Criteria and Algorithms for Certified Passive House Components: Renovation Systems

Version 1.0_en, 29.07.2024 el

Contents

Legal note

The Passive House Institute GmbH (PHI) carries out building physics-related testing and calculations according to information provided by the product manufacturer, the standards set out in this document, and in the following documents:

- Criteria and Algorithms for Certified Passive House Components: Opaque Construction Systems
- Certification of Interior Insulation Systems (currently only available in German: *Zertifizierung von Innendämmsystemen*)
- Information, Criteria and Algorithms for Certified Passive House Components: Transparent Building Components and Opening Elements in the Building Envelope
- Information, Criteria and Algorithms for Certified Passive House Components: Insulated Glass Units and Solar Protection Glazing
- Requirements and Testing Procedures for Energetic and Acoustical Assessment of Passive House Ventilation Systems < 600 m³/h for Certification as “Passive House Suitable Component”
- Requirements and Testing Procedures for Energetic and Acoustical Assessment of Passive House Ventilation Systems > 600 m³/h for Certification as “Passive House Suitable Component”
- Requirements and Testing Procedures for Energetic and Acoustical Assessment of Passive House (Façade-Integrated) Ventilation Systems

For any construction projects using the certified product, it is the responsibility of the project leader, e.g. the architect, to ensure appropriate assessments have been carried out for that building, which may include more detailed or other analyses than those carried out for this certification.

Use of a component certified by the PHI does not guarantee that a project will automatically achieve the Passive House, EnerPHit of PHI Low Energy Building Standard.

In all cases, full details, including drawings and material specifications, are to be made available by manufacturers or suppliers to the engaged Passive House Designer and/or Certifier, who will be permitted to check these against construction information and to perform on-site or other checks as part of the quality assurance process.

The PHI assumes that all submitted documents are free of third-party rights. By submitting the documents for certification, the applicant declares that they are in possession of all rights to the full extent.

Achievement of the PHI's criteria does not preclude the necessity to comply with local building regulations or any other legal standards that may apply. It is imperative that all construction projects adhere to the relevant local and national building codes and obtain any required permits and approvals. The certification by the PHI is supplementary to, and does not replace, any legal or regulatory requirements set forth by local authorities.

1 Preface

The certified component category “Renovation Systems” aims to recognise and promote the use of prefabricated, semi-prefabricated or conventional systems that allow the deep renovation of a whole building that results in a significant reduction in operational energy demand of existing buildings. Certified products are awarded the designation “Certified Passive House Component” and are permitted to use the PHI’s certified component logo for the relevant climate zone, see Figure 1.

Figure 1: PHI Certified Component logo (cool-temperate climate zone)

Through examination and certification, specific performance values of renovation systems are determined and made available, so that these values can reliably be used for the energy efficiency-related planning of refurbishment projects. These values include, but are not limited to, U-values, interior surface temperatures, thermal bridge coefficients (Psi-values) and ventilation heat recovery efficiency.

The long-term goal of this certification is to streamline and thereby accelerate the refurbishment of existing buildings, ideally to the EnerPHit standard, thereby enabling swifter decarbonisation of the existing building stock.

2 Certification criteria

2.1 Summary of certification criteria

Renovation systems are certified in the following way:

The climate zone is allocated, according to section 2.3.

The system design is then analysed and must meet the following:

- All interior surfaces must meet the general hygiene criterion, which concerns the prevention of interior surface condensation and mould growth.
- The opaque envelope must meet requirements concerning interior surface temperature, heat transfer coefficients (U-values), absence of thermal bridges (Psi-values), and, in hot and very hot climates, albedo (optional). Requirements must also be met concerning the ability of interstitial condensation to evaporate within a 12 month period, and concerning the ability for moisture to accumulate on any given surface.
- Transparent components must meet requirements concerning the installed U-value and solar heat gain coefficient / g-value.
- Ventilation systems must meet requirements concerning sound protection, the minimum heat recovery rate or, in hot and very hot climate zones, the minimum humidity recovery rate.
- Finally an installation manual and a guide for occupants concerning use and maintenance must be provided.

Detailed certification criteria are given in the table in section 2.7 and further details, including required documentation are given in section 3.

2.2 Services provided by Passive House Institute

1. Processing of the CAD drawings and preparation of the calculation models of the available details for subsequent heat flow simulations.
2. Calculation of the U-values of the standard building component assemblies.
3. Calculation of the equivalent thermal conductivities according to the methodology set out in the supplement to this document and U-values of the standard building component assemblies, thermal bridge loss coefficients, temperature factors and surface temperatures based on the submitted documents with reference to compliance with the certification criteria. The calculations will be carried out based on a reference substrate construction for wall and roof that is representative of a typical existing building in Europe.
4. Additional calculation of variants for checking thermal improvement or checking the creation of airtightness levels in submitted connection situations. The costs for calculating variants shall be charged to the client after prior consultation.
5. Application of the values determined in point 3 to a reference building energy balance model (created by PHI in designPH and/or PHPP) to confirm that the EnerPHit standard can be comfortably reached using the product in question. See section 2.4 for full details of this.
6. Production of documentation of the results of the certification using isothermal images, specific value sheets and final evaluation of the construction system to be certified, in German or English.

2.3 Assignment of climate zones (regions with identical requirements)

The climate zone is assigned based on the location of the manufacturer's headquarters, or any other region where the manufacturer conducts its operations. The nearest PHPP climate data set will be used; further climate data sets can be requested from PHI where this is uncertain, e.g. in regions with wide variations in altitude. The certification criteria and a certificate that is issued based on them are valid for the assigned climate zone and also for climates with lesser requirements, bearing in mind however that more economical solutions may be possible. These climate zones are as follows:

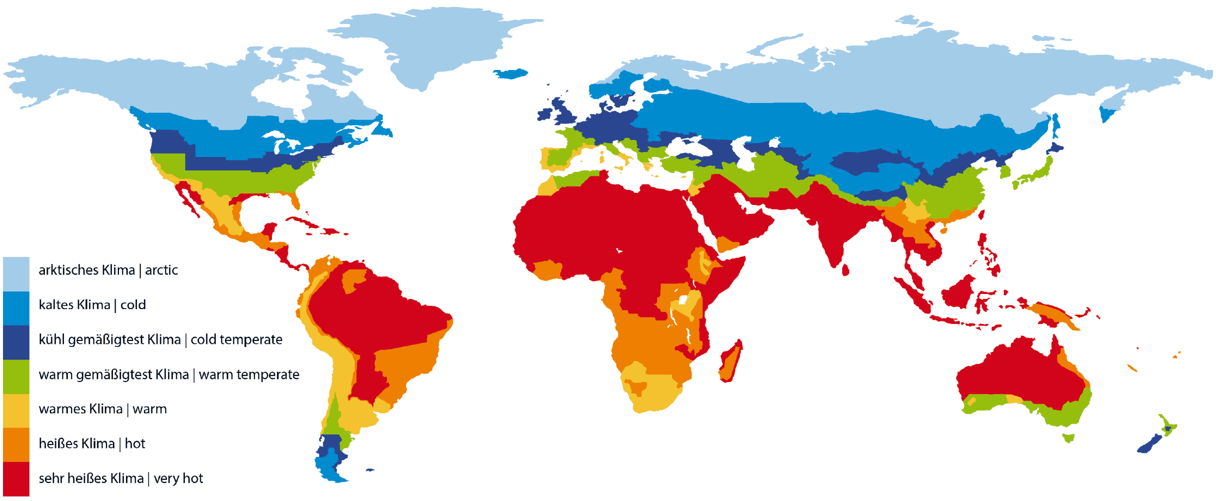


Figure 2: Assignment of regions with identical requirements, based on studies by the PHI

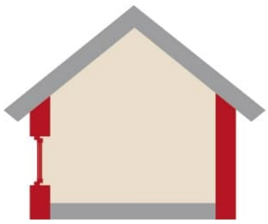
2.4 Renovation system packages

A renovation system in its most basic form will comprise wall refurbishment modules with built-in windows, but can also include one or a combination of roof and floor refurbishment products, as well as ventilation, renewable energy (RES) and heating systems. The combinations can therefore be as follows:

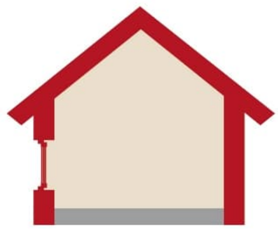
Wall and window modules, plus:

- Roof modules
- Floor modules
- Ventilation system
- Renewable energy system (RES)
- Heating system

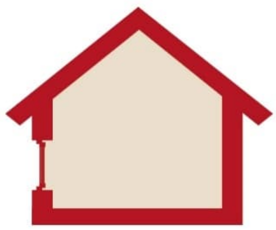
The scope of certification will be indicated by the diagram on the front page of the certificate, as per the diagrams below:



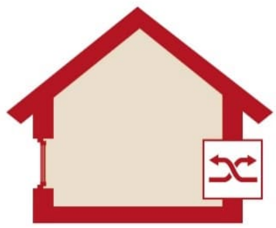
A) Wall and window modules



B) Wall and window modules, plus roof modules



C) Wall and window modules, plus roof modules and floor modules



D) Wall and window modules, plus roof modules and floor modules, plus ventilation

E) Wall and window modules, plus roof modules and floor modules, plus ventilation and photovoltaics

F) Wall and window modules, plus roof modules and floor modules, plus ventilation and photovoltaics and heat pump

Where any of the listed elements are not included, products targeting certification will be assumed to be installed in conjunction with Passive House-standard assemblies and components for the remaining elements. For example, when evaluating and performing thermal calculations for a product incorporating walls, roof and windows, it will be assumed that the floor will also be insulated to the heat transfer coefficient standard for the relevant climate zone separately to the renovation system, that a ventilation system will be installed and that it will ultimately meet the corresponding Passive House-relevant standards.

2.5 Test building calculation

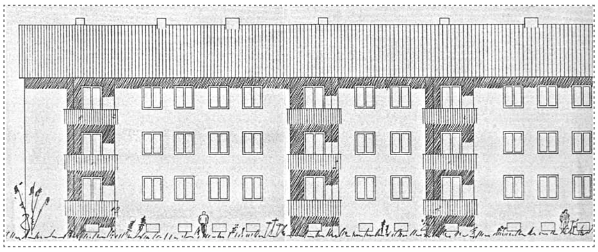
The existing building stock to be refurbished comprises structures of many different shapes and sizes, most of them designed in times where energy efficiency was not a major consideration. Renovation systems must therefore be designed to thermally improve buildings with potentially complex geometries and with various different kinds of material substrates. Additionally, in cases involving systems constructed with materials like insulated timber cassettes supported by metal bearings, variations in the heat transfer coefficient might occur throughout the building due to differences in factors such as the concentration of point thermal bridges and the percentage of timber per square meter.

Part of the process of renovation system certification is therefore generation of a basic PHPP energy balance model, into which the established thermal data is entered, and which is then used to demonstrate whether the EnerPHit standard can be comfortably achieved using the system as-designed. The building itself takes the form of a 1950s central European social housing block, with either 30cm bricks with a lambda value of 0,6 W/(mK) or 25 cm of concrete, with a lambda value of 2.1 W/(mK), with insulation according to the standards used in existing buildings.

An energy balance calculation will then be carried out to check the plausibility of the system achieving the EnerPHit standard according to the Component Method using the latest version of the PHPP. Where key values are not provided by the product in question, typical values for the relevant climate zone will be applied (see also 2.4). In all cases, the calculation will be made available to the manufacturer for their own information. An example verification page is shown in Figure 3, below:

EnerPHit-Verification

10.6 EN PHPP



Building:	EnerPHit Mehrfamilienhaus		
Street:	Rheinstraße 44-46		
Postcode/City:	64283	Darmstadt	
Province/Country:	Hessen	DE-Germany	
Building type:	5-Multi-family house I Apartment building		
Climate data set:	DE-9999-PHPP-Standard		
Climate zone:	3: Cool-temperate	Altitude of location:	144 m
Home owner / Client:	Max Mustermann		
Street:	Rheinstraße 44-46		
Postcode/City:	64283	Darmstadt	
Province/Country:	Hessen	DE-Germany	

Architecture:	Manfred Mustermann			**Mechanical engineer:**	Magdalena Mustermann		
Street:	Rheinstraße 44-46			Street:	Rheinstraße 44-46		
Postcode/City:	64283	Darmstadt		Postcode/City:	64283	Darmstadt	
Province/Country:	Hessen	DE-Germany		Province/Country:	Hessen	DE-Germany	
Energy consultancy:	Martina Mustermann			**Certification:**	Passivhaus Institut GmbH		
Street:	Rheinstraße 44-46			Street:	Rheinstraße 44-46		
Postcode/City:	64283	Darmstadt		Postcode/City:	64283	Darmstadt	
Province/Country:	Hessen	DE-Germany		Province/Country:	Hessen	DE-Germany	

Year of construction:	2023	Interior temperature winter [°C]:	20,0	Interior temp. summer [°C]:	25,0
No. of dwelling units:	20	Internal heat gains (IHG) winter [W/m²]:	4,1	IHG summer [W/m²]:	4,1
No. of occupants:	33,4	Specific heat capacity [Wh/K per m² TFA]:	60	Mechanical cooling:	

Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	1229,2				
Space heating	Heating demand	kWh/(m²a)	29,67	≤	-	-	-
	Heating load	W/m²	18	≤	-	-	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	4	≤	-		-
	Frequency of overheating (> 25 °C)	%	-	≤	-		-
	Frequency of excessively high humidity (> 12 g/kg)	%	0	≤	10		Yes
Airtightness	Pressurisation test result n_{50}	1/h	0,6	≤	1,0		Yes
Moisture protection							
	Smallest temperature factor $f_{Rsi=0.25\ m^2K/W}$	-	0,68	≥	0,47	0,32	Yes
Thermal comfort	All requirements fulfilled?	-					Yes
	U-value	W/(m²K)		≤	1,02		
	U-value	W/(m²K)		≤	1,22		
	U-value	W/(m²K)		≤	1,32		
	U-value	W/(m²K)		≤	0,56		
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	106	≤	-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	74	≤	87	87	Yes
	Renew. energy generation (in rel. to projected building footprint area)	kWh/(m²a)	0	≥	-	-	

EnerPHit (retrofit): Component characteristics

Building envelope to exterior air[1] (U-value)	W/(m²K)	0,15	≤	0,15	Yes
Building envelope towards ground (heat loss/load)	kWh/(m²a)	7,4	≤	12,5	Yes
Wall w/int. insulation in contact w/exterior air (U-value)	W/(m²K)	0,35	≤	0,35	Yes
Flat roof (SRI)	-	72	≥	-	-
Inclined and vertical external surface (SRI)	-	56	≥	-	-
Windows/Entrance doors ($U_{W/D,installed}$)	W/(m²K)	0,69	≤	0,85	Yes
Windows ($U_{W,installed}$)	W/(m²K)	0,75	≤	1,00	Yes
Windows ($U_{W,installed}$)	W/(m²K)	0,81	≤	1,10	Yes
Glazing (g-value)	-	0,50	≥	0,31	Yes
Glazing/sun protection (max. solar load)	kWh/(m²a)	92	≤	-	-
Ventilation (effective heat recovery efficiency)	%	78	≥	75	Yes
Ventilation (humidity recovery efficiency)	%	0	≥	-	-

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

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

EnerPHit (Component method) Classic? Yes

Task:	First name:		Surname:	Signature:
2-Certification	Malte		Mustermann	
Certificate-ID		Issued on:	City:	
		01.01.23	Musterstadt	

Figure 3: Example reference building calculation PHPP verification page

2.6 Certification procedure

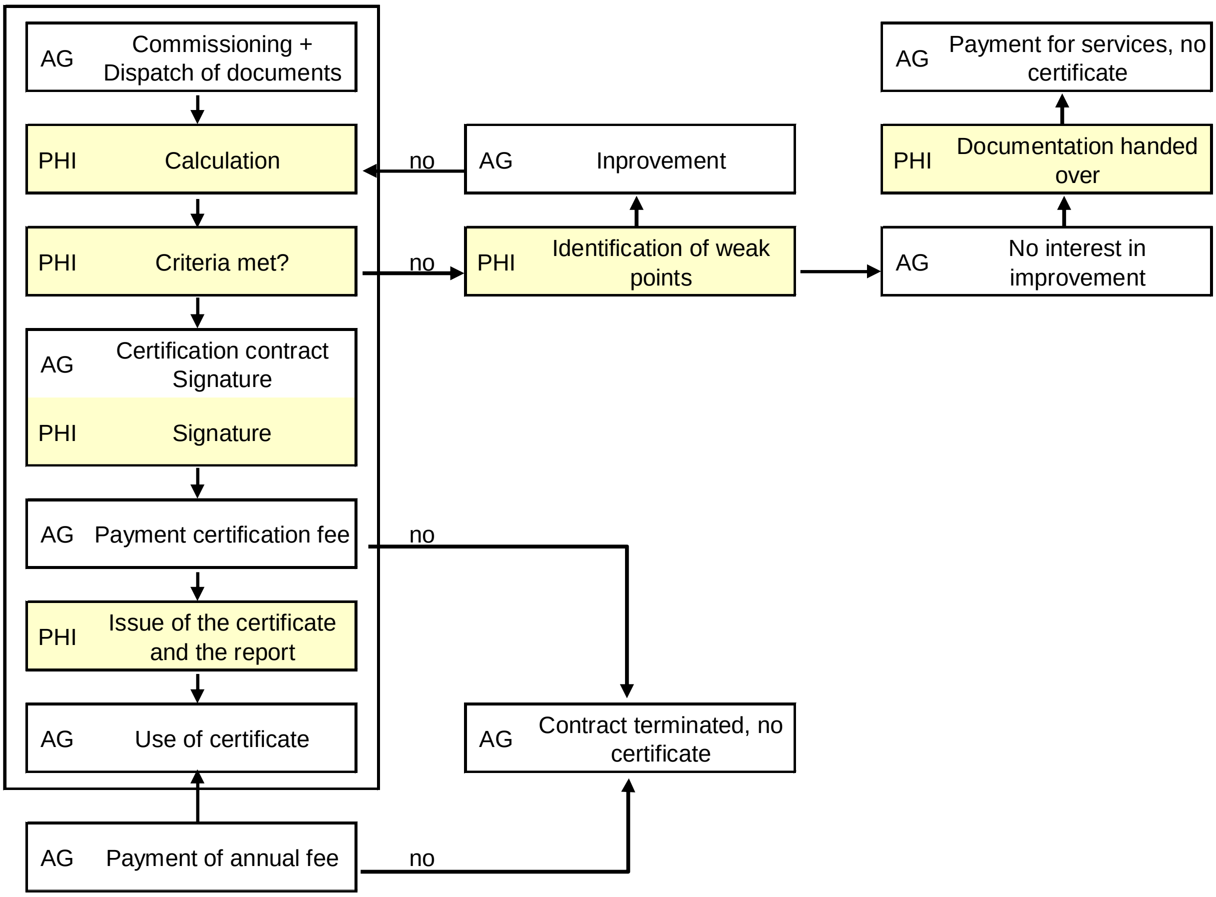


Figure 4: PHI component certification flow chart

2.7 Detailed certification criteria

Table 1: Renovation system certification criteria

Details of each criterion can be found in chapter 3, in the associated sub-section, e.g. ‘2.1 Airtightness concept’ is found under 3.2.1

Climate zone according to PHPP	1.1 Hygiene criterion	1.2 Airtight-ness concept	Building envelope (against…								Windows and exterior doors					4. Ventil-ation system	5. Install-ation manual	6. Occupant manual
			...ground)	...ambient air)				2.3 Absence of thermal bridges Ψ ≤	2.4 Conden-sation limit	2.5 Moisture accumul-ation limit ≤	Overall			Glazing				
			2.1 Max. heat transfer coefficient (U-value)			2.2 Solar Reflectance Index (SRI) of exterior finishes					3.1 Window comfort criterion ($U_{W,installed}$)			3.2 Solar heat gain coefficient (g-value)	3.3 External shading			
			Ground	Exterior insulation	Interior insulation	Flat roofs (< 10°)	Walls and sloped roofs (> 10°, <120°)											
	$f_{Rsi=0.25\ m^2K/W}$ ≥	-	[W/(m²K)]			-	-	[W/(mK)]	-	[g/m²]	[W/(m²K)]			-	-	-	-	-
Arctic	0.80	Compre-hensive guide to be provided to how ≤ 1.0 h^{-1} should be achieved	Ambient air criterion (for either interior or exterior insulation) multiplied by reduction factor of 0.6 / Applies only to climate zones 1-4.	0.09	0.25	-	-	0.010	Conden-sation should be comp-letely evapo-rated at the end of 12 months	200	0.45 (0.35)	0.50 (0.35)	0.60 (0.35)	g/U_g ≥ 0,95	External shading strategy to be provided	Compre-hensive ventilation concept document to be provided.	Compre-hensive guide to install-ation to be provided.	Compre-hensive guide regarding use and mainten-ance to be provided.
Cold	0.75			0.12	0.30	-	-				0.65 (0.52)	0.70 (0.52)	0.80 (0.52)	g/U_g ≥ 0,80				
Cool-temperate	0.70			0.15	0.35	-	-				0.85 (0.70)	1.00 (0.70)	1.10 (0.70)	g/U_g ≥ 0,65				
Warm-temperate	0.65			0.25	0.50	-	-				1.05 (0.90)	1.10 (0.90)	1.20 (0.90)	g/U_g ≥ 0,50				
Warm	0.55			0.50	0.75	-	-				1.25 (1.10)	1.30 (1.10)	1.40 (1.10)	g/U_g ≥ 0,30				
Hot	-			0.50	0.75	90	50				1.25 (1.10)	1.30 (1.10)	1.40 (1.10)	τ_{vis}/g ≥ 1,6				
Very hot	-			0.25	0.45	90	50				1.05 (0.90)	1.10 (0.90)	1.20 (0.90)	τ_{vis}/g ≥ 1,6				

3 Detailed information and documentation requirements

3.1 Hygiene and airtightness

3.1.1 Hygiene criterion

Background:
In colder climates where outdoor temperatures can be lower than the indoor dew point temperature (particularly in the arctic, cold and cool-temperate regions) interior surface condensation can occur. This can lead to mould growth, which can have an adverse effect on occupant health. In order to reduce this risk, all interior surfaces and junctions, including the interior of service penetrations, must meet the hygiene criterion, namely a specific fRsi or surface temperature factor. This is calculated in accordance with ISO 10211 for opaque connections and ISO 10077-2 for opaque-transparent connections. Calculations are carried out by PHI, based on the information listed below (these are the same as for section 3.2.3):

Documentation to be submitted:
- CAD drawings in .dwg or .dxf-format of all relevant junctions, as listed in section 7.
- Materials specification, including rated lambda values according to section 5.2.

Documentation produced:
Thermal FEM modelling outputs, showing the fRsi of all relevant junctions. These will be included in the final report.

Further information:
See section 5 for information regarding calculation methodology. For door thresholds the dew point criterion applies, see section 5.1.2.

Further reading:
'Criteria and Algorithms for Certified Passive House Components: Opaque Construction Systems' and 'Information, available in English at the following link:
https://passiv.de/downloads/03_certification_criteria_construction_systems_en.pdf

Criteria and Algorithms for Certified Passive House Components: Transparent Building Components and Opening Elements in the Building Envelope', available at the following link:
https://passiv.de/downloads/03_certification_criteria_transparent_components_en.pdf

3.1.2 Airtightness concept

Background:
An airtight building envelope is an essential component of a Passive House or any other low energy building. This prevents the escape of warmed or cooled air to the outside, as well as the infiltration of moisture into the building assembly, which can lead to damage in the long term.

A professional quality standard of air- and wind-tightness must be ensured in the building and at connections in terms of planning as well as execution; the plausibility of any solution will be thoroughly checked during the certification process based on the documents submitted. This should be verified by detail drawings (with the airtight layer clearly marked), text descriptions of the creation of the airtight layer, the materials used for this and a general description of the overall system. As a minimum, information for the following details should be provided:

- On the surface of walls (and if present, roofs and floors) and at any module connections
- At the perimeter
- External corners, both regular and inverted
- Window and door connections
- Balcony protrusions
- Roof eaves and verge
- At service penetrations, including the fresh and exhaust air ducts of the ventilation system

The graphical representation should be such that the layers and connections of the membranes and sealing materials to the walls and windows frames are clearly recognisable.
All connection details must be planned and executed in a permanently airtight manner. The airtight layers must be clearly identified in the submitted documents (e.g. outlined in red).

For systems using novel methods of achieving airtightness, assurance of reliability may be requested, e.g. mechanical testing data carried out by a recognised testing laboratory, or details of an existing project where the method has already been used and validated.

A guide must be provided that gives details of the airtightness concept and how this should be installed. It should be possible for the certifier/site supervisor to easily check the installation and integrity of the airtight layer prior to airtightness testing. An evaluation of the airtightness strategy is carried out by PHI, based on the information listed below:

Documentation to be submitted:

- CAD drawings in .dwg, .dxf, or .pdf-format showing the building assembly, with the airtight layer clearly marked.
- A comprehensive guide, as described above under ‘background’ as to how the required airtightness level is to be achieved.
- The results of any tests previously carried out on already built examples of the System.

Documentation produced:
The above information will be included in the final report.

Further information:
For projects using certified renovation systems, an EnerPHit-level of airtightness ($\leq$ 1.0 h^{-1} at 50 Pa pressure differential) must be achievable.

Further reading:
‘Certification of Airtightness Systems’, available at the following link:
https://passiv.de/downloads/03_certification_of_airtightness_systems_en.pdf

3.2 Opaque envelope

The opaque envelope of a building comprises the walls, roofs and floors that make up the physical barrier between inside and outside In Passive Houses, essential factors extend beyond structural and fire performance; they encompass heat transfer, airtightness, and moisture-related attributes, all of which are vital for achieving a comfortable and energy-efficient building. The construction industry offers a wide array of materials and products that can facilitate optimal energy efficiency, and certifying projects that use these materials is generally straightforward. Where 'novel' materials are used and where no long term study of the use of such materials in Passive House projects exists, pilot certification may be considered. This applies e.g. to the use of vacuum insulation panels – see also the article 'Addendum Concerning the Use of Vacuum Insulation' on Passipedia.

3.2.1 Maximum heat transfer coefficient

Background:
Low heat transfer through the building envelope means that the building interior temperature remains comfortable, and the heating or cooling demand remains at a level where it can easily be met with only small amounts of active energy input.

For renovation systems, the required U-values match those required by the EnerPHit standard, see table 1, when following the component method. These are calculated by PHI according to ISO 6946, based on the information listed below. The values are then used in the reference building test calculation, as described in 2.4, to demonstrate that use of the system as-designed can comfortably lead to achievement of the EnerPHit standard.

Documentation to be submitted:
- CAD drawings in .dwg or .dxf-format of all relevant building assemblies, as listed in section 7.
- Materials specification, including rated lambda values according to section 5.2.

Documentation produced:
Thermal FEM modelling outputs, showing the U-values of all assemblies considered. These will be included in the final report.

Further information:
Systems or products using interior insulation are generally intended for retrofit projects, meaning standardisation of thermal performance values is difficult due to the wide range of possible substrates. For such systems seeking certification under this scheme, care must therefore be taken to communicate the substrate type(s) taken into account in the analysis.

The certification will be carried out based on a substrate type for the existing building defined by the manufacturer, e.g. reinforced concrete or hollow brickwork. Further variants are possible; these are treated as secondary certifications, with their own unique ID number.

Regularly occurring or recurrent penetrations and geometric features of the building components are taken into account in the U-value calculation of the standard building components. The criteria for the thermal bridge coefficients must be complied with under consideration of this methodology.

Further reading:
'Criteria and Algorithms for Certified Passive House Components: Opaque Construction Systems', available in English at the following link:
https://passiv.de/downloads/03_certification_criteria_construction_systems_en.pdf
Information specific to interior insulation can be found at the following link (in German):
https://passiv.de/downloads/03_zertifizierungskriterien_innendaemmsysteme.pdf

3.2.2 SRI of external finishes (optional for hot and very hot climates only)

Background:
In hot and very hot climates it is essential to prevent heat ingress into the building in order to reduce cooling demand as far as possible. In addition to sufficient thermal insulation, one way to achieve this is to reflect incoming solar radiation by way of high albedo exterior finishes, especially on the roof. The degree of albedo is expressed as the Solar Reflection Index (SRI), which ranges from 0-100, with higher values indicating greater solar reflectance. Renovation systems intended for use in hot or very hot climate regions are therefore required to meet certain SRIs for roofs and external walls, as per Table 1.

The SRI values are then used in the reference building test calculation, as described in 2.4, to demonstrate that use of the system as-designed can comfortably lead to achievement of the EnerPHit standard.

The criteria are shown below:

	Slope	3-year aged SRI
Flat roofs	≤ 10°	≥ 90
Walls and sloped roof	> 10°, ≤120°	≥ 50

Documentation to be submitted:

- CAD drawings in .dwg, .dxf, or .pdf-format showing example elevations and roof plans of a typical (or pre-existing) building refurbished using the product in question, annotated to indicate the external finishing products to be used and their calculated solar reflectance indexes.
- Manufacturers datasheets of all external finishing products, showing either the solar reflectance index (SRI), or solar reflectance (R) AND thermal emittance (E).

Documentation produced:
The above information will be included in the final report

Further information:
Where manufacturer's datasheets only show the solar reflectance (R) and thermal emittance (E) values, calculations of the SRI must be provided in addition. Where the R and E values of the finishing material are not shown on the datasheets, standard values from e.g. the applicable national or international standard will be accepted, following prior agreement with PHI.

Where submitted as evidence, the 3-year aged SRI values must be provided by a third party testing laboratory, which has been accredited by the relevant national regulating body – this does not need to be a Notified Body.

3.2.3 Absence of thermal bridges

Background:
Thermal bridges, or cold bridges, are disturbances in the geometry of the exterior envelope that can lead to additional heat loss and, in cold climates, low interior surface temperatures. In hot climates the reverse can result; namely hotter than normal surface temperatures and increased cooling demand. Avoidance of these is therefore a fundamental principle of Passive House or low energy building design.

For renovation systems, all thermal bridges must meet a linear heat loss coefficient of ≤ 0,01 W/(mK) as per Table 1, although exceptions may be made where it is clear from the detail geometry or other factors that this will not be possible, and as long as the reference building calculation shows that the EnerPHit standard is likely to be achievable using the product anyway. Calculations are carried out by PHI according to ISO 10211 and ISO 10077-2, based on the information listed below (these are the same as for section 3.1). The values are then used in the reference building test calculation, as described in 2.4, to demonstrate that use of the system as-designed can comfortably lead to achievement of the EnerPHit standard. See section 7 for further details.

Documentation to be submitted:

- CAD drawings in .dwg or .dxf-format of all relevant junctions, as listed in section 7.
- Materials specification, including rated lambda values according to section 5.2.

Documentation produced:
Thermal FEM modelling outputs, showing the fRsi of all relevant junctions. These will be included in the final report.

Further information:
In special cases, such as the geometric thermal bridges or balcony slab penetrations, the equivalent Ψ-value may exceed 0,01 W/(mK); this may be permitted where the detail has been improved as far as economically possible, however the requirements of the hygiene criterion will remain unaffected.

The Ψ-value for the installation thermal bridge of the window frame in the case of window and door installation situations can also exceed 0,01 W/(mK). The maximum thermal resistance of the installed element will remain unaffected by this. The final decision regarding the need for compliance shall be made by the Passive House Institute, based on considerations for occupant comfort and the longevity of the building.

Calculations are based on external dimensions and lengths. See section 5.3 for information regarding three-dimensional thermal bridges.

Further reading:
'Criteria and Algorithms for Certified Passive House Components: Opaque Construction Systems', available in English at the following link:
https://passiv.de/downloads/03_certification_criteria_construction_systems_en.pdf

3.2.4 Condensation limit

Background:
Interstitial condensation, i.e. condensation within the building assembly that generally occurs during winter, can cause damage over the long term, where this does not completely evaporate within a 12 month period and thereby accumulates over time. The damage can be as a result of either e.g. rotting of timber members or freeze-thaw action in masonry construction. For renovation system certification, calculations are carried out by PHI according to the Glaser method to rule out this risk. Where the criteria are not met following this approach, a dynamic simulation according to EN 15026 can be carried out to provide greater detail.

For interior insulation systems or products seeking to achieve certification, a dynamic hygrothermal simulation to EN 15026 is mandatory to ensure proper function and no detrimental effects. Please see the document 'Certification of Interior Insulation Systems' (currently only available in German: 'Zertifizierung von Innendämmsystemen') for full details.

Documentation to be submitted:

- CAD drawings in .dwg or .dxf-format of all relevant building assemblies, as listed in section 7.
- Materials specification, including all relevant mju or sd-values.

Documentation produced:
Calculation outputs of all assemblies considered. These will be included in the final report.

Further information:
This method brings more reliable results for lightweight and airtight components used in cool and non-humid locations away from the equator that do not contain materials with a large water or heat storage capacity. More detailed analyses than those carried out for this certification may be required for specific buildings.

3.2.5 Moisture accumulation limit

Background:
The moisture accumulation limit is based on ISO 13788 and reflects the maximum amount of condensate in order to prevent run-off of liquid water from watertight surfaces during cold winter conditions. Where this is sufficiently high on e.g. vertical surfaces, water can run down and collect at the base of building assemblies, causing damage similar to that described in section 3.2.4. For renovation system certification, calculations are carried out by PHI to rule out this risk.

Documentation to be submitted:

- CAD drawings in .dwg or .dxf-format of all relevant building assemblies, as listed in section 7.
- Materials specification, including all relevant mju or sd-values.

Documentation produced:
Calculation outputs of all assemblies considered. These will be included in the final report.

Further information:
The Ma limit (maximum accumulated moisture content) is based on ISO 13788 and reflects the maximum amount of condensate in order to prevent run-off of liquid water from watertight surfaces. It may make sense in certain cases to calculate a more specific Ma limit according to the materials present in the wall, roof and floor constructions.

3.3 Windows and exterior doors

3.3.1 Comfort criterion

Background:
Windows and other transparent components are generally the weakest thermal parts of the building envelope, enabling higher levels of heat loss and summer loads than e.g. the external walls. Transparent components with a sufficiently high degree of thermal resistance ensure that heat loss or gain is minimised. Furthermore, for heating climates, well-installed transparent components ensure that the minimum interior surface temperature of the glazing is high enough to ensure occupant comfort on cold days. For renovation system certification, calculations of installed U-values are carried out by PHI in accordance with ISO 10077-2 to determine window performance, which should meet the criteria in table 1, which shows the Ug-values to be used in brackets. The reference size for windows is 1,23 by 1,48 m; the reference size for doors is 1,1 by 2,2 m. The values are then used in the reference building test calculation, as described in 2.4, to demonstrate that use of the system as-designed can comfortably lead to achievement of the EnerPHit standard.

Documentation to be submitted:

- Window schedule, marked up to show typical sizes and dimensions
- CAD drawings in .dwg or .dxf-format of all relevant junctions, as listed in section 7.
- Materials specification, including rated lambda values according to section 5.2.

Documentation produced:
Calculation outputs of all components considered. These will be included in the final report.

Further information:
For systems where no specific window is named, a basic window design that reaches the lowest threshold of the Passive House standard for components (e.g. for the cool-temperate climate zone a Uw-value of 0,80 W/(m²K) using a Ug-value of 0,70 W/(m²K) at a reference size of 1,23 by 1,48 m) can be used.

Further reading:
'Information, Criteria and Algorithms for Certified Passive House Components: Transparent Building Components and Opening Elements in the Building Envelope', available in English at the following link:
https://passiv.de/downloads/03_certification_criteria_transparent_components_en.pdf

3.3.2 Solar heat gain coefficient (g-value)

Background:
In heating climates, windows and other transparent components are areas where useful solar energy can be harvested to reduce the need for active heating in the winter time. This is converse to cooling climates, where the admission of solar radiation to the building interior should be prevented to reduce cooling demand. For renovation system certification, evidence of the SHGC/g-value of glazing products should be provided, in accordance with EN 673. The values should meet the criteria in table 1. These are then used in the reference building test calculation, as described in 2.4, to demonstrate that use of the system as-designed can comfortably lead to the achievement of the EnerPHit standard.

Documentation to be submitted:
- Window schedule, marked up to show typical sizes and dimensions.
- CAD drawings in .dwg or .dxf-format of all relevant junctions, as listed in section 7.
- Materials specification, including rated lambda values according to section 5.2.

Documentation produced:
Reference to the evidence provided will be included in the final report.

Further reading:
'Information, Criteria and Algorithms for Certified Passive House Components: Transparent Building Components and Opening Elements in the Building Envelope', available in English at the following link:
https://passiv.de/downloads/03_certification_criteria_transparent_components_en.pdf

'Information, Criteria and Algorithms for Certified Passive House Components: Insulated Glass Units and Solar Protection Glazing:
https://passiv.de/downloads/03_certification_criteria_glazing_en.pdf

3.3.3 External shading

Background:

The prevention of summertime overheating is an essential aspect of Passive House and low energy buildings in order to reduce cooling demand. All products seeking to achieve certification as a renovation system are therefore required to incorporate strategies for external shading for sun-facing windows. These must comply with the requirements detailed in table 1 for installed U-value of windows and doors, and for interior surface temperature / fRsi. The geometry and associated thermal performance values are then used in the reference building test calculation, as described in 2.4, to demonstrate that use of the system as-designed can comfortably lead to achievement of the EnerPHit standard.

Documentation to be submitted:

- Description of external shading concept and system, including details of correct operation
- Detail drawings of external shading systems, including 3D / isometric drawings where these project outwards, showing the distance between outer glazing surface and outer edge of shading

Documentation produced:

Reference to the evidence provided will be included in the final report.

3.4 Ventilation system concept

Background:

Ventilation is an essential component of Passive House or low energy building design. For renovation system certification, a ventilation concept is required that details the type of system and its components, layout and how the minimum heat recovery rate (in heating climates) is to be met.

Manufacturer's datasheets and, where appropriate, third party laboratory testing data should be provided in addition, showing the effective dry heat recovery efficiency with balanced mass flows at external temperatures of between -15 and +10 °C is $\geq$ 75 % for the cool-temperate and warm-temperate climates, and 80 % for the arctic and cold climates. For façade-integrated systems, an electrical efficiency 0,45 W/m³ must also be met to ensure low energy consumption through the operation of the unit. Standard noise protection requirements are also applicable.

For systems where the ductwork is integrated laterally into the façade, e.g. buried within an EIFS system, this must be covered with at least 5 cm of insulation, and the thermal bridging effect of must be calculated to ensure that linear heat loss coefficients are in the acceptable range and can be taken into account when undertaking energy balance modelling. The sound emissions of such systems must also be confirmed to be within acceptable limits. It must also be possible to access ductwork for the sake of maintenance.

Documentation to be submitted:

- Ventilation concept document in PDF format
- Mechanical and electrical / HVAC specification, showing make and model of heat recovery ventilation system to be installed in the system to be certified
- Drawings in CAD or PDF format of proposed / typical ventilation system layout
- Manufacturer's datasheets or third party laboratory testing data to show the effective dry heat recovery, as above.

Documentation produced:

Reference to the evidence provided will be included in the final report.

Further reading:

'Requirements and testing procedures for energetic and acoustical assessment of Passive House (façade integrated) ventilation systems':

https://passiv.de/downloads/03_certification_criteria_single_room_ventilation.pdf

'Requirements and testing procedures for energetic and acoustical assessment of Passive House ventilation systems < 600 m³/h for certification as "Passive House suitable component"'

https://passiv.de/downloads/03_Reqs_and_testing_procedures_ventilation_en.pdf

3.5 Installation manual for the renovation system

A comprehensive installation manual must be provided for all products seeking certification as a renovation system. This should cover the following aspects:

1. If applicable, brief description of safe and secure transportation and delivery of the system, including required training and qualifications of transport personnel regarding e.g. lifting and handling. Details should be given of any ways system components should be protected from damage during transit and handling.
2. Safe and secure storage of system components on site.
3. Machinery and equipment (including safety equipment) required for assembly and installation of system components, including required qualifications of site personnel.
4. Brief requirements for site and building substrate preparation.
5. Step-by-step method for installation of components by a suitably qualified craftsperson, including information on third parties that need to be appointed; the need for specialist training should be minimised.
6. Where it is the case that new services (electrical, plumbing, HVAC, etc.) and/or finishes have to be installed on-site, there should be a documented method for installation that ensures the envelope components are not damaged.
7. Safe disposal of any waste products and unneeded components.
8. Method for maintenance of system over projected service life. This should include remedy of any defects that may occur. Where defects are detected and a component must be replaced, there should be a documented method for panels to be replaced by a qualified craftsperson; again, the need for specialist training should be minimized.
9. Contact details of the manufacturer's technical support department.

Documentation to be submitted:
Installation and maintenance manual in PDF format

Documentation produced:
Reference to the evidence provided will be included in the final report.

Further information:
A distinction is made between certified products that require dwellings to be vacated for site works to be carried out and those that allow occupants to remain in place for the duration of installation.

3.6 Occupant manual

A comprehensive occupant introduction and user manual must be provided for all products seeking certification as a renovation system. This should cover the following aspects:

1. Welcome
    a. Benefits
    b. Myth busting
2. Good Practice guide
    a. Not just needed for Passivhaus buildings
    b. Should mention other systems e.g. PV, solar thermal etc
    c. Recording/calculating your energy use
3. Maintaining comfort
    a. Ventilation systems/ fresh air (where ventilation system(s) are present)
    b. Windows (and blinds)
    c. Air barrier and fabric
    d. Heating system (where heating system(s) are present)
    e. Seasonal changes
4. How to get the most out of your property: What if…?
    a. It's too hot or cold
    b. It's stuffy or draughty
    c. The bills are too high
    d. The air feels dry or damp
    e. It's noisy
    f. In case of increased occupancy or vacation
    g. We want to open the windows
5. Troubleshooting
    a. Emergency actions
    b. Checklist help and support

The above points are based on the template for preparation of the handbook from the UK Passivhaus Trust. The full version of this can be found in English here: https://www.passivhaustrust.org.uk/UserFiles/File/2014/Guidance/PHT_User%20Guidance%20technical%20breifing%20paper_FINAL.pdf

The document should include instructions of how to protect the airtight layer, where this is located close to the interior of the building, e.g. behind plasterboard, and could easily be damaged by drilling or nailing.

Documentation to be submitted:
Occupant introduction and user manual in PDF format

Documentation produced:
Reference to the evidence provided will be included in the final report.

4 Optional features

In the listing of renovation systems on the Component Database, the items listed below can be added as optional features. These are listed for information only and do not form part of the assessment. Products including these features should also provide details of this in the product information/publications and on the manufacturer's website.

4.1 Renewable energy systems

Products that incorporate on-site generation of electricity, e.g. PV installations, will be highlighted in the Component Database. Where included, the system should be described, including all components (panels, support structure, cables, inverter, batteries, grid connection, etc.), as well as all related services – e.g. is this offered as a package, as well as if it is to be installed, connected to the grid and also maintained over the projected service life. Full details of the system and its operation should be given in the Occupant Introduction and User Manual.

For these, additional calculation of connection point thermal bridges may be needed, or decreased thicknesses of insulation taken into account if e.g. panels are recessed.

4.2 Details of ventilation, heating and DHW compatibility

Products that are designed to be used with certain types of HVAC systems, but which do not include these components as part of their offering, will be highlighted in the Component Database. This is to ensure end users are aware of any third party equipment that must be purchased or already in place for the system to function correctly.

4.3 Step-by-step installation

Systems that are installed in one single phase and those that can be installed step-by-step, e.g. over many years, will be highlighted in the Component Database.

For the latter, full details must be given in both the Installation and Maintenance Manual and the Occupant Introduction And User Manual of the relevant parts that can be adapted or connected to in future, also of the intermediate stages, such as points to allow future installation of new windows, ventilation systems etc. All information and details must be sufficiently clear to allow future designers and craftspeople, also of third party organisations, to be able to continue the refurbishment.

4.4 Calculation and reporting of embodied energy and carbon

Products where a Lifecycle Carbon Analysis / LCA has been carried out in line with the applicable standard, to give evidence of specific embodied carbon of the product, will be highlighted in the Component Database. Doing so would serve to highlight products that not only greatly reduce operational energy demand, but are also low in embodied carbon and therefore have a low overall environmental impact.

4.5 Design and Consulting

Products will be highlighted in the Component Database that incorporate professional services such as design services, energy modelling (not only using designPH and PHPP, but also concerning national building energy performance standards and production of Energy Performance Certificates, where this is required by law), and support with funding applications in regions where financial support is available for making thermal and/or energy-related improvements to existing buildings.

4.6 Quality assurance and monitoring

Products that incorporate functional performance testing or other quality assurance services will be highlighted in the Component Database. These may include, but are not limited to airtightness testing (also via a third party), thermal imaging, ventilation system commissioning, heat pump commissioning, electrical systems testing, fire safety systems testing and also the testing of any 'smart' or automation systems, such as thermostatic control or mechanical solar shading systems. The services may also extend to monitoring over the product's projected service life to ensure this is functioning as intended, by way of temperature and humidity sensors, and also analysis of remote monitoring of electricity consumption and the usage of HVAC systems.

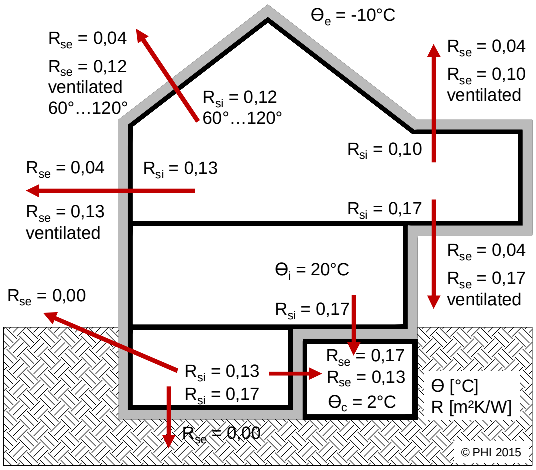
4.7 Maintenance contracts

Products where the manufacturer also offers maintenance services/contracts will be highlighted in the Component Database. This may include preventive and corrective measures to extend the lifespan of components and reduce the likelihood of major repairs being needed; repair or replacement of components that have failed or are not functioning properly, such as the replacement of ventilation filters or the cleaning of ductwork; it may even extend to dismantling and disposal of components that have reached the end of their service life or upon demolition of the building at the end of its lifetime and buy-back of useable parts.

5 Further information

5.1 Temperatures and heat transfer resistances for heat flow simulation

5.1.1 General boundary conditions



R_{si} is always set as 0.25 m²K/W for calculating the temperature factors. In the context of certification of the system, the corresponding outdoor temperatures shall be adopted for opaque building components in the case of rooms or hollow spaces outside of the thermal envelope area. The unheated basement is the only exception.

5.1.2 Selected boundary conditions for determining the hygiene and comfort criteria for transparent components (informative)

Re-gion No.	Name	Boundary condition for hygiene criterion		Hygiene criterion		Dewpoint criterion		Ambient temperature for comfort criterion [°C]	Maximum heat transmission coefficient			
		θ_a	rHi	$\theta_{Si,min}$	f_{Rsi} =0,25m²K/W	$\theta_{Si,min}$	f_{Rsi} =0,25m²K/W		Orientation	[°]	$U_{W,inst.}$	U_W
1	Arctic	-34,00	0,40	9,20	0,80	6,00	0,74	-50	vertical	90	0,45	0,40
									inclined	45	0,50	0,50
									horizontal	0	0,60	0,60
2	Cold	-16,00	0,45	11,00	0,75	7,80	0,66	-28	vertical	90	0,65	0,60
									inclined	45	0,70	0,70
									horizontal	0	0,80	0,80
3	Cool-temperate	-5	0,50	13	0,70	9	0,57	-16	vertical	90	0,85	0,80
									inclined	45	1,00	1,00
									horizontal	0	1,10	1,10
4	Warm-temperate	3,00	0,55	14,00	0,65	10,70	0,45	-9	vertical	90	1,05	1,00
									inclined	45	1,10	1,10
									horizontal	0	1,20	1,20
5	Warm	10,00	0,70	15,50	0,55	14,30	0,43	-4	vertical	90	1,25	1,20
									inclined	45	1,30	1,30
									horizontal	0	1,40	1,40
6	Hot	not relevant		not defined		not relevant		not relevant			1,25	1,20
7	Extremly hot, often humid	not relevant		not defined		not relevant		not relevant			1,05	1,00

5.2 Thermal conductivities

The U-value is calculated in accordance with general technical rules; interruptions of the insulation layers of the standard building component are included in its thermal resistance. The resulting U-value must correspond with the criterion; see Table 1.

In principle, the rated value of the thermal conductivity is taken into account when calculating the U-values. This applies unless other provisions have been made known by the Passive House Institute. The rated value (also known, in some cases, as the 'design value') can be determined in the following ways:

- Tabular values, according to ISO 10456 and, in some cases, according to ISO 10077-2
- Product standards, e.g. EN 13171 for wood fibre insulation, plus safety margin according to DIN 4108, table 2
- Technical approval of a nationally recognised testing institute (value must be designated e.g. λ_R)
- Measurement with statistical evaluation according to ISO 10456, with a minimum of 3 samples

If there is no rated value, then a nominal or declared (λ_D) value of the thermal conductivity determined by a recognised materials testing institute in accordance with the relevant norms can be used as a basis. Similarly to the rated value additions, this nominal value is normally multiplied by 1.25 and the result is used in the calculation.

Different thermal conductivities of anisotropic materials depending on the direction of heat flow shall be taken into account. For example, a factor of 2.2 shall be adopted for wood. Location specific variations due to fluctuations in humidity and temperature may also need to be taken into account for products intended for buildings in extreme climates.

5.3 Three-dimensional and point thermal bridges

If selective penetrations form part of the construction system to be certified, a distinction should be made:

Dowels, anchors, bearings or other point attachment elements occurring regularly across the area should be converted to a delta-U-value (ΔU, W/(m²K)) and added to the standard U-value, see section 7.2; this must remain below the required U-value as shown in Table 1. The reference building model should be used to determine an average U-value where the number of point thermal bridges per square metre varies. Selective thermal bridge loss coefficients are determined by means of 3-dimensional heat flow simulations; this should be discussed with PHI prior to modelling.

Reinforcements or non-repeating elements within individual panels (e.g. timber reinforcements) may be simulated in 3D and converted to the standard U-value, or simulated in 2D and included in the certification as a Psi-value. For the former, the reference building model should be used to determine an average U-value where such elements vary in size, spacing and/or orientation.

Regularly occurring projections (e.g. in the foundation or base of the wall, balcony attachments etc.) should also be determined by means of 3D heat flow simulations and should be converted to the linear thermal bridge; the equivalent Ψ-value thus calculated must remain below 0.01 W/(mK).

5.4 Calculation of fRsi

The temperature factor $f_{Rsi=0.25\,m^2K/W}$ defines the coldest point which can occur on the interior surface of a construction system. For example, if the temperature factor is 0.7, then 70% of the temperature difference between the inside and outside air is still present at the interior surface. If the temperature factor is achieved, then mould and condensation formation can be safely prevented at normal outdoor temperatures, indoor temperatures and indoor air humidity levels. The colder the outdoor climate is, the higher the requirement for the temperature factor will be.

0.25 m²K/W in the index means that the heat transfer resistance to be used is 0.25 m²K/W.

Calculation of the temperature factor f_{Rsi}: $f_{Rsi} = \frac{\theta_{si} - \theta_a}{\theta_i - \theta_a}$

with θ_{si}: minimum interior surface temperature as per multi-dimensional heat flow calculation [°C]

θ_a: outside temperature as per multi-dimensional heat flow calculation [°C]

θ_i: inside temperature as per multi-dimensional heat flow calculation [°C]

6 Services provided by the Passive House Institute

6.1 General certification services

1. Processing of the CAD drawings and preparation of the calculation models of the available details for subsequent heat flow simulations.
2. Calculation of the U-values of the standard building component assemblies.
3. Calculation of the equivalent thermal conductivities according to the methodology set out in the supplement to this document and U-values of the standard building component assemblies, thermal bridge loss coefficients, temperature factors and surface temperatures based on the submitted documents with reference to compliance with the certification criteria.
4. Additional calculation of variants for checking thermotechnical improvement or checking the creation of airtight levels in submitted connection situations. The costs for calculating variants shall be charged to the client after prior consultation.
5. Application of the values determined in 3 to a reference building energy balance model (created by PHI in designPH and/or PHPP) to confirm that the EnerPHit standard can be comfortably reached using the product in question.
6. Production of documentation of the results of the certification using isothermal images, specific value sheets and final evaluation of the construction system to be certified, in German or English.

6.2 Certificate

After a successful certification procedure, payment of annual fee and provision of a signed, stamped and dated copy of PHI's contract concerning general terms and conditions and use of the component seal, the certificate can be issued. This will be made available in digital form, to be downloaded from the PHI component database.

6.3 Inclusion in the Component Database and PHPP

Following successful certification, the product will be added to the PHI component database and the Passive House Planning Package (PHPP) database. The component will also be announced in the newsletters issued by the networks iPHA and IG Passivhaus.

6.4 Coming into force, temporary provisions, further development

The certification criteria and calculation regulations for Passive House suitable opaque building components shall become fully effective with the publication of this document. All previously published criteria shall cease to apply with the coming into force of these provisions. Previously issued certificates have the right of continuance. Old certificates may be changed upon request and applied for. Changes in layout with adaption of the Seal only will be made without charge; new calculations will incur costs. The Passive House Institute retains the right to make future changes.

7 Required connection details for the certification categories

7.1 Two-dimensional details

Two-dimensional connection details form the majority of the calculations considered in renovation system certification; the diagram below shows the standard connection details that can be considered.

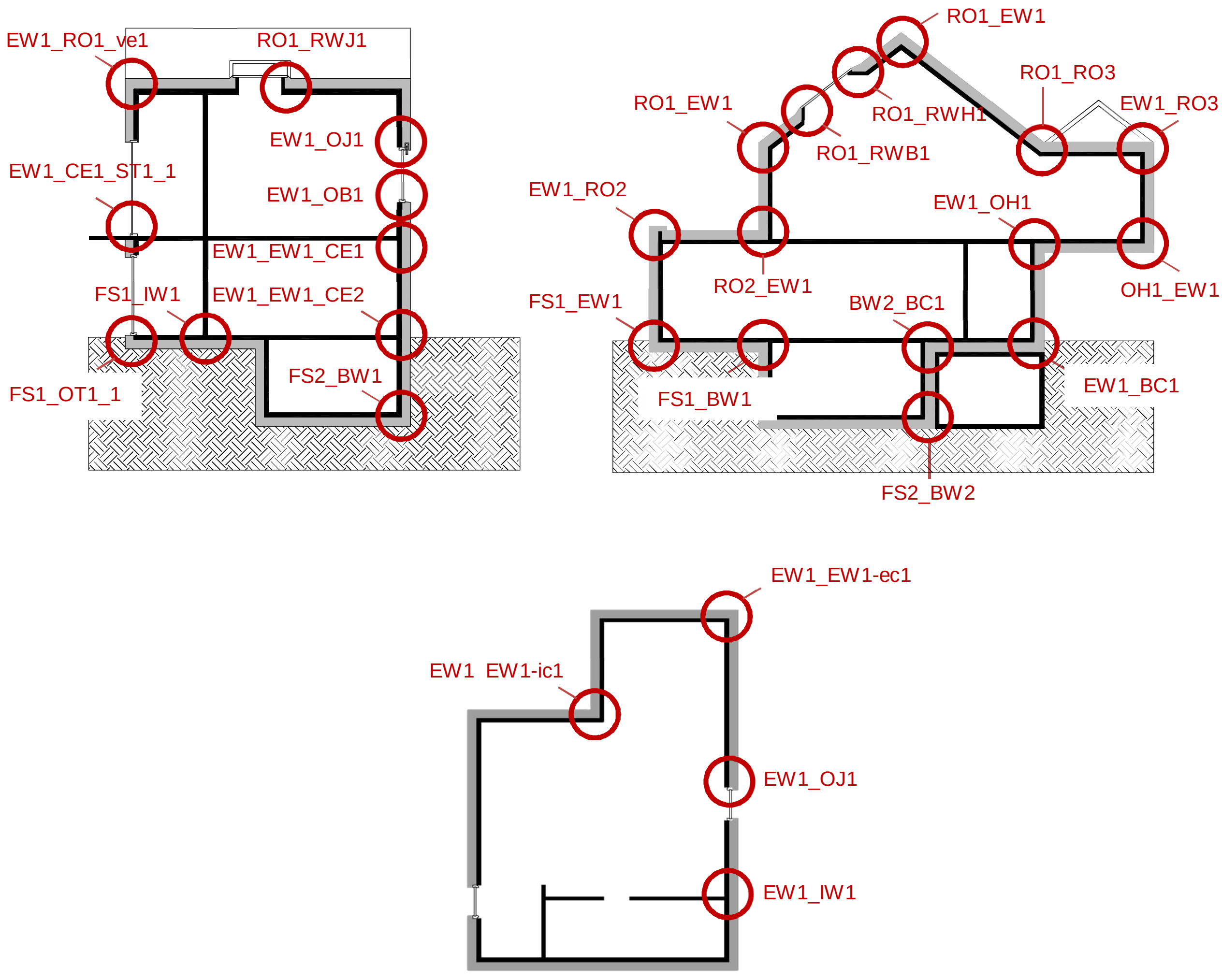


Figure 2: Required connection details

7.2 Three-dimensional details

Where three-dimensional or 'point' thermal bridges exist in the standard construction of walls, floors and roofs, these must be taken into account in the U-value calculation as a ΔU or surcharge, based on the number of elements per m² of external area[1]. Depending on the complexity, this can be done in one of two ways:

- For ETICS systems using EPS with simple façade anchors, the values established in Appendix A of the Passive House Institute publication 'Protokollband Nr. 35: Thermal Bridges and Structural Engineering – the Limits of Thermal Bridge Free Construction' may be used, as long as the design is comparable.
- Where this approach is not applicable, the χ-value [W/K] of the element must be calculated by PHI using three-dimensional FEM software in accordance with ISO 10211.

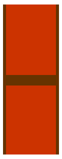
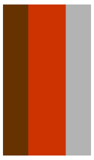
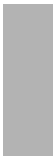
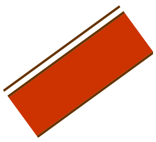
Point thermal bridges can also occur as part of two-dimensional connections, for example where roof beams continue through the external wall to the outside; such penetrations must also be modelled in three-dimensions by PHI and taken into account in the linear heat loss value. These cases should be discussed with PHI prior to certification – see also section 5.3.

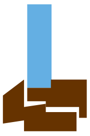
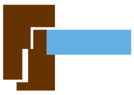
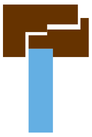
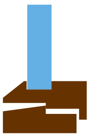
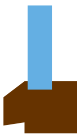
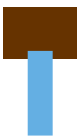
The values of components already certified by PHI can be used without the need for further analysis. Service penetrations are not taken into account in the certification, however these should be considered in the energy balance calculations of real world construction projects.

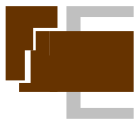
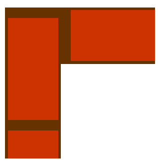
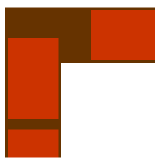
[1] This figure is to be provided by the manufacturer. Depending on the classification of the building and the climate for which the construction system is intended, the number of point thermal bridges required per square metre of external wall may vary; the most conservative figure should be used to ensure the resulting U-values are on the safe side.

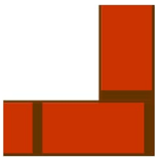
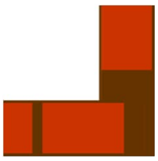
7.3 Abbreviations for building components and specification of connections

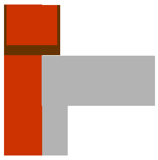
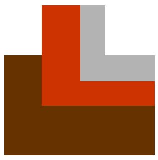
Table i: Categories and two-dimensional connection details (individual details can be left out in agreement with the PHI). Abbreviations are explained below. The connection details contained in the table are only given as examples for understanding the nomenclature. If the corresponding connection situation is not present in the table, the appropriate designation must be agreed with the PHI before certification.

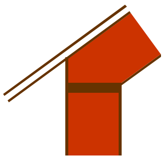
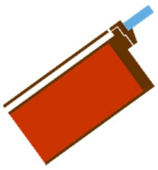
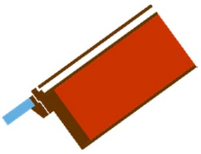
Element(s)	Image	Designation
External wall (e.g. EIFS)		EW1
External wall (e.g. lightweight timber)		EW2
Basement wall		BW1
Separating internal wall		IW1
structural internal wall		IW2
Roof		RO1
Floor slab		FS1
Basement ceiling		BC1

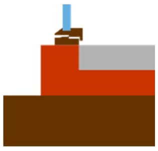
Overhang		OH1
Ceiling		CE1
Ceiling (thicker)		CE2
Window bottom (openable)		OB1
Window side (openable)		OJ1
Window top (openable)		OH1
Window threshold (openable)		OT1
Window bottom (fixed)		FB1
Window side (fixed)		FJ1
Window top (fixed)		FH1

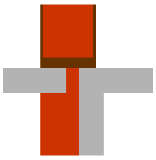
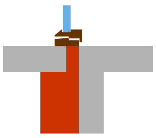
Door threshold		DT1
Door locking side		DJ1
Door hinge side		DJ2
Door top		DH1
Roof window bottom		RWB1
Roof window top		RWH1
Roof window side		RWJ1
Exterior wall exterior corner (e.g. WDVS)		EW1_EW1_ec1
Exterior wall exterior corner (e.g. lightweight timber)		EW2_EW2_ec1
Exterior wall exterior corner (e.g. lightweight timber, reinforced)		EW2_EW2_ec2

Exterior wall exterior corner (e.g. hybrid)		EW1_EW2_ec1
Exterior wall interior corner (e.g. WDVS)		EW1_EW1_ic1
Exterior wall interior corner (e.g. lightweight timber)		EW2_EW2_ic1
Exterior wall interior corner (e.g. lightweight timber, reinforced)		EW2_EW2_ic2
Exterior wall interior corner (e.g. hybrid)		EW1_EW2_ic1
Exterior wall, separating internal wall		EW1_IW1
Exterior wall, structural internal wall		EW1_IW2
Roof ridge		RO1_RO1
Ceiling connection		EW1_EW1_CE1
Ceiling connection (thicker ceiling)		EW1_EW1_CE2

Ceiling connection (hybrid)		EW1_EW2_CE1
Ceiling connection (hybrid, thicker ceiling)		EW1_EW2_CE2
Floor slab edge (with EIFS wall)		FS1_EW1
Floor slab edge (with EIFS-wall, plus insulation apron)		FS1_EW1_pv1
Floor slab edge (with EIFS-wall, plus insulation apron)		FS1_EW1_ph1
Floor slab edge (sunken slab)		FS2_EW1
Floor slab edge (with lightweight timber wall plus insulation apron)		FS1_EW2_pv1
Floor slab, separating internal wall		FS1_IW1
Floor slab, structural internal wall		FS1_IW2
Eaves		EW1_RO1_ea1

Eaves		EW2_RO1_ea1
Eaves		EW2_RO1_ea2
Eaves (attic/cold roof)		EW1_TC1_ea1
Verge		EW1_RO1_ve1
Parapet		EW1_RO1_pp1
Roof window bottom		RO1_RWB1_1
Roof window top		RO1_RWH1_1
Roof window side		RO1_RWJ1_1
Window bottom connection (openable)		EW1_OB1_1
Window bottom connection (openable, offset position)		EW1_OB1_2

Window bottom connection (fixed)		EW1_FB1_1
Window bottom connection (fixed, offset position)		EW1_FB1_2
Window bottom, floor slab		FS1_OT1_1
Window side connection (openable)		EW1_OJ1_1
Window side connection (openable, covered with insulation)		EW1_OJ1_1a
Window side connection (openable, offset position)		EW1_OJ1_2
Window side connection (openable, offset position, covered with insulation)		EW1_OJ1_2a
Window side connection (fixed)		EW1_FJ1_2
Window side connection (fixed, covered)		EW1_FJ1_2a
Window connection top (openable)		EW1_OH1_2a

Window connection top (openable, venetian blind)		EW1_OH1_2a_V1
Window connection side (openable, venetian blind)		EW1_OJ1_2a_V1
Balcony connection		EW1_EW1_CE1_BC1
Basement ceiling, balcony connection		EW1_EW2_CE1_BC1
Basement ceiling, balcony connection, window threshold		EW1_EW2_CE1_BC1 _ST1_1

OUTPHIT – DEEP RETROFITS MADE FASTER, CHEAPER AND MORE RELIABLE

outPHit pairs such approaches with the rigour of Passive House principles to make deep retrofits cost-effective, faster and more reliable. On the basis of case studies across Europe and in collaboration with a wide variety of stakeholders, outPHit is addressing barriers to the uptake of high-quality deep retrofits while facilitating the development of high performance renovation systems, tools for decision making and quality assurance safeguards.

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