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Introductory PHPP Exercise

A Cabin in the Woods

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Note: This document makes reference to the PHPP (PassivHaus Planning Package) which is authored and maintained by:

The Passive House Institute
Rheinstr. 44/46, 64283 Darmstadt, Germany
www.passiv.de

For more information see:

http://passipedia.passiv.de/passipedia_en/planning/calculating_energy_efficiency/phpp_-_the_passive_house_planning_package

as well as:

http://www.passiv.de/07_eng/phpp/PHPP2007_F.htm

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Introduction

PassivHaus projects are assessed via the PHPP (PassiveHaus Planning Package). It is also a major topic within CEPH workshops. The PHPP has lots of worksheets. Navigation comes with practice. PH has rituals and rules which you are going to be getting used to. In preparation for the workshop, here is a simple project, a retreat for a writer, somewhere in the woodland near Manchester to enter into the PHPP. This model is used in the CEPH workshop. You can also use it independently to improve your skills with the PHPP.

Your task is to read the Passive House Planning Package 2007 Manual in order to understand how this retreat gets translated into a PHPP model. The commentary points out some of the places to look and some strategies to take. As designed the performance comes close to that required by PassivHaus. It is a tough building type because the surface area to volume ratio is not optimal and the floor area is small.

Figure 1 is an outside view from the South-West showing the overhang over the large south window and a wooden deck on the south and west. Figure 2 shows that sun penetration is significant in the winter.

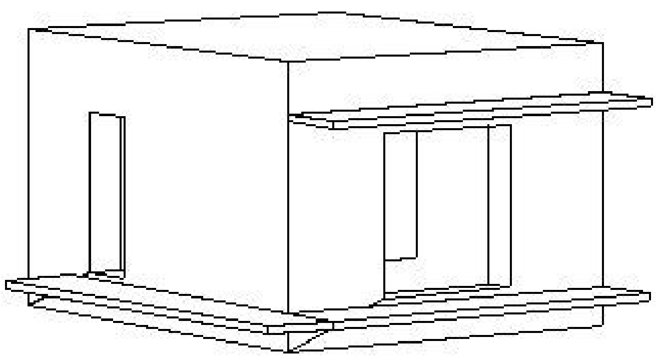


Figure 1 Retreat viewed from South West   Figure 2 Winter solar view from South-East

Figure 3 shows a view inside looking from the SW corner of the room towards an inside partial height mass wall. Behind the mass wall is a kitchen and a vertical cabinet for the heating and ventilation system.


Figure 3 Inside view (from SW corner)

The plan in Figure 4 provides many of the dimensions that you will need (there is a difference between the architectural dimensions and the dimensions used in the PHPP which you will need to learn about).

Figure 5 is a section (looking West) includes dimensions that will be needed for the windows and shading.

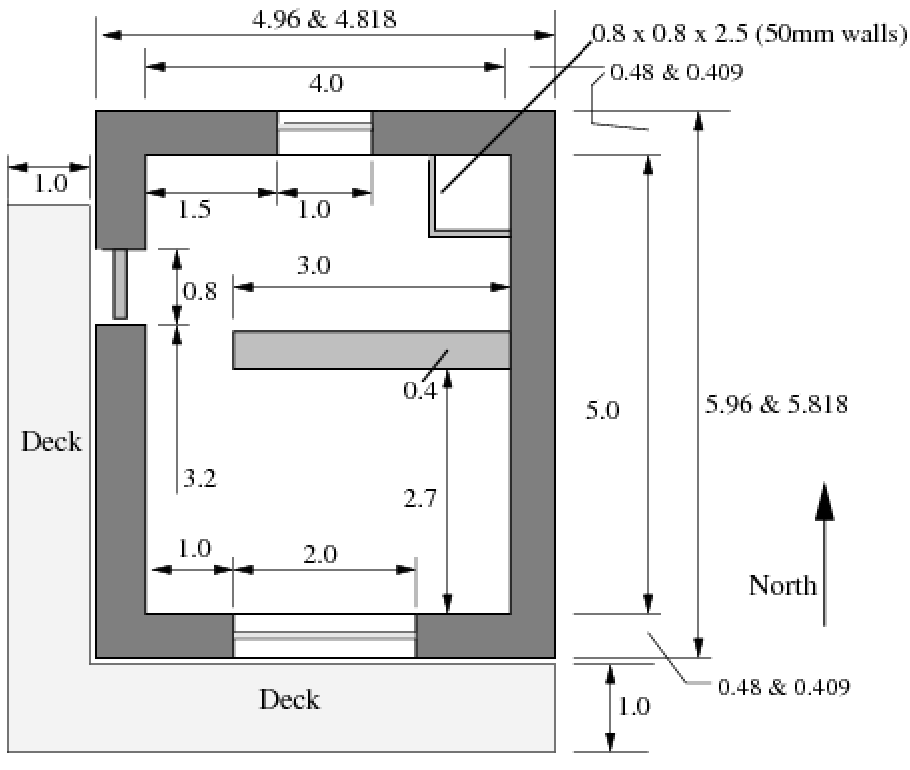


Figure 4 Plan of the retreat

As you read the PHPP Manual you may notice that some information in the drawings is not applicable to the PHPP (e.g. the deck on the south and west sides are not part of the thermal envelope). The constructions for the retreat come from the IBO-Passivhaus-Bauteilkatalog (ISBN 978-3-211-29763-6 SpringerWien New York) also include information that requires interpretation. As with all architectural drawings there will be some missing details so you are going to have do make some assumptions. A PassivHaus assessor might want to know about the assumptions that you have made - so keep notes!

Before you begin, make a copy of the blank English PHPP spreadsheet that came with your PHPP software and manual. Name it something like retreat_base_case. As you progress through each task make backup copies so that you can re-wind from disasters. You might also take screen shots so that you can review your path through the PHPP.

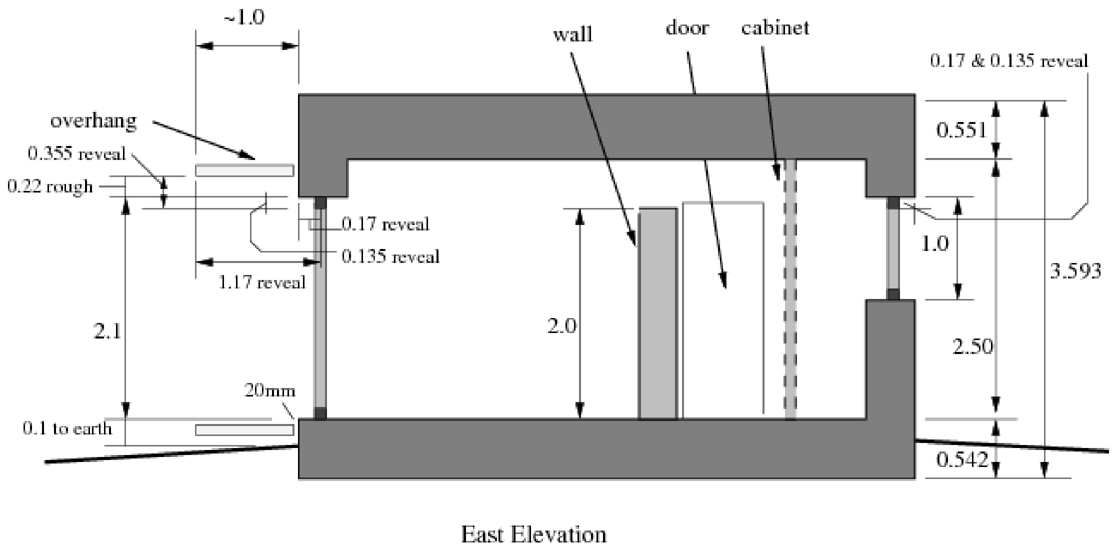


Figure 5 Section through retreat (looking West)

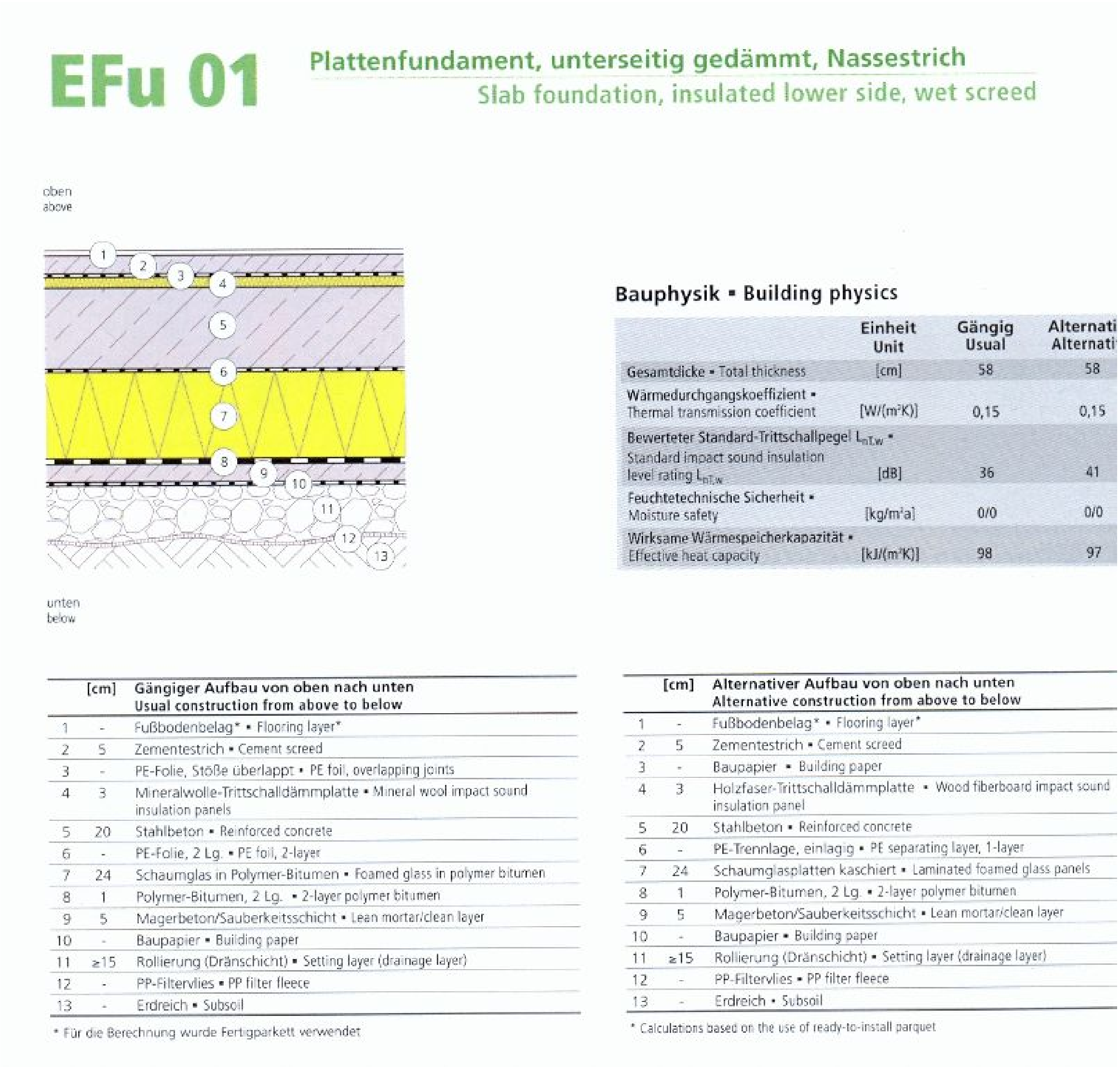
Constructions for the Retreat

The specifications for the wall, roof and floor constructions are listed below in terms of the layers (from outside to inside). In the PHPP constructions are sometimes referred to as assemblies. The information on density and specific heat are not used directly in the PHPP but are included in the Appendix of the IBO book. The wall and the roof make use of I-beams which we will assume are made of technically dried spruce 25mm x 25mm and a 6mm web of OSB at 600mm spacing. The batten for the inner gyp-board layer is assumed to be 25mm at 600mm spacing (so the percentage is the same as for the dried spruce in the I-beams).

For this exercise lets also assume that a fictitious company named ALBA supply wooden window frames with a U-value of 0.70 and triple glazing with a U-value of 0.7, a spacer psi value of 0.049 an installed psi value of 0.025 and a door system with a U-value of 0.8.

In the drawing there is a rectangle in the North-east corner of the cabin which measures 800mm x 800mm. This is a thin-walled (50mm) cabinet for the heat recovery ventilator and ducting. Lets assume the cabinet is constructed for acoustic isolation. Being adjacent to the facade the fresh and exhaust ducts connecting the ventilator will be passing through the facade and have short lengths. How might you use this information in the **ventilation** worksheet? What is the relationship between this cabinet and the treated floor area?

In the drawing there is a partial height (2.0m) partition within the retreat which is a massive stone construction that is 400mm thick. Lets assume that it rests on the flooring screed and that there is no thermal bridge into the foundation. What information related to the mass partition is applicable to the PHPP?



EFu 01

Plattenfundament, unterseitig gedämmt, Nassestrich
Slab foundation, insulated lower side, wet screed

Bauphysik ▪ Building physics

	Einheit Unit	Gängig Usual	Alternati Alternati
Gesamtdicke ▪ Total thickness	[cm]	58	58
Wärmedurchgangskoeffizient ▪ Thermal transmission coefficient	[W/(m²K)]	0,15	0,15
Bewerteter Standard-Trittschallpegel $L_{nT,w}$ ▪ Standard impact sound insulation level rating $L_{nT,w}$	[dB]	36	41
Feuchtetechnische Sicherheit ▪ Moisture safety	[kg/m²a]	0/0	0/0
Wirksame Wärmespeicherkapazität ▪ Effective heat capacity	[kJ/(m²K)]	98	97

	[cm]	Gängiger Aufbau von oben nach unten Usual construction from above to below
1	-	Fußbodenbelag* ▪ Flooring layer*
2	5	Zementestrich ▪ Cement screed
3	-	PE-Folie, Stöße überlappt ▪ PE foil, overlapping joints
4	3	Mineralwolle-Trittschalldämmplatte ▪ Mineral wool impact sound insulation panels
5	20	Stahlbeton ▪ Reinforced concrete
6	-	PE-Folie, 2 Lg. ▪ PE foil, 2-layer
7	24	Schaumglas in Polymer-Bitumen ▪ Foamed glass in polymer bitumen
8	1	Polymer-Bitumen, 2 Lg. ▪ 2-layer polymer bitumen
9	5	Magerbeton/Sauberkeitsschicht ▪ Lean mortar/clean layer
10	-	Baupapier ▪ Building paper
11	≥15	Rollierung (Dränschicht) ▪ Setting layer (drainage layer)
12	-	PP-Filtervlies ▪ PP filter fleece
13	-	Erdreich ▪ Subsoil

* Für die Berechnung wurde Fertigparkett verwendet

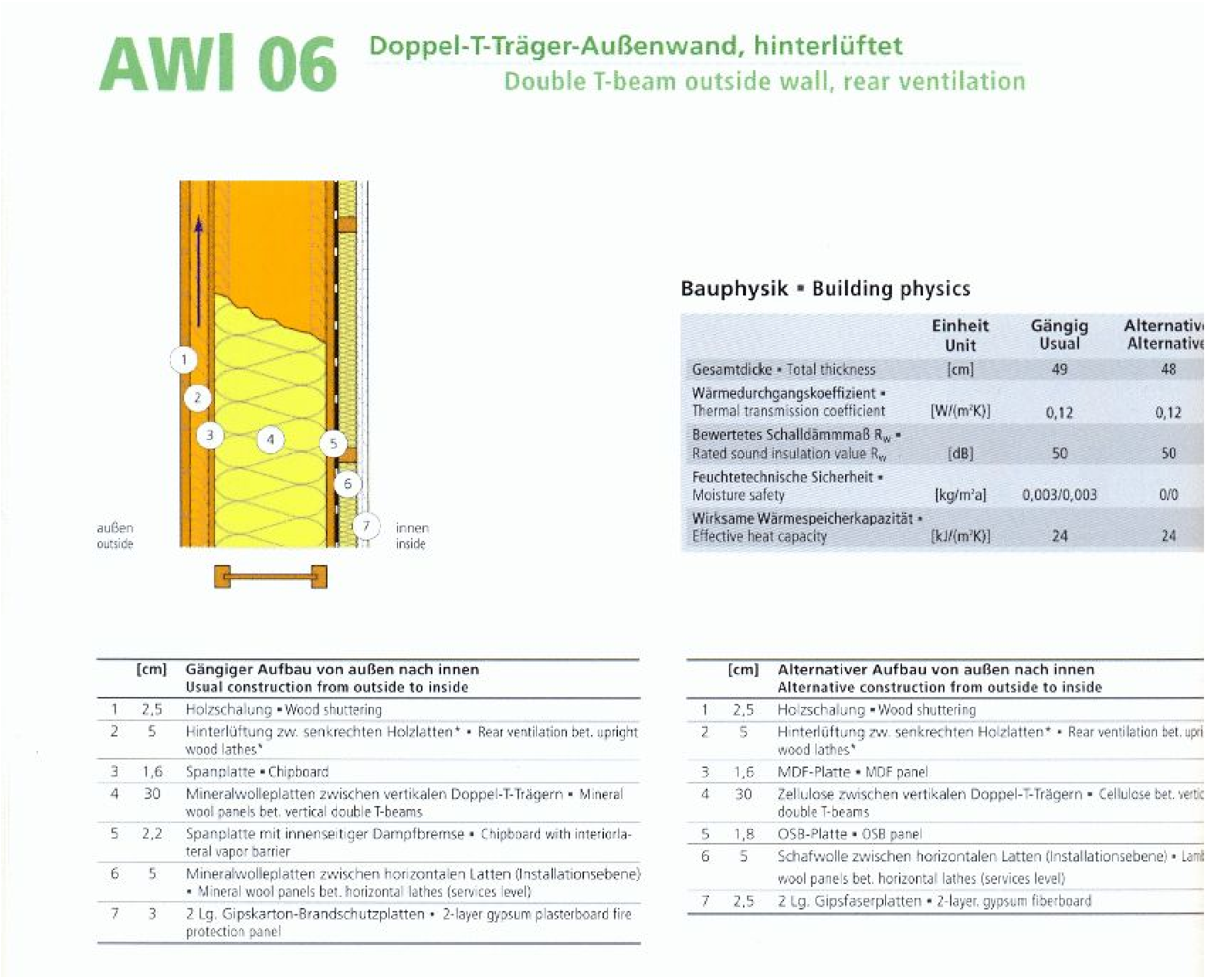
	[cm]	Alternativer Aufbau von oben nach unten Alternative construction from above to below
1	-	Fußbodenbelag* ▪ Flooring layer*
2	5	Zementestrich ▪ Cement screed
3	-	Baupapier ▪ Building paper
4	3	Holzfaser-Trittschalldämmplatte ▪ Wood fiberboard impact sound insulation panel
5	20	Stahlbeton ▪ Reinforced concrete
6	-	PE-Trennlage, einlagig ▪ PE separating layer, 1-layer
7	24	Schaumglasplatten kaschiert ▪ Laminated foamed glass panels
8	1	Polymer-Bitumen, 2 Lg. ▪ 2-layer polymer bitumen
9	5	Magerbeton/Sauberkeitsschicht ▪ Lean mortar/clean layer
10	-	Baupapier ▪ Building paper
11	≥15	Rollierung (Dränschicht) ▪ Setting layer (drainage layer)
12	-	PP-Filtervlies ▪ PP filter fleece
13	-	Erdreich ▪ Subsoil

* Calculations based on the use of ready-to-install parquet

Figure 6: Details of foundation: EFu_01 (outside to inside)

```
 Thick  |Conduc-|Density|Specific  | Description
 (mm)   |tivity |       |heat      |
  10.0     0.850   2400.   1000.     bitumen composit
 240.0     0.045    105.   1000.     foamed glass 105kg
 200.0     1.400   2100.    653.     heavy mix concrete
  30.0     0.050    250.   2000.     Porous wood fiberboard 250kg
  50.0     0.410   1200.    840.     concrete screed
  12.0     0.170   2000.    740.     parquet : Parquet (ready to install) from IBO
```

The interior heat transfer coefficient would be 0.17 (floor orientation) but because it is in contact with the ground the exterior heat transfer coefficient would be zero. The PHPP should report a U-value of 0.155 for this construction.



AWI 06 Doppel-T-Träger-Außenwand, hinterlüftet
Double T-beam outside wall, rear ventilation

Bauphysik ▪ Building physics

	Einheit Unit	Gängig Usual	Alternative Alternative
Gesamtdicke ▪ Total thickness	[cm]	49	48
Wärmedurchgangskoeffizient ▪ Thermal transmission coefficient	[W/(m²K)]	0,12	0,12
Bewertetes Schalldämmmaß R_w ▪ Rated sound insulation value R_w	[dB]	50	50
Feuchtetechnische Sicherheit ▪ Moisture safety	[kg/m²a]	0,003/0,003	0/0
Wirksame Wärmespeicherkapazität ▪ Effective heat capacity	[kJ/(m²K)]	24	24

	[cm]	Gängiger Aufbau von außen nach innen Usual construction from outside to inside
1	2,5	Holzschalung ▪ Wood shuttering
2	5	Hinterlüftung zw. senkrechten Holzlatten* ▪ Rear ventilation bet. upright wood lathes*
3	1,6	Spanplatte ▪ Chipboard
4	30	Mineralwolleplatten zwischen vertikalen Doppel-T-Trägern ▪ Mineral wool panels bet. vertical double T-beams
5	2,2	Spanplatte mit innenseitiger Dampfbremse ▪ Chipboard with interiorlateral vapor barrier
6	5	Mineralwolleplatten zwischen horizontalen Latten (Installationsebene) ▪ Mineral wool panels bet. horizontal lathes (services level)
7	3	2 Lg. Gipskarton-Brandschutzplatten ▪ 2-layer gypsum plasterboard fire protection panel

	[cm]	Alternativer Aufbau von außen nach innen Alternative construction from outside to inside
1	2,5	Holzschalung ▪ Wood shuttering
2	5	Hinterlüftung zw. senkrechten Holzlatten* ▪ Rear ventilation bet. upri wood lathes*
3	1,6	MDF-Platte ▪ MDF panel
4	30	Zellulose zwischen vertikalen Doppel-T-Trägern ▪ Cellulose bet. vertic double T-beams
5	1,8	OSB-Platte ▪ OSB panel
6	5	Schafwolle zwischen horizontalen Latten (Installationsebene) ▪ Lam wool panels bet. horizontal lathes (services level)
7	2,5	2 Lg. Gipsfaserplatten ▪ 2-layer gypsum fiberboard

Figure 7: Details of walls: AWI_06 (outside to inside)

```
Thick |Conduc-|Density|Specific Description
(mm)  |tivity |       |heat     |
 25.0    0.140     650.    2000.  weatherboard (ignored in PHPP)
 50.0                             ventilated air space (ignored in PHPP)
 16.0    0.080     780.    2000.  MDF based on info in IBO PassivHaus
300.0    0.040      35.    1900.  celulose fiber flakes and I-beam (see below)
 18.0    0.130     650.    1700.  OSB wood
 50.0    0.040      30.    1500.  lambswool felt insulation (4.2% wood batten)
 25.0    0.190     950.     840.  white gypboard
```

Because there is a ventilated rain-screen in this construction we ignore the weatherboard and the air gap and set both the inside and outside heat transfer coefficient to 0.13. The PHPP should report a U-value of 0.107 for this construction.

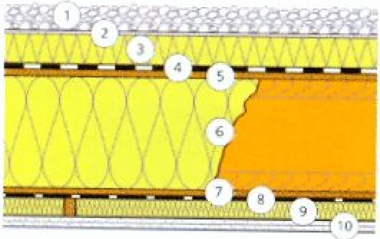
Note the 300mm insulation with the I-beam should be treated as several layers within the construction definition. The I-bean is assumed to be at 600mm centres. Each layer is a mix of wood or OSB and cellulose. The outside and inside layers includes 25mm thickness of wood and the rest is cellulose. This gives a percentage of wood of (4.2%). The centre insulation layer is composed of cellulose and OSB (1%). In the PHPP entry we combine the two layers with 4.2% wood into a single 50mm layer and use a 250mm layer for the 1% wood portion. The lambswool felt insulation layer also has a batten which we will assume has 4.2% wood. Only 8 layers can be input without modifying the worksheet (lets avoid such risks).

Note that identical layers e.g. the inner and outer solid wood portions of an I beam can be lumped together. This can sometimes be used to save layers!

DAI 05

Doppel-T-Träger-Flachdach
Double T-beam flat roof

außen
outside



innen
inside

Bauphysik • Building physics

	Einheit Unit	Gängig Usual	Alternative Alternative
Gesamtdicke • Total thickness	[cm]	57	56
Wärmedurchgangskoeffizient • Thermal transmission coefficient	[W/(m²K)]	0,10	0,10
Bewertetes Schalldämmmaß R_w • Rated sound insulation value R_w	[dB]	56	56
Feuchtetechnische Sicherheit • Moisture safety	[kg/m²a]	0,002/0,002	0/0
Wirksame Wärmespeicherkapazität • Effective heat capacity	[kJ/(m²K)]	28	32

	[cm]	Gängiger Aufbau von außen nach innen Usual construction from outside to inside
1	6	Kies 16/32 • Gravel 16/32
2	-	Filtervlies (Polypropylen) • Filter fleece (polypropylene)
3	8	Extrudiertes Polystyrol, CO_2-geschäumt • Extruded polystyrene, CO_2 foamed
4	1	Polymerbitumen-Abdichtung 2 Lg. mit Dampfdruckausgleichsschicht • 2-layer polymer bitumen seal with vapor pressure compensation layer
5	1,8	Spanplatte • Chipboard
6	30	Mineralwollepl. zw. Doppel-T-Trägern • Mineral wool panel bet. double T-Beams
7	1,8	Spanplatte • Chipboard
8	-	Alu-Dampfsperre, selbstklebend • Self-adhesive aluminum vapor barrier
9	5	Mineralwolle zwischen Latten • Mineral wool bet. lathes
10	3	2 Lg. Gipskarton-Brandschutzplatten • 2-layer gypsum plasterboard fire protection panels

	[cm]	Alternativer Aufbau von außen nach innen Alternative construction from outside to inside
1	6	Kies 16/32 • Gravel 16/32
2	-	Filtervlies (Polypropylen) • Filter fleece (polypropylene)
3	8	Extrudiertes Polystyrol, CO_2-geschäumt • Extruded polystyrene, CO_2 foamed
4	1	PE-Abdichtung und PP-Schutzvlies • PE-sealing and PP protective fleece
5	1,8	OSB-Platte • OSB panel
6	30	Zelluloseflocken zw. Doppel-T-Trägern • Cellulose flakes bet. double T-beams
7	1,8	OSB-Platte • OSB panel
8	-	PE-Dampfbremse, selbstklebend • Self-adhesive PE-vapor barrier
9	5	Schafwolle zwischen Latten • Lambswool between lathes
10	2,5	2 Lg. Gipsfaserplatten • 2-layer gypsum fiberboard

Figure 8: Details of roof construction: DAI_05

```
 Thick |Conduc-|Density|Specific  Description
 (mm)  |tivity |       |heat      |
  60.0   0.360    1840.      840.   gravel : Gravel
  80.0   0.040      38.     1450.   XPS CO2 foamed : XPS extruded polystyrene
   3.0   0.060    1090.     1000.   bitumen paper : (ignored in PHPP)
  18.0   0.130     650.     1700.   OSB wood
 300.0   0.040      35.     1900.   cellulose fiber flakes (layers as in AWI_06)
  18.0   0.130     650.     1700.   OSB wood
  50.0   0.040      30.     1500.   lambswool felt insulation (with 4.2% batten)
  25.0   0.190     950.      840.   White painted Gypboard
```

The heat transfer coefficients are 0.1 for the inside and 0.04 for the outside. There are mixed layers (insulation and I beam sections) so follow the pattern established in the wall construction. Because there are only two column percentages we can use for the mixed layers we have to assume that the batten in the lambswool felt layer is the same as in the cellulose layer. The PHPP reports a U-value of 0.088 - 0.090 for this construction.

Door: assume that the door is 0.8m wide and 2.1m height and that the U-value of the door is 0.8. Look at the areas worksheet for the door data cells. And what else are you supposed to do with the area of the door? Is shading an issue with doors? Are there reveals with doors?

The PHPP Worksheets

Give your self time to read through the PHPP manual. Next look at the drawings and specifications and write down information for later use in the PHPP. It will take a few iterations of scanning the manual to locate the appropriate sections of the PHPP. OK, open up your retreat_base_case.xls file!

Read the following section *before you enter* your details. There are several paths through the PHPP. We suggest you start with the **Verification** worksheet and progress to the **U-Value** worksheet and then to the **U-List** worksheet and then to the **Wi-Type** worksheet and then the **Areas** worksheet. This sequence allows you to have full access to the pull-down selection lists of your constructions and windows. Once you get used to the process you can fine tune this for your style of working.

The **verification** worksheet (Figure 9) includes high level data such as the enclosed volume, number of occupants, internal heat gains and desired inside temperature. There is a small space at the top of the verification sheet for images of your project. You will need to remove the security lock on the workshop page to insert images. This page would also be a good place to insert documentation about the approach you are taking and the assumptions that you are making (making life easier for the assessor of the PHPP can save time).

For the purposes of this exercise lets assume that there are 1.5 people, on average, in the retreat. If you set the verification worksheet *planned number of occupants* to *design* (rather than *verification*) the 1.5 people is rounded up to two people (see Figure 10).

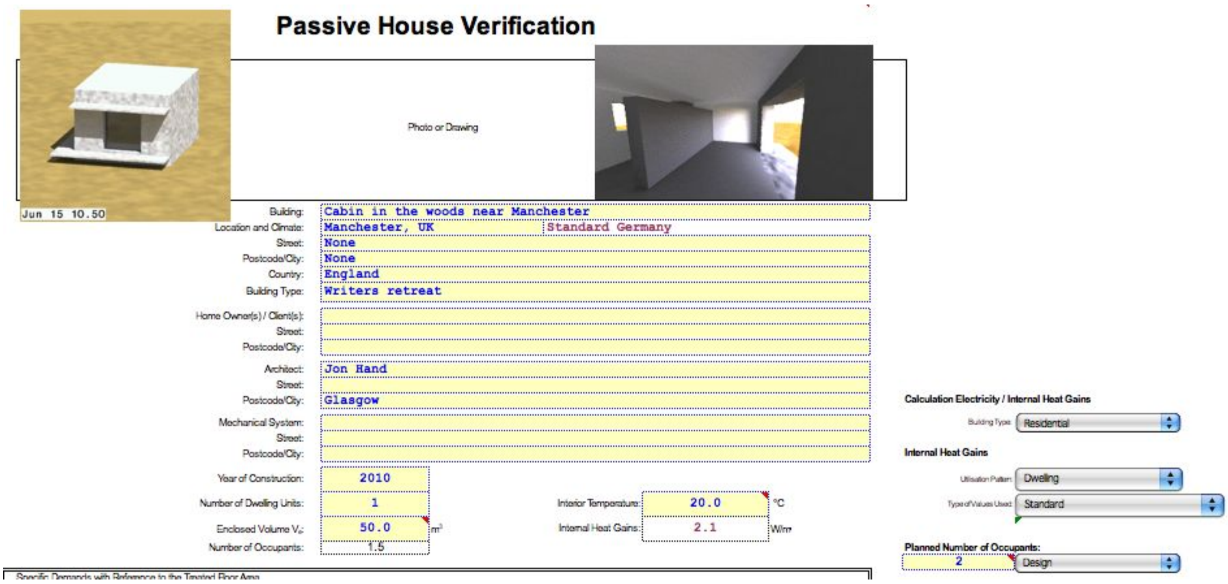


Figure 9: Verification worksheet

Figure 10 is a detail of the lower right portion of Figure 9 which further specifies the building type, the *Utilization pattern*, *Type of Values Used* and which method to use for the calculations. As you progress you will see the space heating demand cells will begin to be populated with interim results.

For this example select the *monthly calculation method* and find the UK Manchester climate location in the **Climate Data** worksheet. This location is not immediately obvious, first select regional data and then northern Europe and then the Manchester climate from the list.

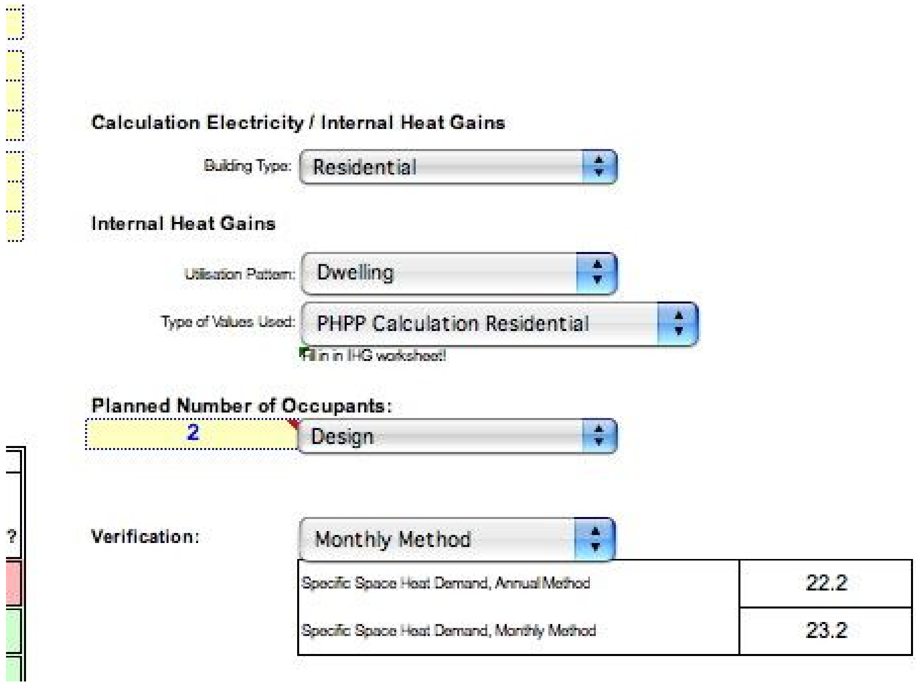


Figure 10: Verification worksheet detail

U-Values worksheet

The thermal envelope has thermophysical properties defining these will be the topic of this section.

The **U-Value** worksheet is going to be based on a collection of details from the IBO Passive House book of construction details. Figures 6-8 have been extracted from the IBO book for reference. One challenge is that the IBO book was written as a general reference and the figures and details require interpretation for application within PassivHaus projects.

For example the AWI_06 wall construction in the IBO book (Figure 7) does not fully describe the wooden I-beam or the batten near the inside of the wall. For purposes of this exercise the web of the I-beam is 6mm MDF and the wood sections can be considered as 25mm square and I-beams are used at 600mm centres. The I-beam also has a ventilated weatherscreen and if you look at page 53 of the PHPP manual you will find rules needed to translate this detail.

For this retreat you will need to define constructions for the walls, foundation and the roof. Using the rules on page 53 enter these constructions and then compare with the figures on the next page.

Building: Cabin in the woods near Manchester

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

Assembly No. 1 — Building Assembly Description: Efu_01 (floor)

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

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.	bitumen	0.850					10
2.	foamed glass	0.045					240
3.	heavy concrete	1.400					200
4.	fibreboard acoustic	0.050					30
5.	concrete screed	0.410					50
6.	parquet	0.170					12
7.							
8.							
				Percentage of Sec. 2		Percentage of Sec. 3	Total 54.2 cm

U-Value: 0.155 W/(m²K)

Building: Retreat in the woods

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

Assembly No. 1 — Building Assembly Description: AWI_06 (wall)

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

	Area Section 1	λ [W/(mK)]	Area Section 2 (optional)	λ [W/(mK)]	Area Section 3 (optional)	λ [W/(mK)]	Total Width Thickness [mm]
1.	MDf 3	0.080					16
2.	cellulose 4	0.040	wood	0.130			50
3.	cellulose 4	0.040			OSB	0.170	250
4.	OSB 5	0.130					18
5.	lambswool	0.040	wood	0.130			50
6.	gypboard	0.190					25
7.							
8.							
				Percentage of Sec. 2: 4.2%		Percentage of Sec. 3: 1.0%	Total 40.9 cm

U-Value: 0.109 W/(m²K)

Figure 11: U-value worksheets for floor and wall constructions

The treatment of layers which include both insulation and framing or battens is a key skill and the facilities of the PHPP will be tested when attempting to enter the layers of the roof based on the information in Figure 8. If we want to stay within the bounds of the existing cells we are limited to 8 layers and there are only two percentages for alternative materials e.g. the battens and I-beam. Compare your solution to this with Figure 12 on the next page.

Assembly No.	Building Assembly Description
2	DAI 0 (roof)

Heat Transfer Resistance [m²K/W] interior R_{si}: 0.10 exterior R_{se}: 0.04

	Area Section 1	λ [W/mK]	Area Section 2 (optional)	λ [W/mK]	Area Section 3 (optional)	λ [W/mK]	Total Width Thickness [mm]
1.	gravel	0.360					60
2.	XPS 2	0.040					80
3.	Osb 3	0.130					18
4.	cellulose	0.040	wood	0.130			50
5.	cellulose	0.040			OSB	0.170	250
6.	osb 5	0.130					18
7.	lambswool 6	0.040	wood	0.130			50
8.	gypboard	0.190					25
				Percentage of Sec. 2: 4.2%		Percentage of Sec. 3: 1.0%	Total: 55.1 cm

U-Value: 0.089 W/(m²K)

Figure 12: Roof construction

After you have completed the individual entries to the U-values worksheet select the U-list worksheet where you will find a summary of what is available for use within the project. And if you think you will be wanting to try alternatives you could add in additional constructions for reference later in the project.

Passive House Planning

U - LIST

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

Assembly No.	Type Assembly Description	Total Thickness	U-Value
		m	W/(m²K)
1	Efu_01 (floor)	0.542	0.15
2	AWI_06 (wall)	0.409	0.11
3	DAI_05 (flat roof)	0.551	0.09
4			
5			
6			

Figure 13: U-list worksheet

Areas Worksheet

For the **Areas** worksheet your task is to apply the rules for building dimensions and treated floor area to the drawings and enter the required cells. Note the user subtraction cell at (O 32). What items inside the cabin need to be excluded from the calculation of treated floor area? For this exercise we do not include the floor area at the south window recess.

In the PHPP manual you will find that there are several definitions of volumes in the PHPP (pages 83, 97). This cabin has a flat ceiling, but with a sloped ceiling there are some volume calculations that still use 2.5m heights (a ritual within the PHPP) for air changes per hour ventilation calculations.

The **List of Areas** is where you will be transcribing your calculated areas into the **Area Group Designations**. For this retreat there is essentially a one-to-one mapping between the facade and the group designations. Imagine though, if the project was a large villa - the details for lots and lots of rooms are going to have to be distilled into these designations - keeping careful notes is going to be critical to retain your sanity and ensure that if the assessor asks you questions about your submitted PHPP you can provide the relevant information.

The *Temperature Zones* fields use A, B, P and X of the upper portion of Figure 14 represent boundary conditions. For this project there are no X entries. And for this exercise we will be using what are termed certified PH details and junctions in the retreat so we will not be filling in thermal bridge information (we will add them in the workshop). The lower part of Figure 14 includes some pre-defined entries e.g. South Windows and External Doors which are associated with a group number. It also has space for user defined building elements that will make up the thermal envelope of the retreat. Each entry has a name (short and clear) a group number which expands to an 'assigned to group'. To the right of this is a quantity column (we only need one of each entity in this small retreat) and its dimensions.

There are rules for dimensions (e.g. omitting ventilated air gaps in weather screens) so double check this. What you see on the drawing might not be what is expected in the PHPP.

Building: Cabin in the woods near Manchester   Heat Der

					S
Group Nr.	Area Group	Temp Zone	Area	Unit	Commer
1	Treated Floor Area		0.00	m²	Living ar
2	North Windows	A	0.00	m²	
3	East Windows	A	0.00	m²	
4	South Windows	A	0.00	m²	
5	West Windows	A	0.00	m²	
6	Horizontal Windows	A	0.00	m²	
7	Exterior Door	A	0.00	m²	Please s
8	Exterior Wall - Ambient	A	0.00	m²	Window
9	Exterior Wall - Ground	B	0.00	m²	Tempera
10	Roof/Ceiling - Ambient	A	0.00	m²	Tempera
11	Floor Slab	B	0.00	m²	
12			0.00	m²	Tempera
13			0.00	m²	Tempera
14		X	0.00	m²	Tempera
15	Thermal Bridges Ambient	A	0.00	m	Units in
16	Perimeter Thermal Bridges	P	0.00	m	Units in
17	Thermal Bridges Floor Slab	B	0.00	m	Units in
18	Partition Wall to Neighbour	I	0.00	m²	No heat
Total Thermal Envelope			0.00	m²	

				Ar
Area Nr.	Building Element Description	Group Nr.	Assigned to Group	Quan-tity
	Treated Floor Area	1	Treated Floor Area	
	North Windows	2	North Windows	
	East Windows	3	East Windows	
	South Windows	4	South Windows	I
	West Windows	5	West Windows	
	Horizontal Windows	6	Horizontal Windows	
	Exterior Door	7	Exterior Door	
1				
2				
3				
4				
5				
6				

Figure 14: Initial state of the Areas worksheet.

Fill in as much as possible before you look at Figure 15 on the next page.

Review your input and see if the User Subtraction makes sense. Notice that each of the facade walls is part of the same group (8). Groups are a way to assign boundary conditions.

Area Input

Area Nr.	Building Element Description	Group Nr.	Assigned to Group	Quan-tity	x (	a [m]	x	b [m]	+	User-Deter-mined [m²]	-	User Sub-traction [m²]	-
	Treated Floor Area	1	Treated Floor Area	1	x (	4.000	x	5.000	+		-	1.55	
	North Windows	2	North Windows										
	East Windows	3	East Windows										
	South Windows	4	South Windows	Please complete in Windows worksheet onl									
	West Windows	5	West Windows										
	Horizontal Windows	6	Horizontal Windows										
	Exterior Door	7	Exterior Door	1	x (	0.80	x	2.10	+		-		) -
1	South Wall	8	Exterior Wall - Ambient	1	x (	4.96	x	3.65	+		-		) -
2	East Wall	8	Exterior Wall - Ambient	1	x (	5.96	x	3.65	+		-		) -
3	North Wall	8	Exterior Wall - Ambient	1	x (	4.96	x	3.65	+		-		) -
4	West Wall	8	Exterior Wall - Ambient	1	x (	5.96	x	3.65	+		-	1.70	) -
5	Roof	10	Roof/Ceiling - Ambient	1	x (	4.96	x	5.96	+		-		) -
6	Foor slab	11	Floor Slab	1	x (	4.96	x	5.96	+		-		) -
7					x (		x		+		-		) -

Figure 15: Areas worksheet with user defined entities

WinType worksheet

Window frames: lets assume that the window frames are 135mm wide on the left and right and head and 150mm wide at the sill. Lets also assume that the frame is ~100mm deep and that the frame has a U-value of 0.70, the spacer associated with the glass has a linear transmittance of 0.049 and the so-called installation psi value is 0.025 (supplied by the manufacturer as part of their documentation).

We need to consider where to place the windows within the depth of our wall. If we place them flush with the inside face of the wall the reveal is rather deep and less sunlight will enter the room. If we place the frame at the outside face the installed psi value will be higher (the outside insulation cannot wrap around the frame). Lets use a compromise position and set the face of the glass back 175mm from the outer face of the wall.

Window glass: lets assume that Alba are supplying a triple glazing product which has a g-value of 0.5 and a U-value of 0.7.

Passive House Planning

GLAZING ACCORDING TO CERTIFICAT

for frame types, go to row: 71

Assembly No.	Type Glazing	g-Value	U_g-Value W/(m²K)
1	Alba tripple prototype	0.500	0.700
2			
3			

FRAME TYPE ACCORDING TO CERTIFICATION

for glazings, go to row: 2

Type Frame	U_f-Value Frame W/(m²K)	Frame Dimensions Width - Left m	 Width - Right m	 Width - Below m	 Width - Above m	Thermal Bridge Ψ_{Spacer} W/(mK)	Thermal Bridge $\Psi_{Installation}$ W/(mK)
Alba super frame	0.70	0.135	0.135	0.150	0.135	0.049	0.025

Figure 16: Details of glazing and frames from WinType worksheet

Windows worksheet

Read the **windows** worksheet (a few times). There are many concepts related to the overall opening, the frame and the glass. Have a look at a worked example PHPP for a useful window (and door) descriptions. For this exercise we assume that there is a company call Alba which is introducing a new glazing and framing system to the UK market and we want to test its use in the retreat.

REDUCTION FACTOR SOLAR RADIATION,

Building: Cabin in the woods near Manchester

Annual Heat Demand: kWh/(m²a)

Climate:	GB - Manchester										
Window Area Orientation	Global Radiation (Cardinal Points)	Shading	Dirt	Non-Perpendicular Incident Radiation	Glazing Fraction	g-Value	Reduction Factor for Solar Radiation	Window Area	Window U-Value	Glazing Area	Average Global Radiation
maximum:	kWh/(m²a)	0.75	0.95	0.85				m²	W/(m²K)	m²	kWh/(m²a)
North	80	0.75	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	80
East	180	0.75	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	180
South	367	0.75	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	367
West	181	0.75	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	181
Horizontal	271	0.75	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	271
		Total or Average Value for All Windows.				0.00	0.00	0.00	0.00	0.0	

					Window Rough Openings		Installed		Glazing		Frame		g-Value	U-Value		
Quantity	Description	Deviation from North	Angle of Inclination from the Horizontal	Orientation	Width	Height	in Area in the Areas worksheet	Nr.	Select glazing from the WinType worksheet	Nr.	Select window from the WinType worksheet	Nr.	Perpendicular Radiation	Glazing	Frames	W
		Degrees	Degrees		m	m	Select:		Select:		Select:		-	W/(m²K)	W/(m²K)	
								0		0		0				
								0		0		0				
								0		0		0				
								0		0		0				

Figure 17: Initial windows worksheet (left and right portions).

On the windows work sheet you will be entering the rough opening areas as found in the drawings as well as the orientation of the window (north is zero, east is 90 degrees etc.) and the surface that it is placed into (assuming that you first entered the walls/roof/floor into the areas worksheet). Good names for entities makes them easy to select and reduces errors.

Essentially, you will be filling in information on several of worksheets which causes other fields to be calculated. Until you have finished the PHPP is working with an incomplete set of information. If you look at the verification worksheet part way through the process you might find that the heating demands are high (because you have not defined your windows) or there is an overheating problem because you have yet to fill in the shading worksheet.

Again, get as far as you can before you turn to the next page and look at the data within Figure 18.

					Window Rough Openings		Installed		Glazing		Frame		g-Value
Quantity	Description	Deviation from North	Angle of Inclination from the Horizontal	Orientation	Width	Height	in Area in the Areas worksheet	Nr.	Select glazing from the WinType worksheet	Nr.	Select window from the WinType worksheet	Nr.	Perpendicular Radiation
		Degrees	Degrees		m	m	Select:		Select:		Select:		-
1	South window	180	90	South	2.000	2.100	South Wal	1	Alba tripp	1	Alba std w	1	0.50
1	North window	0	90	North	1.000	1.000	North Wal	3	Alba tripp	1	Alba std w	1	0.50
								0		0		0	

	g-Value	U-Value		Window Frame Dimensions				Installation			
Nr.	Perpendicular Radiation	Glazing	Frames	Width - Left	Width - Right	Width - Below	Width - Above	Left 1/0	Right 1/0	Sill 1/0	Head 1/0
	-	W/(m²K)	W/(m²K)	m	m	m	m				
1	0.50	0.70	0.59	0.14	0.14	0.15	0.14	1	1	1	1
1	0.50	0.70	0.59	0.14	0.14	0.15	0.14	1	1	1	1
0											
0											
0											

	Ψ-Value		Results			
Head 1/0	Ψ_{Spacer}	$\Psi_{Installation}$	Window Area	Glazing Area	U-Value Window	Glazed Fraction per Window
	W/(mK)	W/(mK)	m²	m²	W/(m²K)	%
1	0.049	0.025	4.2	3.14	0.83	0.75
1	0.049	0.025	1.0	0.52	0.94	0.52

Figure 18: Windows worksheet (left middle right portions)

Did you need to go back to your drawings and find particular dimensions? The Installation cells were straightforward for the retreat, but it can bend your mind if you have complex frames or multiple glazings within one rough opening.

Filling in the window worksheet will have had an impact on other worksheets in the PHPP. Look back at the areas worksheet. What do you notice has changed?

...r- ...²]	-	User Subtraction [m²]	-	Subtraction Window Areas [m²]	) =	Area [m²]	Selection of the Corresponding Building Element Assembly	Nr.	U-Value [W/(m²K)]
	-	1.46			) =	18.5			
						1.0	From Windows sheet		0.942
						0.0	From Windows sheet		0.000
...worksheet only!						4.2	From Windows sheet		0.832
						0.0	From Windows sheet		0.000
						0.0	From Windows sheet		0.000
	-		)-		=	1.7	U-Value Exterior Door		0.80
	-		)-	1.0	=	16.6	AWL_06 (wall)	1	0.109
	-		)-	0.0	=	21.2	AWL_06 (wall)	1	0.109
	-		)-	4.2	=	13.4	AWL_06 (wall)	1	0.109
	-	1.70	)-	0.0	=	19.5	AWL_06 (wall)	1	0.109
	-		)-	0.0	=	28.0	DAI 0 (roof)	2	0.089
	-		)-	0.0	=	28.0	ESU_01 (floor)	3	0.155
	-		)-	0.0	=			0	
	-		)	0.0	=			0	

Figure 19: Areas sheet detail after work in windows worksheet.

Shading worksheet

Scan the **shading** section of the PHPP manual (page 76) and the worksheet. There is one overhang in the retreat. What else is there that needs to be taken into account? The term *reveal* in the PHPP is used for the vertical sides of the wall adjacent to the window. One dimension is from the face of the glass to the face of the wall. The other dimension is from the edge of the glass to the edge of the facade that potentially shades the glass. Building components which are horizontal and which can shade the glass are termed *overhangs*. Thus the reveal at the head of the window opening is considered an *overhang*. How many overhangs are there? If you think there is only one think again.

Take your time with the dimensions needed for this worksheet. Look at the drawings to locate the overhang in relationship to the south window glass and the reveal at the head of the south window. Notice that the glass is set into the facade and the sun entering the room will be further reduced by the reveals. But is it the overhang or the head reveal that is most likely to shade the glass?

The face of wall to face of glass (reveal distance) is 170mm and the edge of glass to the shading edge of the reveal on the left and right and head is 135mm. The north window reveal at the head of the window needs to be entered as an overhang - did you spot that? The sun rarely sees the north facade but the reveal does reduce the diffuse light reaching the glass.

And you will need to transform the architectural dimension of the overhang (1.0m from the face of the wall). The distance from the face of the glass needs to be added and so this becomes 1.170m. The distance from the edge of glass to the overhang we will use the 220mm (above rough opening) + 135mm (width of the frame).

Passive House Plann

CALCULATING SHADING

Climate: GB - Manchester

Building: Retreat in the woods

Latitude: 53.5 °

Orien-tation	Glazing Area m²
North	0.52
East	0.00
South	3.14
West	0.00
Horizontal	0.00

Quantity	Description	Deviation from North	Angle of Inclination from the Horizontal	Orientation	Glazing Width	Glazing Height	Glazing Area	Height of the Shading Object	Horizontal Distance	Window Reveal Depth	Di
		Degrees	Degrees		m	m		m	m	m	
					w_G	h_G	A_G	h_{Hori}	d_{Hori}	o_{Reveal}	
1	South_windw	180	90	South	1.73	1.82	3.1			0.17	
1	North window	0	90	North	0.73	0.72	0.5			0.17	

Window Reveal Depth	Distance from Glazing Edge to Reveal	Overhang Depth	Distance from Upper Glazing Edge to Overhang	Additional Shading Reduction Factor	Horizontal Shading Reduction Factor	Reveal Shading Reduction Factor	Overhang Shading Reduction Factor	Total Shading Reduction Factor
m	m	m	m	%	%	%	%	%
o_{Reveal}	d_{Reveal}	o_{over}	d_{over}	r_{other}	r_H	r_R	r_O	r_S
0.17	0.135	1.17	0.22		100%	97%	90%	87%
0.17	0.135	0.17	0.14		100%	90%	90%	82%

Figure 20: Shading worksheet (left and right portions)

The new information in the shading worksheet will have an impact on other worksheets. Which ones? On the following page some of the dependencies are shown.

Passive House Planning

REDUCTION FACTOR SOLAR RADIATION, WINDOW U-VALUE

Building: Retreat in the woods

Annual Heat Demand: 23 kWh/(m²a)

Heating Degree Hours: 68.4

Climate: GB - Manchester

Window Area Orientation	Global Radiation (Cardinal Points)	Shading	Dirt	Non-Perpendicular Incident Radiation	Glazing Fraction	g-Value	Reduction Factor for Solar Radiation	Window Area	Window U-Value	Glazing Area	Average Global Radiation	Transmission Losses	Heat Gains Solar Radiation
maximum:	kWh/(m²a)	0.75	0.95	0.85				m²	W/(m²K)	m²	kWh/(m²a)	kWh/a	kWh/a
North	80	0.82	0.95	0.85	0.522	0.50	0.34	1.00	0.94	0.5	80	64	14
East	180	0.75	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	180	0	0
South	367	0.87	0.95	0.85	0.748	0.50	0.52	4.20	0.83	3.1	367	239	404
West	181	0.75	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	181	0	0
Horizontal	271	0.75	0.95	0.85	0.000	0.00	0.00	0.00	0.00	0.0	271	0	0
		Total or Average Value for All Windows.				0.50	0.49	5.20	0.85	3.7		303	418

Figure 21: Windows sheet after shading details added.

Ventilation worksheet

Now it is time to check-out the **ventilation** worksheet (PHPP manual page 81). You will find that a number of cells have already been filled in. The default supply air is going to be 30 cubic metres per hour per person and thus 45 is the supply air requirement for 1.5 people. You need an extract volume and in the PHPP this is usually assigned to rooms such as kitchen, bathroom or WC.

For this exercise create a new category of room with a flow rate of 45 so there is no imbalance in the supply and extract. In the section on *Daily Operation Duration* below notice that the *standard rate* is used for 20 hours a day and the *basic rate* is used for 4 hours a day to reflect periods when the retreat is not occupied. Why bother? Well air flow costs in terms of heat loss and running costs.

VENTILATION DATA

Building: Cabin in the woods near Manchester

Treated Floor Area A_{TFA}	m²	18	(Areas worksheet)
Room Height h	m	2.5	(Annual Heat Demand worksheet)
Room Ventilation Volume (A_{TFA}*h) = V_V	m³	46	(Annual Heat Demand worksheet)

Ventilation System Design - Standard Operation

Occupancy	m²/P	12				
Number of Occupants	P	1.5				
Supply Air per Person	m³/(P*h)	30				
Supply Air Requirement	m³/h	45				
Extract Air Rooms		Kitchen	Bathroom	Shower	WC	Other
Quantity						1
Extract Air Requirement per Room	m³/h	60	40	20	20	45
Total Extract Air Requirement	m³/h	45				
Design Air Flow Rate (Maximum)	m³/h	45				

Average Air Change Rate Calculation

Type of Operation	Daily Operation Duration h/d	Factors Referenced to Maximum	Air Flow Rate m³/h	Air Change Rate 1/h
Maximum		1.00	45	0.98
Standard	20.0	0.77	35	0.75
Basic	4.0	0.54	24	0.53
Minimum		0.40	18	0.39
x Residential Building	Average value	0.73	Average Air Flow Rate (m³/h): 33	Average Air Change Rate (1/h): 0.71

Figure 22: Ventilation worksheet (upper portion)

In the middle of the ventilation worksheet (Figure 23) is a section for EN 13790 infiltration. This is described on page 85 of the PHPP handbook. Lets assume that the site is slightly sheltered. Because we do not yet have a pressure test for the building do not fill in the cells related to pressure testing. The 0.7 value entered into the *Wind Pressure Coefficient* cell was taken from the table above it on the worksheet.

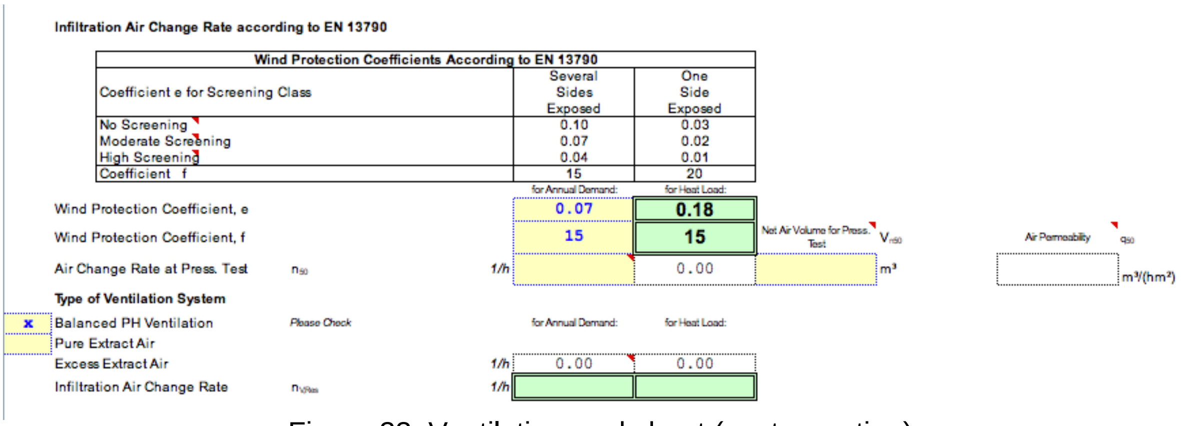


Figure 23: Ventilation worksheet (centre portion)

In the lower portion of the **ventilation** worksheet are cells describing how the heat recovery ventilation system works. Select one of the available units that has an efficiency greater than 80%.

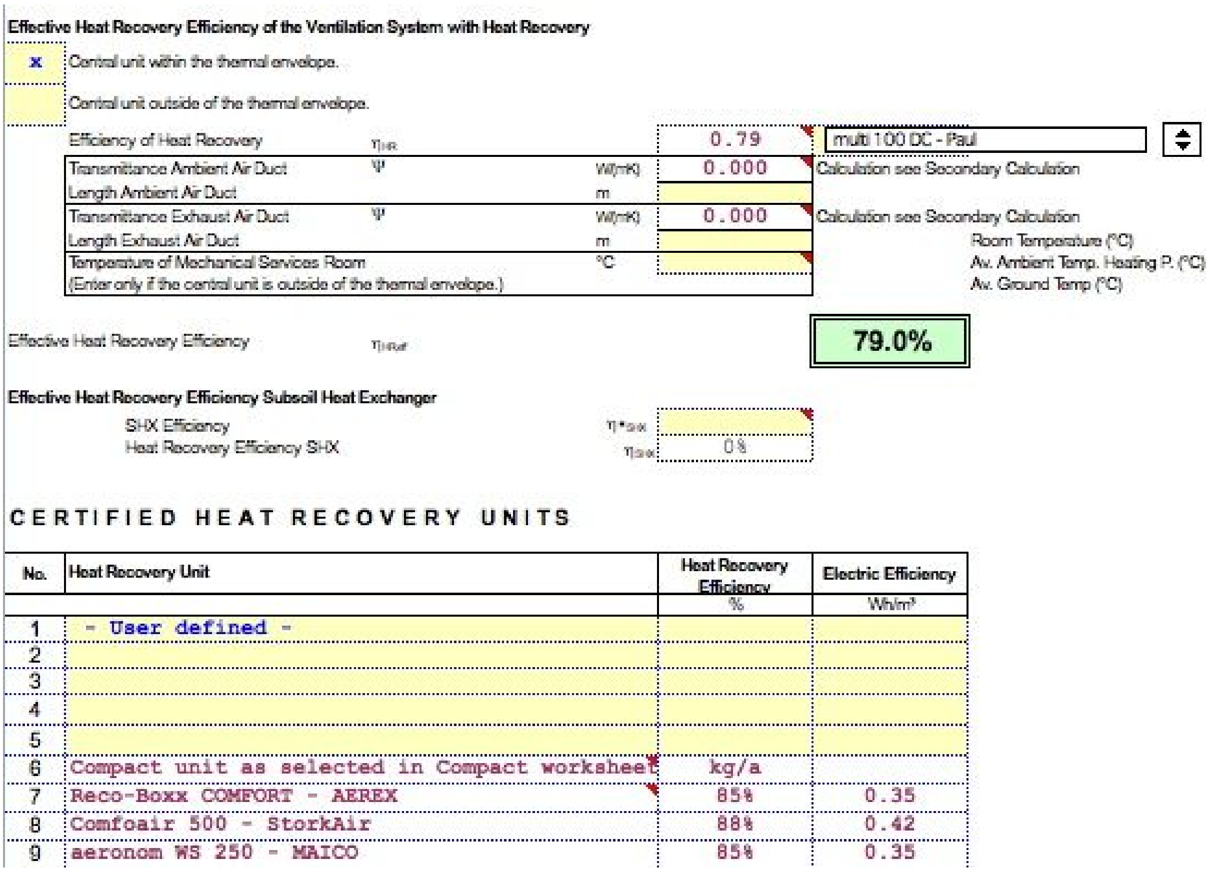


Figure 24: Ventilation worksheet (lower portion)

Note that when air duct details are added the efficiency will be reduced so start with the most efficient system. Choose the 200 DC Paul which is 92% efficient rather than the multi 100 DC unit by Paul which is only 79% efficient). You can switch components if this efficiency is not required.

Assume 150mm supply and exhaust duct sizes and 100mm of insulation (lambda 0.16) and a length of 0.5m for both supply and exhaust. These details are entered in a form to the right of the HRV cells (Figure 25). This will reduce the overall efficiency of the MVHR system to

89.1%.

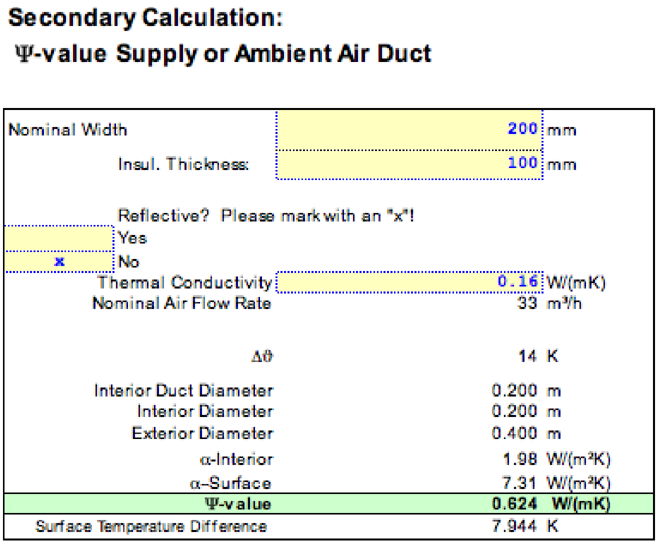


Figure 25: Secondary duct definitions (ventilation worksheet)

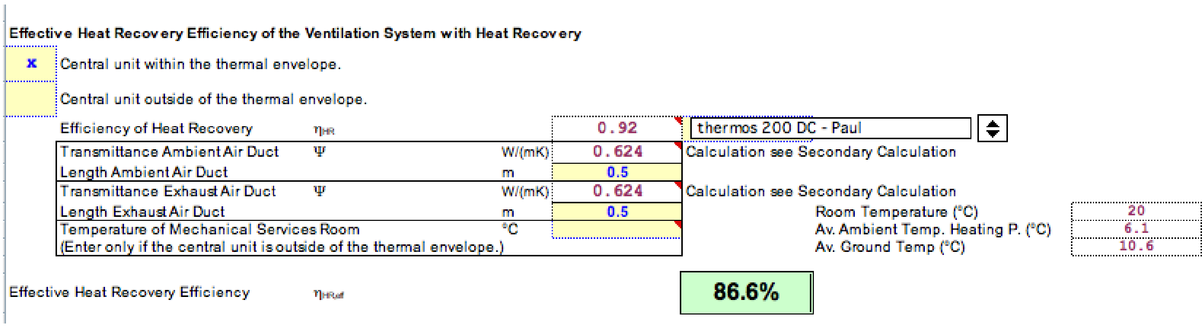


Figure 26: HRV performance after update

Internal heat gains worksheet

Because we are in design mode rather than verification mode we need to visit the IHG worksheet and make sure that the green cell value is entered into the yellow cell (or we will not get 7.32W/m2 credit for the occupants).

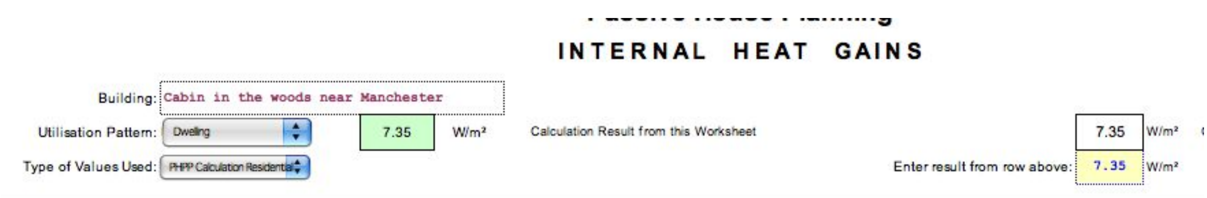


Figure 27: Internal heat gains worksheet

Ground worksheet

This is an optional page. It is ok to set the ground characteristics. In the building data enter the slab area and perimeter and the U-value. You need to check the *Floor Slab Type* box that indicates slab-on-grade. Some of the cells will remain blank on this worksheet. Some cells will already be filled in when you go to this worksheet.

HEAT LOSSES VIA THE GROUND

Ground Characteristics				**Climate Data**			
Thermal Conductivity	λ	2.0	W/(mK)	Av. Indoor Temp. Winter	T_i	20.0	°C
Heat Capacity	ρc	2.0	MJ/(m³K)	Av. Indoor Temp. Summer	T_i	25.0	°C
Periodic Penetration Depth	δ	3.17	m	Average Ground Surface Temperature	$T_{g,ave}$	10.6	°C
				Amplitude of $T_{g,ave}$	$T_{g^\wedge}$	6.0	°C
				Length of the Heating Period	n	6.7	months
				Heating Degree Hours - Exterior	G_t	68.4	kKh/a
Building Data				Floor Slab U-Value	U_f	0.151	W/(m²K)
Floor Slab Area	A	29.6	m²	Thermal Bridges at Floor Slab	Ψ_B*l	0.00	W/K
Floor Slab Perimeter	P	21.8	m	Floor Slab U-Value incl. TB	U_f'	0.151	W/(m²K)
Charact. Dimension of Floor Slab	B'	2.71	m	Eq. Thickness Floor	d_t	13.2	m
Floor Slab Type (select only one)							
			Heated Basement or Underground Floor Slab				Unheated basement
		x	Slab on Grade				Suspended Floor
For Basement or Underground Floor Slab							
Basement Depth	z		m	U-Value Belowground Wall	U_{wB}		W/(m²K)
Additionally for Unheated Basements				Height Aboveground Wall	h		m
Air Change Unheated Basement	n	0.20	h⁻¹	U-Value Aboveground Wall	U_W		W/(m²K)
Basement Volume	V		m³	U-Value Basement Floor Slab	U_B		W/(m²K)
For Perimeter Insulation for Slab on Grade				**For Suspended Floor**			
Perimeter Insulation Width/Depth	D	0.40	m	U-Value Crawl Space	U_{Crawl}		W/(m²K)
Perimeter Insulation Thickness	d_n	0.24	m	Height of Crawl Space Wall	h		m
Conductivity Perimeter Insulation	λ_n	0.045	W/(mK)	U-Value Crawl Space Wall	U_W		W/(m²K)
				Area of Ventilation Openings	εP		m²
Location of the Perimeter Insulation	horizontal			Wind Velocity at 10 m Height	v	4.0	m/s
(check only one field)	vertical	x		Wind Shield factor	f_W	0.05	-
Additional Thermal Bridge Heat Losses at Perimeter				Steady-State Fraction	Ψ_{Pstat}*l	0.000	W/K
Phase Shift	β		months	Harmonic Fraction	Ψ_{Pharm}*l	0.000	W/K
Groundwater Correction							
Depth of the Groundwater Table	z_W	3.0	m	Transm. Belowground El. (w/o Ground)	L_{e}	4.46	W/K
Groundwater Flow Rate	q_W	0.05	m/d	Relative Insulation Standard	d/B'	4.89	-
				Relative Groundwater Depth	z_W/B'	1.11	-
Groundwater Correction Factor	G_W	1.0001572	-	Relative Groundwater Velocity	l/B'	0.30	-

Figure 28: Ground worksheet

Verification worksheet

Return to the verification worksheet. Make the building type is still *residential* and the internal heat gains utilization pattern as *dwelling* and the type of values as *PHPP Calculation Residential* and the planned number of occupants as 2 and the adjacent selection box as *design*.

If you forgot to set your climate, the standard assumption of central Germany will result in a heating demand over 40 kWhr/m2/a but it you selected Manchester climate the heating prediction will be close to the requirements for PassivHaus certification (e.g. around 24 kWhr/m2/year). Given that the area/volume relationship of the retreat is not optimal and the internal floor area is small this is a very good result!

...nands with Reference to the Treated Floor Area					
Treated Floor Area:	18.5	m²			
	Applied:	Monthly Method		PH Certificate:	Fulfilled?
Specific Space Heat Demand:	**25**	**kWh/(m²a)**		**15 kWh/(m²a)**	**No**
Pressurization Test Result:		h⁻¹		0.6 h⁻¹	
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):		kWh/(m²a)		120 kWh/(m²a)	
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):		kWh/(m²a)			
Specific Primary Energy Demand Energy Conservation by Solar Electricity:		kWh/(m²a)			
Heating Load:	20	W/m²			
Frequency of Overheating:	4	%	over	25 °C	
Specific Useful Cooling Energy Demand:		kWh/(m²a)		15 kWh/(m²a)	
Cooling Load:	6	W/m²			

Figure 29: Verification worksheet

Options to explore

Options for making the retreat more efficient are up to you to explore. What happens if you put in a better quality of glazing - say a glazing U-value of 0.5? What happens if you claim more floor space by shrinking the internal partition footprint (there is no overheating) from 400mm to 100mm? What about the recess at the south window? What happens if you increase the thickness of the glass foam in the foundation to 300mm (and reduce the concrete to compensate)? Can you reduce the prediction to 16kWhr/m2/year?

Meeting the PassivHaus evaluation criteria as defined on page 23 of the PHPP manual is possible with this cabin. Explore the PHPP and use your experience to accomplish this!

Specific Demands with Reference to the Treated Floor Area					
Treated Floor Area:	19.7	m²			
	Applied:	Monthly Method		PH Certificate:	Fulfilled?
Specific Space Heat Demand:	**16**	**kWh/(m²a)**		**15 kWh/(m²a)**	**No**
Pressurization Test Result:		h⁻¹		0.6 h⁻¹	
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):		kWh/(m²a)		120 kWh/(m²a)	
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):		kWh/(m²a)			
Specific Primary Energy Demand Energy Conservation by Solar Electricity:		kWh/(m²a)			
Heating Load:	18	W/m²			
Frequency of Overheating:	33	%	over	25 °C	
Specific Useful Cooling Energy Demand:		kWh/(m²a)		15 kWh/(m²a)	
Cooling Load:	12	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:

Figure 30: Verification page after several iterations.