (1/h)		c_{Air} (Wh/(m³K))			
Ext. Vent. Heat Flow Coeff., $H_{V,e}$	413	*	0,228	*	0,33	=	31,1	W/K
Ground Vent. Heat Flow Coeff., $H_{V,g}$	413	*	0,200	*	0,33	=	27,3	W/K

Q_T W/K Q_L W/K   kWh/a

Can come from nature or mechanical Ventilation (without heat recovery)

Working with PHPP

Inputs to PHPP – Summer shading (House F.)

arbour as natural shading, cheap and sure

			Summer	Summer			
	Upper Glazing Edge to Overhang	Shading Reduction Factor (Summer)	Shading Reduction Factor, z	Horizontal Shading Reduction Factor	Reveal Shading Reduction Factor	Overhang Shading Reduction Factor	Total Summer Shading Reduction Factor
	m	%	%	%	%	%	%
	d_{Over}			r_H	r_L	r_O	r_V
North	0,00	100%	100%	78%	83%	98%	63%
East	1,40	100%	100%	100%	96%	93%	89%
East	1,20	100%	100%	93%	90%	92%	77%
East	0,00	100%	30%	100%	96%	99%	29%
East	0,00	100%	100%	82%	90%	99%	73%
South	0,25	50%	100%	92%	89%	66%	27%
South	0,25	50%	100%	92%	89%	66%	27%
South	0,25	50%	100%	92%	100%	67%	31%
South	0,25	50%	100%	87%	89%	66%	25%
South	0,25	50%	100%	87%	100%	67%	29%
South	0,25	50%	100%	87%	89%	66%	25%
South	0,25	50%	100%	87%	100%	67%	29%
West	0,00						
West	1,40						
West	1,20						

East and west windows are typical overheating elements.
Put in the z value of the used shading system.

Source:

Working with PHPP

Inputs to PHPP – Summer shading (House F.)

Interior Heat Sources Q_I 2,10 * 165 = 347 2,1

Frequency of Overheating $h_{\vartheta \geq \vartheta max}$ **43,9%** **at an overheating limit of ϑ_{max} = 25 °C**

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

S U M M E R

Climate:	Garmisch-P.	Interior Temperature:	20 °C
Building:	passive house Freundorfer	Building Type/Use:	one family house
Location:	Oberbayern	Treated Floor Area A_{TFA}:	165,2 m²
Specific Capacity	84 Wh/K per m² FS	Standard Occupancy:	5,0 Pers
Overheating Limit:	25 °C		

	Building Element	Temperature Zone	Area m²		U-Value W/(m²K)		Red. Factor fT,Summer		H_{Summer} Heat Conducance
1,	Exterior Wall - Ambie	A	230,4	*	0,108	*	0,92	=	23,0
2,	Exterior Wall - Groun	B	116,3	*	0,099	*	1,00	=	11,5
3,	Roof/Ceiling - Exteri	D	[illegible]	*	0,096	*	0,62	=	7,3
6,		A		*		*	0,92	=	
7,		X		*		*	0,69	=	
8,	Windows	A	46,2	*	0,856	*	1,00	=	39,5
9,	Exterior Door	A	5,0	*	0,650	*	1,00	=	3,2
10,	Exterior Thermal Brid	A	158,2	*	-0,032	*	0,92	=	-4,7
11,	Perimeter Thermal Bri	P	43,7	*	-0,020	*	1,00	=	-0,9
12,	Ground Thermal Bridge	B		*		*	1,00	=	

Exterior Heat Flow Coefficient, $H_{T,e}$ 68,4 W/K

Ground Heat Flow Coefficient, $H_{T,g}$ 10,6 W/K

The capacity for buffering energy depends on the used materials.

Working with PHPP

Inputs to PHPP – First result summer comfort (House F.)

Wellbeing without overheating (sheet Summer)

	Orientation of the Area	Angle Factor Summer		Shading Factor Summer		Back Reflection		g-Value (perp. radiation)		Area m²		Glazing Fraction		Aperture m²
1.	East	0,84	*	0,87	*	0,95	*	0,52	*	8,3	*	76%	=	2,3
2.	South	0,84	*	0,55	*	0,95	*	0,52	*	29,1	*	72%	=	4,9
3.	West	0,84	*	0,76	*	0,95	*	0,52	*	6,6	*	76%	=	1,6
4.	North	0,84	*	0,63	*	0,95	*	0,52	*	2,1	*	67%	=	0,4
5.	Horizontal	0,84	*	1,00	*	0,95	*	0,00	*	0,0	*	0%	=	0,0

Heat Gains Solar Radiation Q_S Total 9,1

	Specif. Power q_I W/m²		A_{TFA} m²		W
Interior Heat Sources Q_I	2,10	*	165	=	347

Frequency of Overheating $h_{\vartheta \geq \vartheta max}$ **11,3%** **at an overheating limit of ϑ_{max} = 25 °C**

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

If the value is over 10% go to sheet Summer-S and put in some roller blinds.

Working with PHPP

Inputs to PHPP – Heat requirement

Criteria 1 - Specific annual heat demand:

Energy used for space heating is

< 15 kWh/(m²a)

A passive house is a building with such a low heating load that it can be heated by the anyway existing ventilation system.

Working with PHPP

Inputs to PHPP – Result transmission heat losses (House F.)

	Building Element	Temperature Zone	Area m²		U-Value W/(m²K)		Temp. factor f_t		G_t kKh/a		kWh/a	Treated Floor Area
1.	Exterior Wall - Ambient Ai	A	228,2	*	0,104	*	1,00	*	84,0	=	1997	
2.	Exterior Wall - Ground	B	116,3	*	0,120	*	0,50	*	84,0	=	588	
3.	Roof/Ceiling - Exterior Ai	D	122,5	*	0,101	*	1,00	*	84,0	=	1040	
4.	Floor Slab	B		*		*	0,50	*		=		
5.		A		*		*	1,00	*		=		
6.		A		*		*	1,00	*		=		
7.		X		*		*	0,75	*		=		
8.	Windows	A	48,4	*	0,717	*	1,00	*	84,0	=	2915	
9.	Exterior Door	A	2,5	*	0,647	*	1,00	*	84,0	=	135	
10.	Exterior Thermal Bridge (l	A	162,0	*	-0,036	*	1,00	*	84,0	=	-493	
11.	Perimeter Thermal Bridge (	P	44,5	*	-0,020	*	0,50	*	84,0	=	-37	
12.	Ground Thermal Bridge (len	B		*		*	0,50	*		=		
	Total of all building envelope areas		515,4									kWh/(m²a)
	Transmission Heat Losses Q_T									Total	6147	36,3

$$Q_T = A * U * f_T * G_T$$

$$\text{oder } Q_T = \Sigma(U_i * A_i * G_{Ti}) + \Sigma(\Psi_i * l_i * G_{Ti})$$

f_T Temp. Factor (reduction faktor)

G_T Heating degree hours: Difference of the temperature between inside and outside added up hour by hour all over the heating time. (different in different climate regions)

Source:

Working with PHPP

Inputs to PHPP – Result ventilation losses (House F.)

				A_{TFA} m²		Room Clearance m		m³	
Ventilation System:	Effective Air Volume V_{RAX}			169,5	*	2,50	=	423,8	
Actual Efficiency of Heat Recovery	η_{eff} 83%								
Efficiency of Subsoil Heat Exchanger	η_{SHX} 20%		$n_{V,system}$ 1/h		Φ_{HR}		$n_{V,Res}$ 1/h	1/h	
Energetically Effective Air Exchange n_V			0,309	(1	0,86	) +	0,028	= 0,071	
	V_V m³		n_V 1/h		c_{Air} Wh/(m³K)		G_t kKh/a	kWh/a	kWh/(m²a)
Ventilation Heat Losses Q_V	424	*	0,071	*	0,33	*	84,0	= 831	4,9
			Q_T kWh/a		Q_V kWh/a		Reduction Factor Night/Weekend Economy	kWh/a	kWh/(m²a)
Total Heat Losses Q_L		(	6147	+	831	)	1,0	= 6978	41,2

$$Q_V = V_V * n_V * c_p\rho * G_T$$

V_V: exchange volume of the ventilation system

n_V: energetic operative air change

$c_p\rho$: specific heat capacity of air (capability of containing heat = 0.33 Wh/m³K (the potential))

		kWh/a		kWh/a		Economy		kWh/a	kWh/(m²a)
Total Heat Losses Q_L	(	6147	+	831	)	1,0	=	6978	41,2

$$Q_L = Q_T + Q_V$$

Working with PHPP

Inputs to PHPP – Result solar heat gains (House F.)

	Orientation of the Area	Reduction Factor see Windows		g-Value (perp. radiation)		Area m²		Global Radiation Heating Period kWh/(m²a)		kWh/a
1.	East	0,50	*	0,52	*	8,33	*	185	=	402
2.	South	0,40	*	0,52	*	29,14	*	356	=	2149
3.	West	0,42	*	0,52	*	6,64	*	275	=	399
4.	North	0,30	*	0,52	*	4,28	*	145	=	97
5.	Horizontal	0,40	*	0,00	*	0,00	*	360	=	0

Gross Solar Heat Gains Q_S Total 3047 kWh/a; 18,0 kWh/(m²a)

$$Q_S = r * g * A_F * G$$

r: reductions factor of shading, dirt and angle to the sun

g: solar heat gain coefficient of the glasses with vertical sun transit

G: global radiation during the heating days. (slide climate data)

Source:

Working with PHPP

Inputs to PHPP – Result internal heat gains and heat requirement

	kh/d		Heating Period d/a		Specif. Power q_I W/m²		A_{TFA} m²		kWh/a	kWh/(m²a)
Internal Heat Sources Q_I	0,024	*	225	*	2,10	*	169,5	=	1922	11,3
Free Heat Q_F							$Q_S + Q_I$	=	4969	29,3
Ratio of Free Heat to Losses							Q_F / Q_L	=	0,71	
Utilization Factor Heat Gains η_G					$(1 - (Q_F / Q_L)^5) / (1 - (Q_F / Q_L)^6)$			=	94%	
Heat Gains Q_G							$\eta_G * Q_F$	=	4668	27,5

Heating of persons and equipment

Slide IHS

			kWh/a	kWh/(m²a)
Annual Heat Requirement Q_H	$Q_L - Q_G$	=	2310	**14**

	kWh/(m²a)		(Yes/No)
Limit	15	**Requirement met?**	**Yes**

$$Q_H = Q_T + Q_V - \eta*(Q_S + Q_I)$$

η : utilization factor heat gains

Source:

Working with PHPP

Inputs to PHPP – Heat load

Criteria 2 – Heat load:

power used to heat the building is 10 W/m² (normally 100!)

The critical days are

•A very cold but sunny day

•or a moderate cold day but nearly without any sun

Working with PHPP

Inputs to PHPP – Result heat load (House F.)

cold but clear day ▼ | moderate but bleak day ▼

Nr. Heat Load Region: 0 — Standard chosen — Cl

	Design Temperature		Radiation:	East	South	West	North	Horizontal	
Weather Condition 1:	-6,0	°C		15	50	15	5	5	W/m²
Weather Condition 2:	-1,0	°C		5	5	5	5	5	W/m²
Ground Design Temperature	10,0	°C							

	Building Elements	Temperature Zone	Area m²		U-Value W/(m²K)		Factor always 1 (except "X")		Temp. Diff. 1 K		Temp. Diff. 2 K		P_T 1 Watt		P_T 2 Watt
1.	Exterior Wall - Ambient	A	228,2	*	0,104	*	1,00	*	26,0	or	21,0	=	618	or	499
2.	Exterior Wall - Ground	B	116,3	*	0,120	*	1,00	*	10,0	or	10,0	=	140	or	140
3.	Roof/Ceiling - Exterior	D	122,5	*	0,101	*	1,00	*	26,0	or	21,0	=	322	or	260
4.	Floor Slab	B		*		*	1,00	*	10,0	or	10,0	=		or	
5.		A		*		*	1,00	*	26,0	or	21,0	=		or	
6.		A		*		*	1,00	*	26,0	or	21,0	=		or	
7.		X		*		*	0,75	*	26,0	or	21,0	=		or	
8.	Windows	A	48,4	*	0,717	*	1,00	*	26,0	or	21,0	=	902	or	729
9.	Exterior Door	A	2,5	*	0,647	*	1,00	*	26,0	or	21,0	=	42	or	34
10.	Exterior Thermal Bridge (le	A	162,0	*	-0,036	*	1,00	*	26,0	or	21,0	=	-153	or	-123
11.	Perimeter Thermal Bridge (l	P	44,5	*	-0,020	*	1,00	*	10,0	or	10,0	=	-9	or	-9
12.	Ground Thermal Bridge (leng	B		*		*	1,00	*	10,0	or	10,0	=		or	
13.	House/Apartment Separating	I	0,0	*		*	1,00	*	3	or	3	=		or	

Transmission Heat Losses P_T — Total = 1863 or 1530

Ventilation System:

		m²		m		m³
Effective Air Volume, V_{RAX}		169,5	*	2,50	=	424

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

Efficiency of Heat Recovery of the Subsoil Heat Exchanger η_{SHX}: 20%

	$n_{V,system}$ 1/h		Φ_{HR}		$n_{V,Res\ (Heat\ Load)}$ 1/h		1/h
Energetically Effective Air Exchange n_V	0,309	* (1 -	0,86	) +	0,070	=	0,113

Ventilation Heat Load P_V

V_V m³		n_V 1/h		c_{Air} Wh/(m³K)		Temp. Diff. 1 K		Temp. Diff. 2 K		P_V 1 W		P_V 2 W
423,8	*	0,113	*	0,33	*	26,0	or	21,0	=	410	or	331

Working with PHPP

Inputs to PHPP – Result heat load (House F.)

Total Heat Load P_L = 2273 W or 1861 W

	Orientation of the Area	Area m²		g-Value (perp. radiation)		Reduction Factor see Windows		Radiation 1 W/m²		Radiation 2 W/m²		P_S 1 W		P_S 2 W
1.	East	8,3	*	0,5	*	0,5	*	15,0	or	5	=	33	or	11
2.	South	29,1	*	0,5	*	0,4	*	50,0	or	5	=	302	or	30
3.	West	6,6	*	0,5	*	0,4	*	25,7	or	5	=	37	or	7
4.	North	4,3	*	0,5	*	0,3	*	5,0	or	5	=	3	or	3
5.	Horizontal	0,0	*	0,0	*	0,4	*	5,0	or	5	=	0	or	0

Heat Gain - Solar Heat Load, P_S Total = 375 or 52

Internal Heat Load P_I

Specif. Power W/m²		A_{TFA} m²		P_I 1 W		P_I 2 W
1,6	*	170	=	271	or	271

Heat Gains P_G

		P_G 1 W		P_G 2 W
$P_S + P_I$	=	646	or	323
$P_L - P_G$	=	1627	or	1538

Annual Heat Load P_H = 1627 W

Floor Space Specific Annual Heat Load P_H / A_{TFA} = 9,6 W/m²

P_H: Heat load. Maximum „very cold but sunny day“ or „moderate day without sun“

A_{TFA}: Treated floor area (TFA)

Source:

Working with PHPP

Inputs to PHPP – Result heat load (House F.)

PHPP heat load - last line

	$P_L - P_G$	=	1627	or	1538	
Annual Heat Load P_H		=		1627		W
Floor Space Specific Annual Heat Load P_H / A_{TFA}		=		9,6		W/m²

Max. supply air temperature input 52 °C

Supply air temp. w/o supplementary heating $\vartheta_{supply,min}$ 16 °C Max. Supply Air Temp. $\vartheta_{sup,max}$ 52 °C

Compare: Heat load that can be transported by supply air. $P_{Supply\ Air,Max}$ = 1536 W specific: 9,1 W/m²

In this case the heat load is to small. $P_{Supply\ Air,\ max.} < P_H$

Source: