Passive House Institute

version 10b of the Criteria

General Information
-
Technical Specifications
-
Example Documents

Building Certification Guide

Please note: From version 10c the Building Certification Guide is integrated into the Criteria for Buildings. It is discontinued as a separate document.

Imprint and Disclaimer

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Scope of content and exclusion of liability

This Guide is intended to supplement to the "Criteria for the Passive House, EnerPHit and PHI Low Energy Building Standards" ("Criteria") published by the Passive House Institute and posted online. It explains the Criteria's requirements given here in a brief and precise manner.

The Guide was compiled with the greatest care and to the best of our knowledge and belief. However, no liability can be accepted for any content-related shortcomings or errors. Any liability for the accuracy and completeness of the contents and data and in particular for any damage or consequences arising from the use of the information presented here is therefore excluded.

In this guide, the generic masculine is used for better readability. Female and other gender identities are explicitly included as far as they are relevant to the statement.

Welcome to the Building Certification Guide!

I am delighted that you are interested in the Passive House Institute's building certification quality assurance program. To date, thousands of builders around the world have already certified their buildings as Passive House projects or EnerPHit retrofits. Twenty years of experience shows that the high level of comfort and energy savings associated with these standards is achieved through independent quality testing.

I hope that this first edition of this guide will fully answer your questions about building certification. If you are still missing important information, please do not hesitate to contact us at:

building.certification@passiv.de

I wish you every success in your energy efficient construction or renovation project!

Zeno Bastian
Passive House Institute

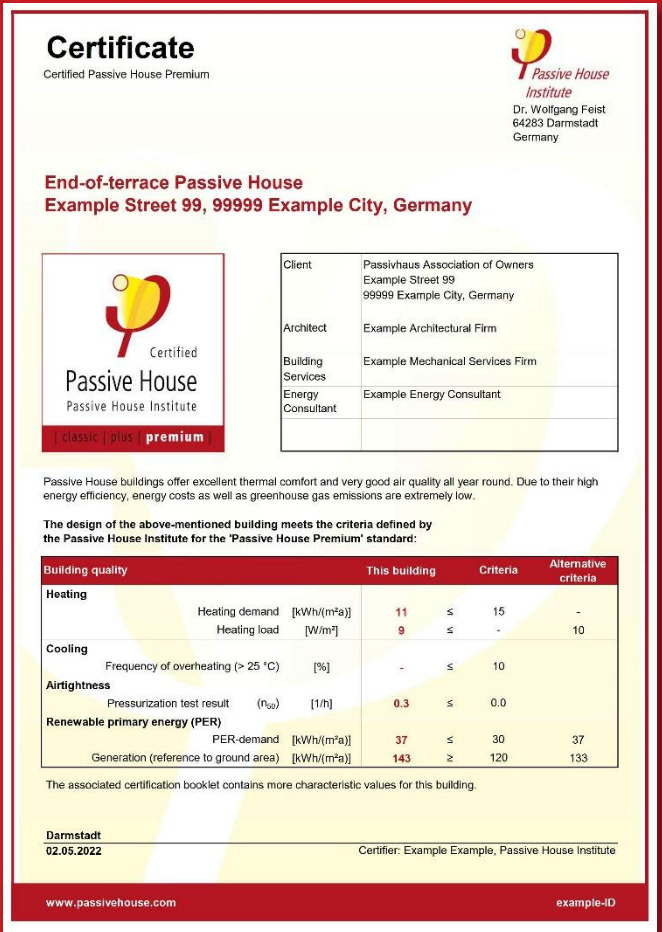
Sections one and **two** of this guide are aimed at building professionals and building owners who are interested in energy efficient construction and renovation. They present the energy standards of the Passive House Institute and explain the advantages and process of building certification.

The **third section** serves the Designers and Consultants as an aid in the certification process. It explains clearly what is meant by the precise requirements in the certification Criteria and what types of documents can be submitted as proof. However, the Guide does not replace the Criteria published on the website of the Passive House Institute. These remain the legally valid definition of the Passive House and EnerPHit Standards.

Contents

1. Introduction

Benefits of certification



Certificate

Certified Passive House Premium

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

End-of-terrace Passive House
Example Street 99, 99999 Example City, Germany

Certified Passive House Passive House Institute | classic | plus | premium |

Client	Passivhaus Association of Owners Example Street 99 99999 Example City, Germany
Architect	Example Architectural Firm
Building Services	Example Mechanical Services Firm
Energy Consultant	Example Energy Consultant

Passive House buildings offer excellent thermal comfort and very good air quality all year round. Due to their high energy efficiency, energy costs as well as greenhouse gas emissions are extremely low.

The design of the above-mentioned building meets the criteria defined by the Passive House Institute for the 'Passive House Premium' standard:

Building quality			This building		Criteria	Alternative criteria
Heating						
Heating demand		[kWh/(m²a)]	11	≤	15	-
Heating load		[W/m²]	9	≤	-	10
Cooling						
Frequency of overheating (> 25 °C)		[%]	-	≤	10	
Airtightness						
Pressurization test result	(n_{50})	[1/h]	0.3	≤	0.0	
Renewable primary energy (PER)						
PER-demand		[kWh/(m²a)]	37	≤	30	37
Generation (reference to ground area)		[kWh/(m²a)]	143	≥	120	133

The associated certification booklet contains more characteristic values for this building.

Darmstadt
02.05.2022

Certifier: Example Example, Passive House Institute

www.passivehouse.com example-ID

Quality assured!

During the building certification process, the **detailed planning** is carefully and comprehensively examined. Supporting documents from the **construction**, such as the airtightness test, complete the quality control. A certificate is only issued if the exact **Criteria** as defined are met without exception.

Advantages for the owner

- Certainty that the **agreed-upon energy standard** will actually be achieved.
- **Increase in property value** through independent quality assessment.
- The reviewed energy balance using the Passive House Planning Package (PHPP) can be submitted for various subsidy programs.

www.passivehouse-international.org → Passive House → Legislation & Funding

- The Certifier can spot energy-saving measures which would be too costly and go above and beyond what is required for the Passive House Standard. **Construction costs** can be saved this way.
- With a **plaque** on the building's facade, the high efficiency Standard can be made visible to the public.

Advantages for the Designer

- **Prevention of errors** due to thorough external checking of planning prior to the start of construction.
- Recognition as a **Certified Passive House Designer** is possible by submitting a certified building.

Energy Standards

Passive House

Solln_AWV Architektur Werkstatt Vallentin ©Jakob Kanzleiter

LCT One Dornbirn picture: Norman A. Müller

More comfort – less energy

Passive House buildings are characterised by particularly high levels of comfort with very low energy consumption. This is achieved primarily through the use of Passive House components (e.g. Passive House windows, insulation, heat recovery). From the outside, Passive House buildings do not differ from conventional buildings, because "Passive House" means a standard and not a particular type of construction.

Why Passive House?

- Excellent levels of comfort
- Consistent fresh air all throughout the building
- Structurally-sound and durable construction
- Extremely low energy costs - even with rising energy prices
- Improved indoor air quality and hygiene
- Passive House buildings are eligible for subsidies in many countries / regions

Certified
Passive House
Passive House Institute
| **classic** | plus | premium |

Frankenberg © Michael Tribus Architecture

Tochoji Temple © Miwa Mori

EnerPHit

Passive House benefits also in existing buildings

The Passive House Standard cannot always be achieved in building renovations at a reasonable cost. This is due, for example, to unavoidable thermal bridges through existing basement walls. The Passive House Institute has developed the EnerPHit standard for such buildings.

The EnerPHit seal provides the certainty that an optimum thermal protection standard has been implemented for the respective existing building. Through the use of Passive House components, EnerPHit certified buildings offer nearly all the advantages of a Passive House building to the residents - while at the same time offering optimum cost-effectiveness.

An EnerPHit retrofit includes the insulation of the floor, exterior walls and roof with Passive House insulation thicknesses, installing Passive House windows and reducing air leaks. A ventilation system with heat recovery ensures reliable fresh air. Thermal bridges are reduced to a reasonable extent.

The Passive House Institute offers the **EnerPHit Retrofit Plan** (see page 19) for staged retrofits, as well as quality assurance through a pre-certification.

PHI Low Energy building

For the difficult cases

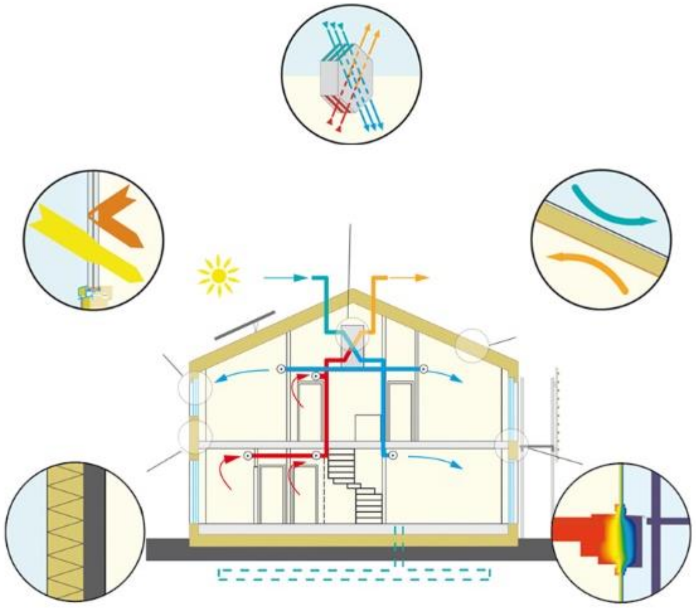
The PHI Low Energy Building Standard is suitable for buildings which, for a variety of reasons, may not quite reach the stringent Passive House Criteria:

- Small buildings in cold and shaded locations
- Countries in which suitable Passive House components are not yet fully available
- Buildings that aim for but miss the Passive House Standard due to errors in planning or execution

The requirements for energy demand, airtightness and comfort are lower than for Passive House buildings. The required documentation is the same as for the Passive House Standard, so that certification provides accurate assessment of the building's energy demand.

The Passive House, EnerPHit and Low Enegy Building Standards can be used worldwide.

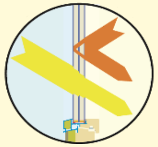
Necessary measures differ depending on the local climate. Typically, the following 5 measures lead to the Passive House.



The five key principles

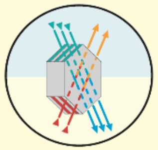
Five key principles

Passive House windows



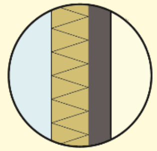
In temperate and cold climates, triple-glazing and insulated window frames ensure heat gains in winter. In warmer climates, double glazing is usually sufficient.

Adequate ventilation strategy



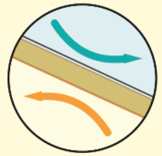
Passive House buildings are supplied with consistent fresh air via the ventilation system. The heat exchanger ensures that air is supplied to rooms at nearly the room temperature without the need for additional heating – cold and heat remain outside.

Thermal insulation



A well-insulated building keeps warmth in during winter and heat out during summer.

Airtightness

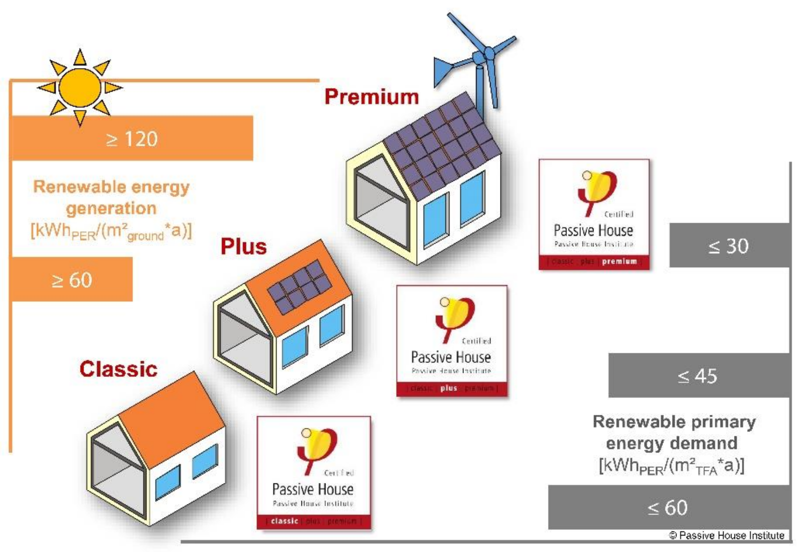


A Passive House building has a continuous airtight outer shell. This protects the building structure, prevents energy losses and improves comfort.

Thermal bridge reduced design

Especially in temperate and cold climates, Passive House buildings are planned without thermal bridges. This ensures even lower heating costs and prevents building damage.

With “Plus" and “Premium" ready for a renewable energy future



The low energy demand of Passive House buildings can be easily supplied with renewable energy.

The Passive House Institute has developed an innovative method to optimize buildings in planning for the use of renewable energy. The benchmark for this is the need for renewable primary energy or PER (see box). The lower the PER demand, the less is the effort and the space required for solar energy or wind power to supply the building. In this way, the full renewable supply can be realized cost-effectively and in a way that is environmentally friendly

In addition to the tried-and-tested Passive House Classic Standard, buildings that have a particularly low PER demand and additionally produce renewable energy (for example with photovoltaic panels on the roof) can reach Passive House Plus or even Premium. Analogously, the EnerPHit classes Classic, Plus and Premium are available for retrofits of existing buildings.

Detailed information about the PER-method and the Passive House classes: www.passipedia.org → Passive House certification → “The new Passive House Classes”

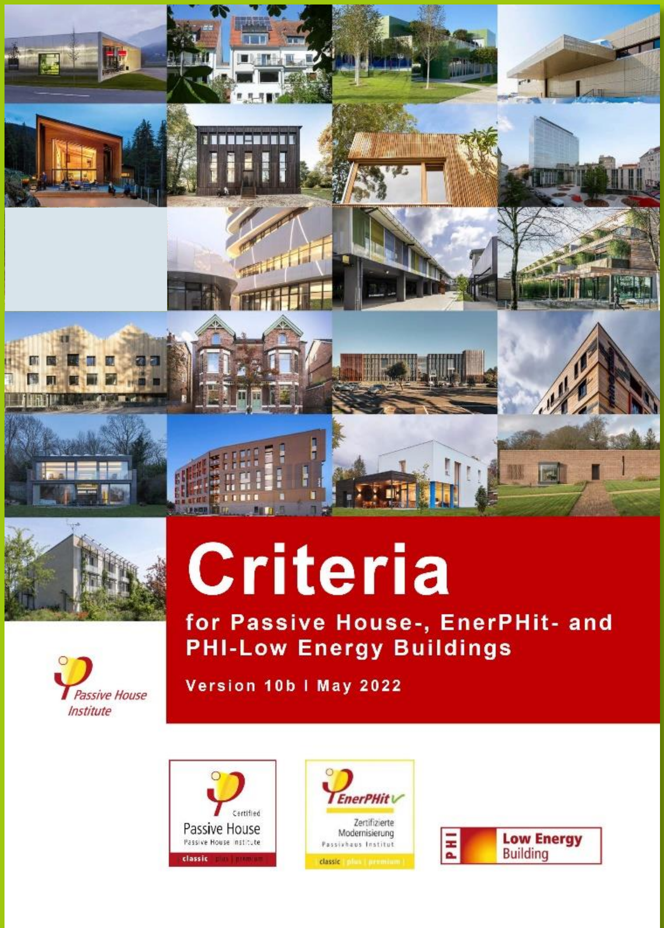
Sustainable energy supply with the PER process

The supply of renewable energy naturally varies depending on solar radiation, wind strength and precipitation. For a future supply with 100% renewable energy, some of the generated electricity must be stored temporarily. This energy storage process invariably results in losses. Particularly in seasonal long-term storage e.g. the generation of storable methane gas, only about one third of the original energy is available. The PER demand expresses how much renewable energy has to be generated originally to cover the entire energy demand of a building. It also accounts for the storage losses.

*Example***:** In regions remote from the equator electricity generated by photovoltaic is highest during summer. However, the energy demand for heating is greatest in winter. A low heating demand, as typical for Passive House buildings is therefore particularly useful in order to avoid storage losses and thus achieving a low PER demand.

2. General information regarding certification

Criteria



Transparent, clearly defined requirements

The Passive House Criteria were defined by the Passive House Institute 25 years ago. They precisely define the different requirements which a building must fulfil in order to achieve the highly efficient Passive House Standard. In addition to the Passive House Standard, the current document containing the Criteria also includes the EnerPHit Standard that was introduced in 2010 for building retrofits using Passive House components and the requirements for a PHI Low Energy Building which were introduced in 2015.

Anyone buying or commissioning a house built to one of these three standards should always expressly demand a **building in accordance with the definition set out by the Passive House Institute** – preferably with certification. This will ensure legal certainty in case of conflict.

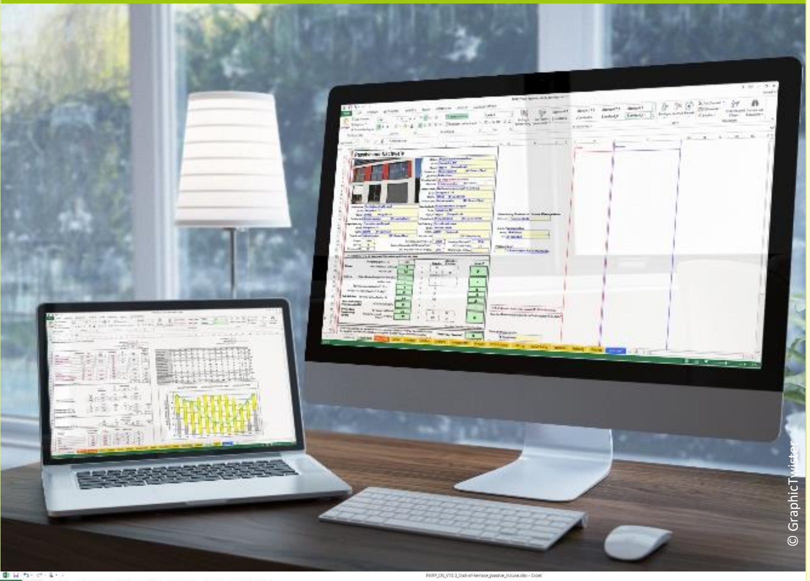
The English version of the Criteria as well as translations : www.passivehouse.com → Certification → Buildings → Energy Standards | Criteria

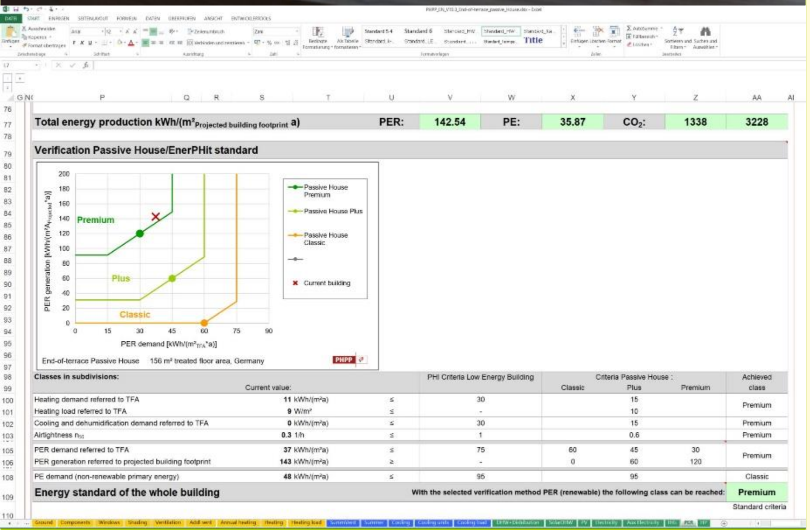
Where can I find the Criteria?

The latest version of the document "**Criteria for the Passive House, EnerPHit and PHI Low Energy Building Standard" ("Criteria")** is always available on the Passive House Institute website. The German, English and Spanish versions are published directly by the Passive House Institute. These represent the legally valid definition of the Passive House Standard.

International partners of the Passive House Institute have prepared translations of the Criteria in other languages on their own responsibility. Since the Passive House Institute does not check all these translations, they are only intended as information and in case of doubt are not legally binding. Translations may not necessarily contain the latest version of the Criteria.

In principle, certification will take place according to the currently valid version of the Criteria applicable at the start of the planning. New versions of the Criteria that are published during the course of the project do not have to be adopted.





Outline of the Criteria

The Criteria consist of two main parts besides the introduction: the actual Criteria and the "Technical regulations for building certification" as well as an appendix.

The requirements for the Passive House, EnerPHit and the PHI Low Energy Building Standards are fully specified in Section 2 **"Criteria"**. In addition, this section also contains general minimum requirements for thermal comfort, user satisfaction and structural integrity that are not energy-relevant and which apply equally for all three standards.

Furthermore, the boundary conditions which are to be applied in the PHPP for verification of the three Standards are specified here – for example with reference to the indoor temperature or the hot water demand. Section 2 can also be used as a definition of the three Standards irrespective of certification, e.g. for a building specification.

Section 3 **"Technical Regulations for Building Certification"** describes how verification of compliance with the Criteria takes place in the context of certification. Besides specifying the certification procedure, in particular it also contains a list of all the documents to be submitted to the Certifier.

Section 4 **"Appendix"** contains supplementary regulations on detailed certification issues.

Verification using the Passive House Planning Package (PHPP)

Compliance with the Criteria is verified specifically through the energy balance calculation using the PHPP. The PHPP automatically checks whether the requirements of the chosen Standard are complied with ("Verification" worksheet).

Because additions or minor adjustments are made to the Criteria from time to time, you must make sure that the Criteria are verified using the **appropriate version of the PHPP**. The version number can be found in the footer of the Criteria. The version number should match the PHPP version (number before the dot).

Can my building be certified?

Certification can be applied to a wide range of uses, e.g. residential, office/administration or schools. For special uses such as swimming pool, supermarket, hospital or other, the requirements may differ from the normal Passive House criteria and must therefore be agreed directly with the Passive House Institute.

In general, only entire buildings or annexes to existing buildings that contain at least one external wall, a roof area and a ground floor slab and/or basement ceiling can be certified. Special regulations can be found in the FAQ section (see page 62).

Passive House Certifiers

Passive House building Certifiers course

The Passive House Institute itself provides certification in Germany, Austria and internationally. In addition, there are many accredited Passive House building Certifiers globally. These are contractually authorised by the Passive House Institute to perform certification using its seal and in accordance with its standards. Most Certifiers operate mainly in their respective countries. In principle however, any Certifier may certify buildings in any other country if they know the language well and have the necessary expertise. There is no national monopoly for a specific Certifier.

The accredited Certifiers have extensive practical experience relating to Passive House buildings, supplemented by intensive two-stage training.

PASSIVE HOUSE
CERTIFIER
Passive House Institute accredited

The exact requirements for becoming a Certifier: www.passivehouse.com/training → Certificates | Exams → Building Certifier

Passive House building Certifiers meeting

First steps

Which Certifier should I choose?

Certification can be done by the Passive House Institute or one of the accredited Certifiers. A full **list of all Certifiers** with contact data can be found on the Passive House Institute's website. If possible, it is advisable to engage a Certifier in your own country as they will be more familiar with the local construction technology and statutory provisions. In principle however, Certifiers from other countries may also be engaged. The languages in which certification can be performed are stated in the list of Certifiers.

The list of accredited building Certifiers: www.passivehouse.com → Certification → Buildings → Building Certifiers

Request a quotation

If you have chosen a Certifier, you can contact hem via e-mail or telephone and request an offer for the certification of your building. The Certifier will usually ask you for the following information, on the basis of which they can calculate an offer:

- Useful area of the building
- Approximate time schedule of the construction project
- Initial energy balance with the Passive House Planning Package (if available)
- (preliminary) design plans (floor plans, cross-sections, elevations)
- Brief project description (use, construction type)
- Total construction costs
- What previous Passive House experience do the Designers (architects and building services engineers) have?
- Other special features of the project

If the quotation corresponds with your expectations, you can engage the Certifier.

How much does certification cost?

There are no centrally fixed prices for certification. Each Certifier calculates their offer so that the expected expenses for meticulous checking of the respective building are covered. In addition, a modest fee is included in this calculation which every Certifier pays to the Passive House Institute to cover expenses for the on-going support and resources that it provides to all Certifiers.

Certification procedure

Each certified building will appear on a **world map** but the precise address of the building and the owner's name is not included. The map is to be found at www.passivehouse.com → Certification → Buildings

Additionally, we recommend that you enter a more exact description of the building in the international **Passive House Database**. This database is often viewed by building owners looking for suitable Designers for their building projects using the reference projects.

Passive House Database:

www.passivhausprojekte.de

We strongly recommend that you contact the certifier at **an early stage of the planning** as the certifier can identify any problems in the construction project and can easily remedy these at this stage. However, in general, certification can also be applied for after the building has been completed.

The certification procedure typically consists of the following phases:

- **Initial check** – at the start of the project
  The Certifier will check whether the project contains special aspects and will clarify how these should be assessed in the building certification.
- **Preliminary review** – design phase
  Assessment of the concepts for the design, insulation and building services, and of the preliminary version of the PHPP calculation for consistency with the certification criteria. This kind of preliminary review makes sense particularly in the case of large projects, and if the planning team has little experience with the Passive House Standard.
- **Design stage review** – before the start of construction work
  All energy-relevant planning documents, the technical data of the construction products and the complete Passive House Planning Package (PHPP) calculation should be submitted to the certifier preferably before the start of the construction work. After a careful review and comparison with the energy balance calculation, the certifier will inform the client of any necessary corrections. If all is well, the Certifier will confirm that the envisaged energy standard will be achieved with the implementation of the planning at hand. Execution of the construction work can now begin
- **Queries regarding certification** – Continually during planning and construction
  For planning decisions which affect the energy balance, it may make sense to coordinate with the Certifier at an early stage how these decisions will be assessed in the context of certification if the Passive House designer is uncertain. This is particularly important in the case of large projects and where the Passive House designers are less experienced. Continuous communication during the course of the project outside of the actual assessment times may incur considerable time expenditure for the Certifier, therefore it is advisable to clearly state in the agreement whether this is included in the offer.


Passivhaus in Kasel, Stein Hemmes


Winter Building, Hamburg, © Jörn Hustedt

- **Final review** – after completion of the construction work
  After completion of the construction work, any changes to the planning will be updated in the final review and proof from the execution of construction work (e.g. airtightness test, documentation of flow rate adjustment of the ventilation system, construction manager's declaration) will be checked.

Checking execution of the construction work - optional
Checking execution of the construction work on site does not automatically constitute part of the certification procedure. Additional quality assurance of the construction work by the certifying authority does however make sense if the construction management does not have any experience with the construction of Passive House buildings or with EnerPHit retrofits.

Taking into account of the certification procedure in the project schedule
The Certifier needs some time for careful checking of the planning. This should be taken into account in the project schedule in order to avoid delays or implementation of the construction work before clearance by the Certifier. This applies particularly to the main review and approval after changes to the planning. The time of the airtightness test should also be carefully planned so that even though the airtight envelope of the building may be complete, it is still accessible.

Certificate
If all Criteria have been fulfilled, the building owner will receive the following:

- The Certificate
- A supplementary booklet with documentation of the energy balance calculation and all relevant characteristic values of the building
- A wall plaque (optional)

The authenticity of the certificate will be confirmed by an identification number that will be specially issued to the Certifier by the Passive House Institute for each building. This can be found in the bottom of the certificate.

Within the last several years, Passive House has rapidly increased in popularity, with several thousand units certified according to the strict criteria of the Passive House Institute.

Current information on the number of certified Passive Houses: www.passivehouse-international.org → iPHA

Consultancy services and energy balances

Specific building characteristics with reference to the treated floor area							
	Treated floor area	m²	156.0		Criteria	Alternative criteria	Fullfilled?[2]
Space heating	Heating demand	kWh/(m²a)	11	≤	15	-	Yes
	Heating load	W/m²	9	≤	-	10	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	0	≤	15		Yes
	Frequency of overheating (> 25 °C)	%	-	≤	-		-
	Frequency of excessively high humidity (> 12 g/kg)	%	0	≤	10		Yes
Airtightness	Pressurisation test result n_{50}	1/h	0.3	≤	0.6		Yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	48	≤	-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	37	≤	30	37	Yes
	Generation of renewable energy (in relation to projected	kWh/(m²a)	143	≥	120	133	

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			Passive house Premium?	Yes
Task: 1-Design	First name: Example	Surname: Example		Signature:
Certificate-ID: example-ID	Issued on: 02.05.22	City: Darmstadt		

Passive House project planning is an important part of the planning for a building. The most important tool for this purpose is the Passive House Planning Package (PHPP). An energy consultant uses PHPP to calculate the building's energy balance and annual demands.

The PHPP model shows exactly which measures will have to be planned and implemented to achieve the Passive House or EnerPHit Standard. For example, these may include the thickness of the thermal insulation and the quality of the windows and ventilation system.

The energy consultant should also make suggestions for building optimisation, e.g. for avoiding thermal bridges. The architect can then use this information in the planning. The design planning and execution planning together with the PHPP calculation are then submitted to the Certifier for checking.

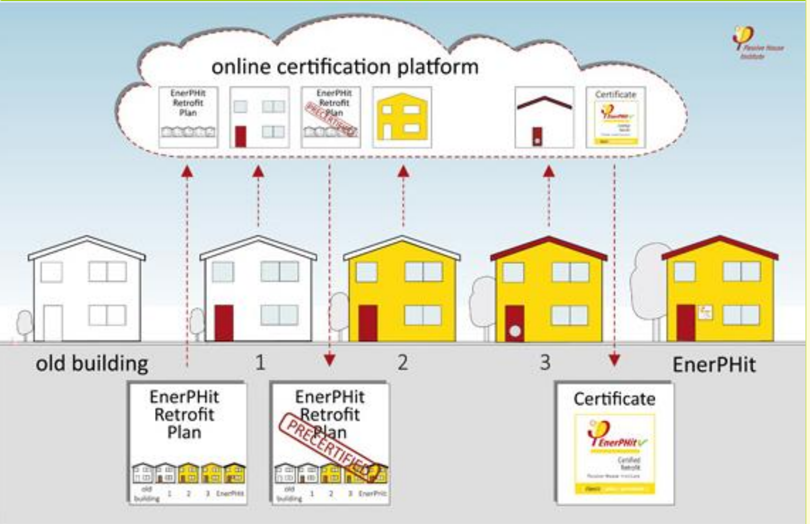
We recommend that one of the more than 7000 **Certified Passive House Designers or Consultants** should be entrusted with the Passive House project planning. They have received training concluding with an examination set by the Passive House Institute. Many Certified Passive House Designers or Consultants have specialised in the construction of Passive House buildings and have extensive practical experience in addition.

Most of the accredited Certifiers offer consultancy services and Passive House project planning with PHPP. However, in order to ensure impartial assessment, accredited Certifiers may not be Passive House Designers or Consultants at the same time for a building they certify.

The Passive House Institute offers consulting and Passive House project planning with PHPP as well as building certification.

Search for a Certified Passive House Designer or Consultant at www.passivehouse.com/training → Search for Certified Passive House Designers

Quality assurance for staged retrofits



Scheduler

EnerPHit Retrofit Plan: End-of-terrace Passive House, Example City, DE-Germany

Assemblies	Last renewal	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2016	2017	2020	2025	2026	2030	2035	2040	2045	2050	2055
Retrofit steps:															1	2		3	4		5				
Render facade	1971																	X							
Facade decoration	1966																	X							
Balconies/Loggias	1953																	X							
Exterior door	1976																	X							
Pitched roof covering	1966																	X							
Flat roof																									
Roof weatherings	1981																	X							
Window	1990																				X				
Blinds / sun screens	1990																				X				
Basement ceiling	2016															X									
Boiler	2010																		X						
Ventilation	2035																				X				
Solar thermal system	2026																		X						
Airtightn. test: X, Leakage search: (X)																		(X)			X				

Many building owners do not wish to completely modernize their building all at one time and in-stead renovate only those components of their building which are currently in need of repair. In this case it is often possible to simultaneously bring the thermal protection to a future-proof level at little extra cost using Passive House components.

You should be prepared for the current and all subsequent modernisation steps before starting. This is the only way to be sure that everything fits together and the building owner can count on having a comfortable building with low energy costs once the final step is completed.

The EnerPHit Retrofit Plan (to be found in the PHPP files) provides a methodology for this type of overall plan. For additional quality assurance, the Passive House Institute offers pre-certification as an EnerPHit (or a Passive House) project.

This requires a carefully prepared EnerPHit Retrofit Plan showing that the first retrofit step has been implemented achieving at least 20 % energy savings. The exact requirements are explained in the "Pre-certification for staged retrofits" section of the Criteria.

The pre-certificate provides building owners and planners the certainty that upon completion of all of the steps of their plan, they will achieve the standard which they are aiming to meet.

EnerPHit
Retrofit Plan
Pre-certified
Passive House Institute

Certification Platform

The Certification Platform

Passive House Certifier

1. Creates a Designer account for the project's Passive House Consultant and additional Observer accounts for other individuals involved in the project.

2. Creates a new project and customizes the checklist according to the project characteristics.

3. Reviews project documentation uploaded by the PH Consultant.

Project Design & Construction Team

1. Receives the login information via an automated email from the Certification Platform

2. Accesses the Platform

3. Starts compiling project documentation following the well-structured checklist

The Passive House Institute has created a free, interactive, comprehensive online platform for the Designer and Certifier to use for communication and checking all requirements of the Criteria and their progress towards building certification.

The goal of the online platform is to offer guidance for Designers of Passive House buildings and Certifiers throughout the certification processes. In this way, the quality assurance is set to the highest standards, optimizing the decision making process.

One of the key characteristics of the online certification platform is the capability to adapt every project type ranging from new building projects to staged retrofits. This makes it valuable for implementing quality assurance in Passive House and EnerPHit projects.

The Platform is structured to enable an interactive workflow which is supported by comments, reminders and checkboxes. It is designed to improve quality assurance and streamline the certification process.

The communication between the Project Team and the Certifier is organised around a carefully designed checklist which makes reference to all the important aspects regarding the two main focus areas: energy efficiency and quality assurance.

With a staged retrofit project, every action must be correctly scheduled and carefully recorded in order to allow and optimize future improvements. The Online Certification Platform centralises the information, allowing the team to establish the optimal retrofit steps. When the time comes for the next refurbishment step, the information regarding work already completed is available on the Platform, regardless of whether the team changes.

The Online Certification Platform is the backbone of the entire information exchange which takes place during the certification process between the Designer and the Certifier. It also creates a record of the process.

The online certification platform: certification.passivehouse.com

3. Documents to be submitted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cool, temperate climate
CERTIFIED COMPONENT
Passive House Institute

The documents that must be submitted to the Certifier are listed in the section on "**Documents to be submitted**" in the Criteria. Among other things, these include the plans for the building envelope and building services and technical data sheets for the energy-relevant products. The Certifier will check whether the submitted documents contain the information required for verification and whether they correspond with the input in the PHPP. The section order in this chapter matches the section order of the Criteria and the one of the Certification Platform.

Meticulous planning is absolutely essential for implementing high quality construction work on site to achieve Passive House buildings and EnerPHit retrofits. If planning is **meticulous**, not only success is likely, but all the documents that are necessary for certification will already be present and these will only need to be submitted to the certification platform. The Designer's work assembling and uploading the documentation will be relatively easy.

Submitting documents digitally

All documents are submitted digitally via the **Platform** – unless the Certifier has agreed otherwise. Signed hard copy documents such as the Blower-Door report may be uploaded as a scan.

Certified Passive House components

The extensive use of certified Passive House components streamlines planning and certification because independently **certified energy relevant characteristic values** for the PHPP calculation are available for these components. In principle, the installation of non-certified products is permissible; however, in this case it may be time-consuming or difficult to provide reliable proof of the characteristic values.

Certified component database:
www.passivehouse.com → component database

Plans

All plans are to be submitted in a **file format** that can be read by the Certifier, usually as a .pdf, .dwg or .dxf file. These must be to scale and must include all necessary **dimensions** for determining the relevant measurements (Treated Floor Area, envelope surface areas, junction lengths etc.). All areas of the façade, windows etc. that are entered in the PHPP must be easily identifiable in the plans. If necessary, additional markings (in colour) and labelling or position numbers should be added to the plans.

Passive House Planning Package (PHPP)

Whether a building achieves the energy standard defined by the Passive House Institute is always verified by means of an energy balance calculation using the PHPP. At the same time, the PHPP is an accurate, well organized energy efficiency **planning tool** for architects and specialised planners.

The energy demand calculated with the PHPP has been compared with the measured energy consumption for a large number of buildings – and found to be in excellent agreement. The PHPP is used worldwide and is now available in over 20 languages. As an addition to the PHPP, the 3D planning tool **designPH** facilitates design modelling and data input.

Preparing the energy balance for the building using the PHPP

We recommend that a **Certified Passive House Designer** be entrusted with the preparation of the PHPP calculation for your building. In principle however, anyone who is sufficiently qualified can prepare a PHPP calculation for certification. Participation in a **PHPP Workshop** is recommended if you do not have any experience in using the PHPP. Training as a certified Passive House Designer also includes a PHPP basic course.

Compliance with the Criteria must be verified using the **latest version** of the PHPP available when planning started. However, transferring to a newer version introduced after the planning process started is not necessary. The PHPP calculation should be submitted as an **Excel file** (not as a printout or a .pdf file).

PHPP-Workshops: www.passivhaus-planer.eu → Courses/Examinations

PHPP and **designPH** can be purchased at www.passivehouse.com → PHPP → PHPP / designPH order form

Overview of **Design tools**: www.passipedia.org → Tools / PHPP

Further **Guides and Aids** for Passive House buildings: www.passipedia.org → Guides and Aids

PHPP: Rules for certification

For certification, all PHPP worksheets that are relevant for the respective building must be filled in. PHPP worksheets with calculations that are not relevant for the building may remain empty – for example, the worksheet "Cooling units" will remain empty if the building is not actively cooled. The use of the worksheet “Ground” is optional. If it is not being filled, the PHPP will estimate the heat losses through the ground on a simplified assumption basis.

The Criteria specify **boundary conditions** for the PHPP calculation, which must be applied. As a rule, these are already pre-set in the PHPP and may not be changed without consultation with the Certifier.

If a significant **deviation** of the actual use from the **standard boundary conditions** in the PHPP is expected, a second PHPP variant with the deviating boundary conditions (e.g. expected consumption) must be calculated. This applies in particular to countries with higher electricity or hot water consumption based on experience.

Similarly, for certification, the modelling conventions described in the **PHPP Manual** must be adhered to. For example, the manual describes how the Treated Floor Area should be calculated.

Because the PHPP is an Excel file, in principle the user has the option of changing the **mathematical formulae**. This allows for greater flexibility of the calculation - for example in the case of buildings with special uses. However, this must always be agreed with the Certifier. For buildings with common uses such as residential buildings, offices, and schools, formulae generally do not need to be changed. The Certifier usually exports the values into an empty PHPP file prior to checking in order to exclude any manipulation of the formula.

This Guide provides only an overview of how the aspects that affect the energy performance of the building are accounted for in PHPP. The reader should refer to the PHPP Manual for more detailed modelling instructions.

Climate data

The climate-relevant boundary conditions play an important role for the heating and cooling demands as well as for dimensioning of the systems. Realistic results can only be calculated with the PHPP if a climate data set matching the location of the building is used.

The PHPP works with climate data sets which consist of monthly average values, supplemented with data for calculating the heating and cooling loads and the location-specific PER factors.

Permissible climate data sets

Only climate data sets which have been checked and approved by the Passive House Institute may be used for building certification. In the menu in the PHPP worksheet "Climate", these can be identified by means of a **7-digit number** before the name of the location.

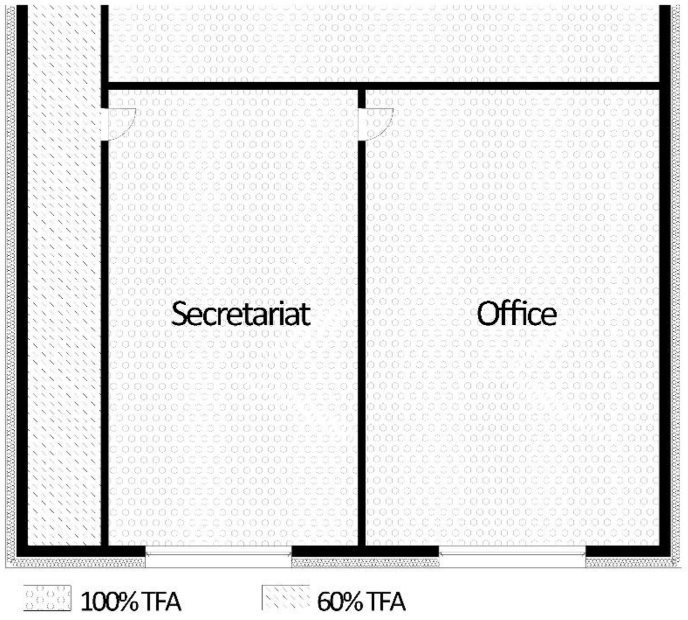
In addition, the climate data set **must match the building location**. The geographical proximity to the location naturally plays a key role. The auxiliary calculation at the top right of the "Climate" worksheet serves to assist in the selection. However, adjacent locations can have very different climates if the geographical features are different, e.g. coastal and inland areas, hilltops and valleys, cities and countryside.

Therefore we strongly recommend that the use of a climate data set should be **agreed with the Certifier at an early point in time**. If a matching climate data set is not available in the PHPP, the Certifier can commission the Passive House Institute with the preparation of a new climate data set for a fee to cover the costs.

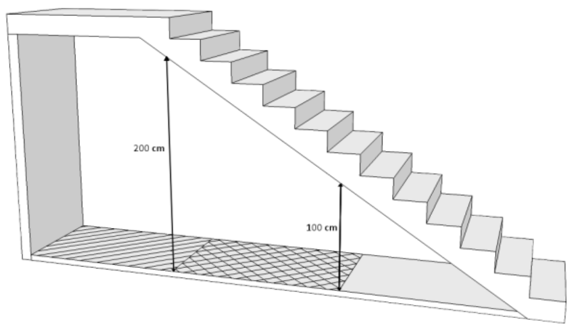
Summer temperature tool can be found at www.passipedia.org → Tools / PHPP

The purpose of this tool is to modify existing PHPP climate data for higher temperatures during summer months. The modified temperature profile can be used to test a building's summer comfort under extreme summer conditions, future climate projections or for inner city locations (urban heat island).

Architectural planning documents



Example rooms / access areas in non-residential buildings



TFA stairs

File formats and reference to the PHPP

As explained on page 22, dimensions and other values inserted in PHPP must be clearly set out in plans and other supporting documentation so the Certifier can easily and quickly find them.

In particular, plans and optional other supporting files (e.g., Excel calculators, CAD drawings, etc.) must support and calculate these three important measurements: Treated Floor Area, the volume for air leakage testing, and the volume for ventilation rates.

Treated Floor Area

The Treated Floor Area (TFA) is the **reference area** on which all the characteristic values for the energy demand in the PHPP are based. This means that the total energy demand e.g. for space heating is divided by the number of square metres of Treated Floor Area, which results in an area-specific value. In this way, identical limit values can be specified for buildings of varying sizes and it is easy to compare buildings with each other. The TFA is approximately equivalent to the gross internal floor area, the main difference being that the TFA excludes the areas occupied by internal walls.

Careful ascertainment of the TFA is absolutely essential as it is the denominator in calculating the area-specific values of the Criteria. If the Certifier calculates a smaller TFA, those area-specific values increase, and the building may not meet the Criteria or be certified.

The rules for determining TFA are described in the PHPP Manual in the section relating to the "Areas" worksheet. The calculation must be documented with dimensions and calculations for every room, either in the PHPP worksheet "Areas" or as a separate spreadsheet. The names of rooms used in this calculation sheet must correspond with the names used in the floor plans.

An article on Differentiation between Vv and Vn50 values can be found at: www.passipedia.org → Mechanical systems → Ventilation

Single Family Home TFA and Vn50 calculation - see the ‘example documents‘ section.

In the PHPP files you will find the **Room Book Tool** and the **SFH Aid Tool**. These files contain templates with auxiliary calculations for PHPP. In addition to the calculations, the files can be used as documentation.

Example plans

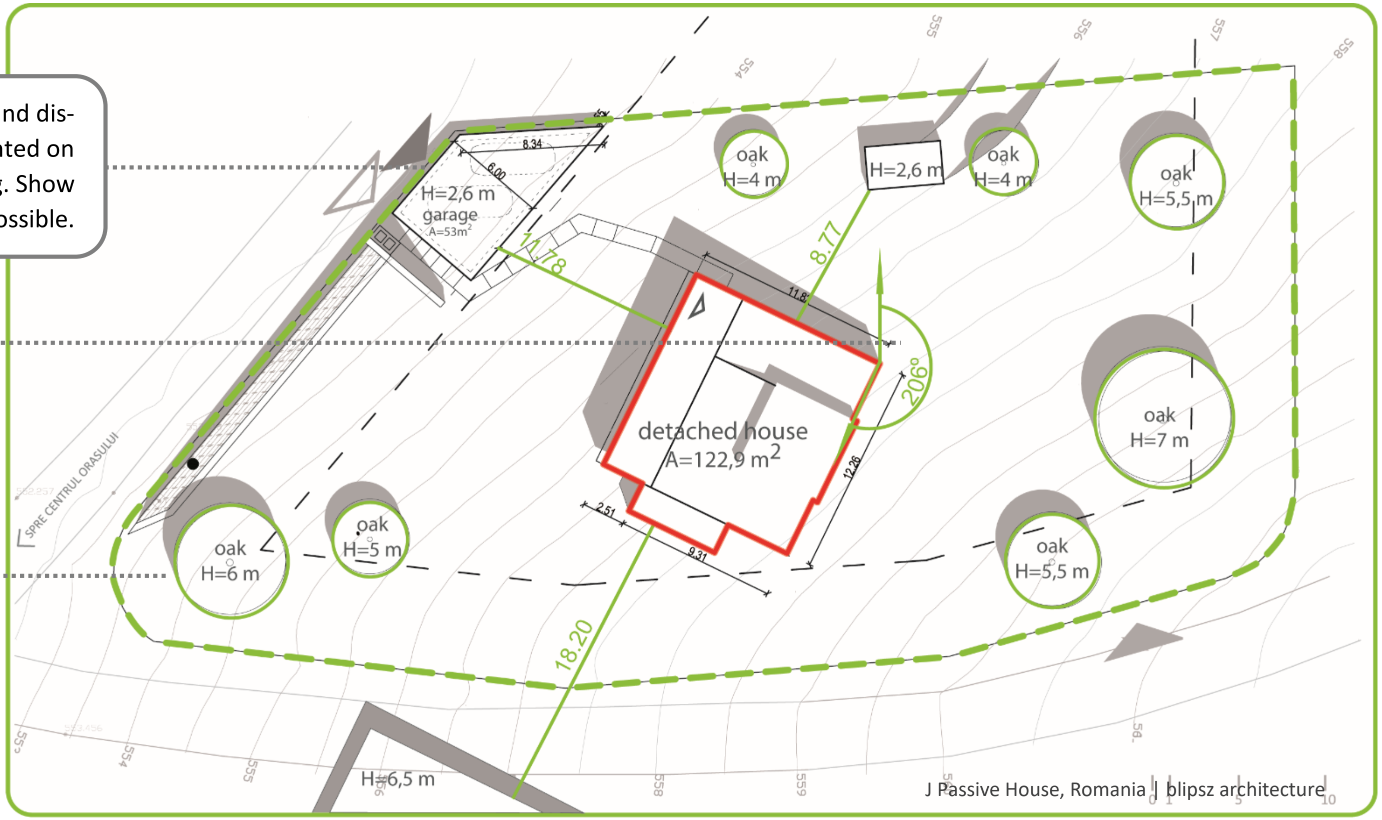
Site plan

Neighbouring buildings including their height and distance to the proposed building must be represented on the site plan if they shade the building. Show topography if possible.

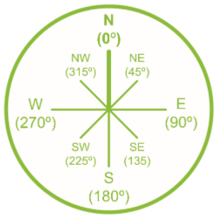
Angle of deviation from North

Neighbouring vegetation or / and any other elements which shade the building, including height and type of vegetation (e.g. coniferous or deciduous) must also be shown

Graphic identification of the building envelope intended for certification



See page 27 for acceptable file formats and general requirements



Scale:
1:200

Angle of deviation from North:
206°

Complete address:
Passive House str. 1
Passive City, 12345

Geographic coordinates:
44 °00`N, 25°30`E,

Height above the sea level:
+/-0.00=556.0m

Floor plan

Cross section

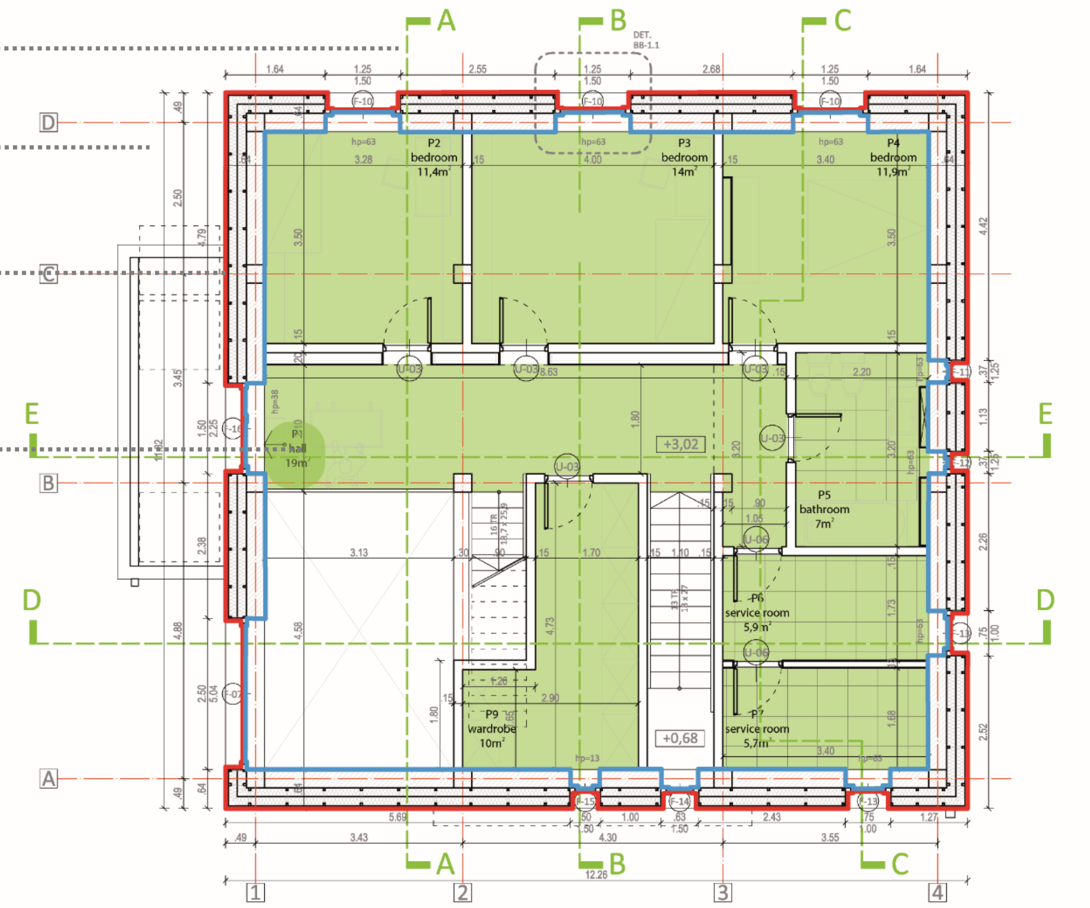
Dimensions

Clear and accurate representation of walls, windows, and doors

Graphic identification and calculation of each assigned TFA together with the surface calculated, and code names and the percentage used in the calculation

Graphic identification of areas where the room height is below 1 m or 2 m to support TFA calculation

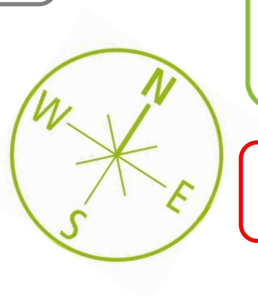
Any unconditioned (i.e. non-heated) adjacent spaces must be marked and named accordingly



J Passive House, Romania | blipsz architecture

Scale:
1:50
or
1:100

See page 27 for acceptable file formats and general requirements



Graphic identification and external dimensions of the thermal envelope

Graphic identification of the airtight layer

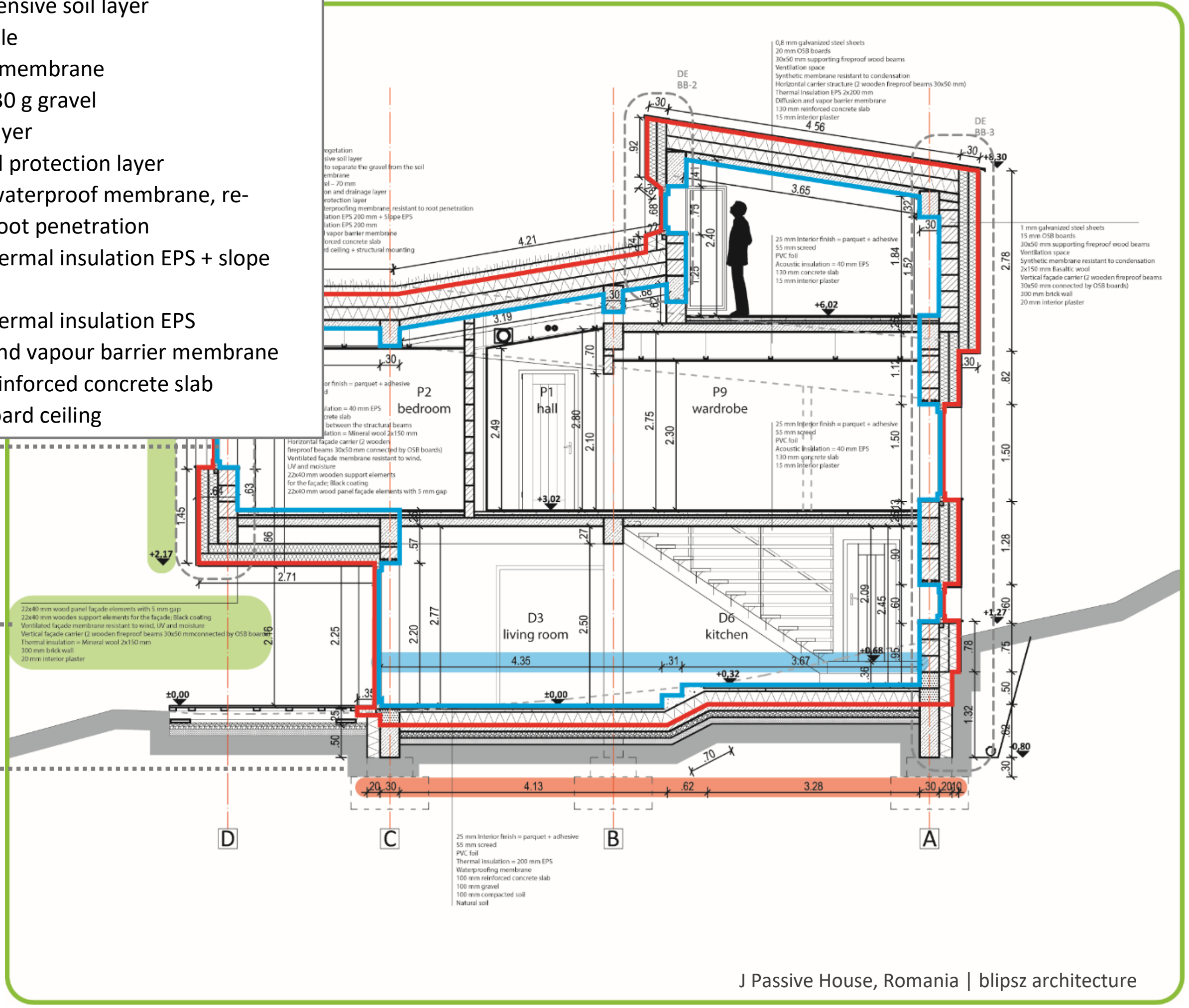
Section

Roof assembly 1 – Green roof
30 mm roof vegetation
40 mm extensive soil layer
Metal profile
Geotextile membrane
70mm 15-30 g gravel
Drainage layer
Mechanical protection layer
Synthetic waterproof membrane, resistant to root penetration
200 mm thermal insulation EPS + slope EPS
200 mm thermal insulation EPS
Diffusion and vapour barrier membrane
130 mm reinforced concrete slab
Gypsum board ceiling

Correct representation of walls, windows, doors, roofs, and floor

Description of each unique envelope assembly (including heterogeneous layers, e.g.: wood/insulation) with their features: manufacturer and product, thickness, thermal conductivity

Dimensions



J Passive House, Romania | blipsz architecture

Scale:
1:50
or
1:100

See page 27 for acceptable file formats and general requirements

Graphic identification and external dimensions of the thermal envelope

Graphic identification of the airtight layer

Elevation

Show outdoor and exhaust air vents, grid types, distance from ground

Make sure to show clearly and to name any unheated adjacent rooms accordingly

Show the different type of surfaces (e.g. cladding, stucco etc.)

Make sure to name all surfaces and windows using the same naming convention on the drawings, on the window schedule and in the PHPP

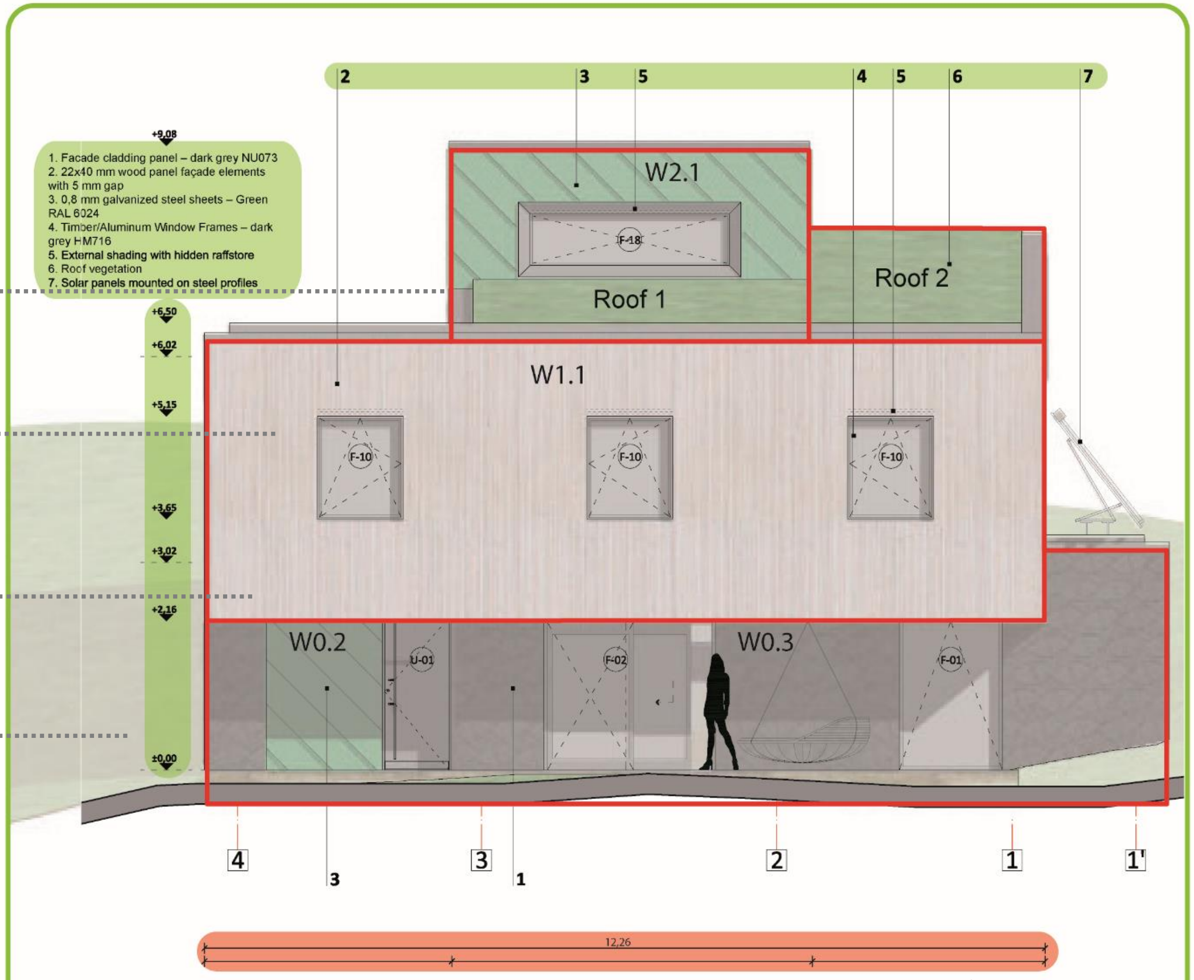
Correct representation of walls, windows, and doors

Make sure to show clearly the wall surfaces in contact with the ground as well as the ground line for semi-buried walls

Dimensions

Scale: 1:50 or 1:100

See page 27 for acceptable file formats and general requirements



J Passive House, Romania | blipsz architecture

Graphic identification and external dimensions of the thermal envelope

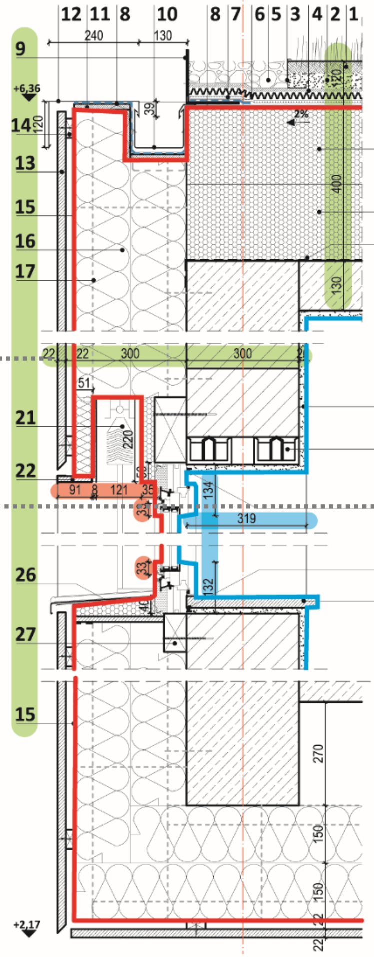
Standard and connection details

Detailed **construction drawings** should be prepared and submitted to the Certifier for **all** assemblies and connections of the building envelope. The thermal bridge details must be easily identifiable in the PHPP.

Thickness in mm of heterogeneous layers

Description of each component of the detail (incl. heterogeneous layers), product manufacturer and name, thickness [mm], thermal conductivity

For masonry/concrete materials:
a| resistance class
b| reinforcement degree
c| volume density



1. 30 mm roof vegetation
2. 40 mm extensive soil layer
3. Metal profile to separate the gravel from the soil
4. Geotextile membrane
5. 70 mm 15-30 gr gravel
6. Water retention and drainage layer
7. Mechanical protection layer
8. Synthetic waterproofing membrane, resistant to root penetration
9. Perimetral plastic profile with side penetrations for drainage
10. 13x20 cm galvanized steel rectangular gutter
11. 15 mm OSB board
12. Drip edge - galvanized steel profile
13. 22x40 mm wood panel façade elements with 5 mm gap
14. 22x40 mm wooden support elements for the façade; Black coating
15. Ventilated façade membrane resistant to wind, UV and moisture
16. 2x150 mm thermal Insulation – Basalt wool
17. Vertical façade carrier (2 wooden fireproof beams 30x50 mm connected by OSB boards)
18. Diffusion and vapor barrier membrane
19. 200 mm thermal Insulation EPS + Slope EPS
20. 200 mm thermal Insulation EPS
21. External shading with hidden raff store
22. OSB + galvanized steel profile
23. Interior plaster applied until the concrete slab level
24. Window perimeter plaster, applied on airtight tape layer
25. 30 mm wooden interior window sill
26. Aluminum exterior window sill
27. 60x100 mm window footing wooden beam
28. Prefabricated lintel

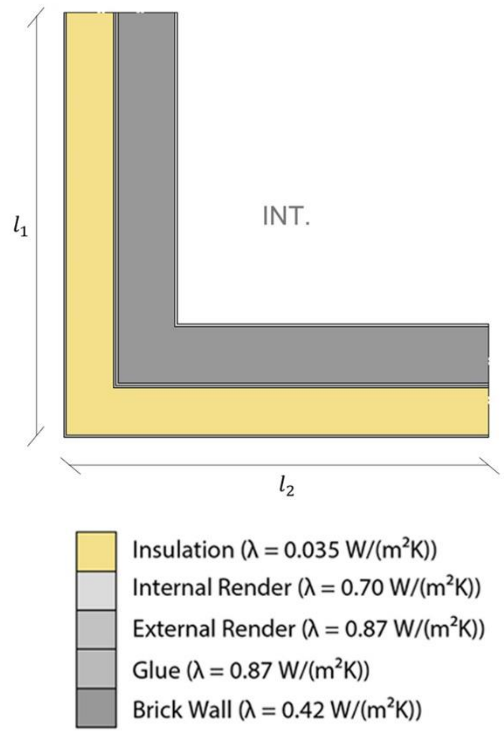
J Passive House, Romania | blipsz architecture

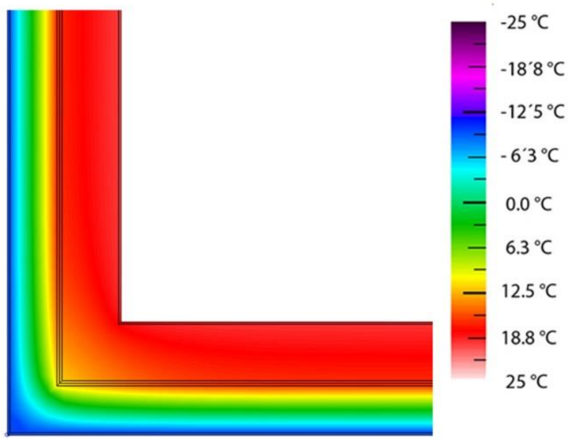
Scale:
1:5
or
1:10
or
1:20

See page 27 for acceptable file formats and general requirements

Graphic identification and external dimensions of the thermal envelope

Graphic identification of the airtight layer





Required product verification

- Manufacturer, model type and technical data sheets of **insulation materials**. Rated values of the long-term thermal conductivity according to national product standards or building authority approval are admissible.
- In hot and very hot climates: verification of the **radiation characteristics** of the surface of walls and roofs.
- **Verification of moisture characteristics** (see further below) particularly in the case of interior insulation and in hot, humid climates (if there are doubts on the part of the Certifier regarding protection against excessive moisture accumulation).

Thermal bridge calculations

Passive House buildings should be planned in a **thermal bridge free** manner as far as possible which simplifies the Passive House certification. This is the case when the insulation thickness is not reduced at the connection detail and if there are no penetrations of the insulation layer by materials with a higher thermal conductivity. If that is the case, then thermal bridge calculations will not be necessary for Passive House verification.

The use of certified Passive House construction systems with predefined connection details facilitates thermal bridge free construction.

If thermal bridges are unavoidable, then the **thermal bridge coefficient** (Ψ value) for each thermal bridge must be verified. Where possible, documented values of comparable constructions are sufficient verification. If the construction differs slightly, a moderately higher value should be used as a conservative assumption. Otherwise, a thermal bridge calculation in accordance with EN ISO 10211 will be necessary.

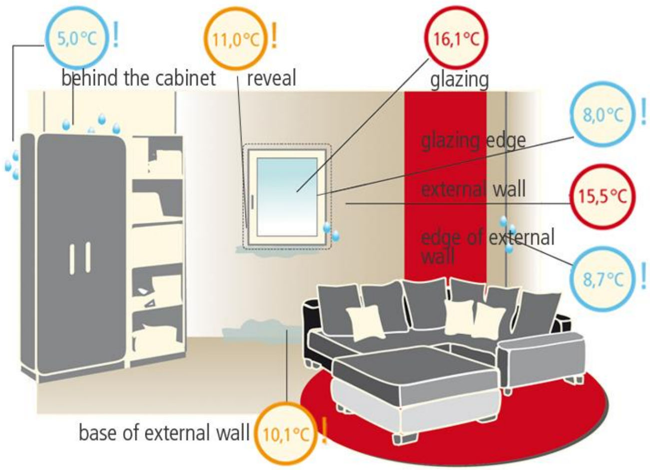
Calculated thermal bridge details for all relevant connection points are available for certified Passive House wall and construction systems and can be requested from the manufacturer. These are admissible as verification for the thermal bridge coefficient if the actual implementation corresponds with the calculated details to a large extent.

Certified wall and construction systems:
www.passivehouse.com → component database → Opaque building envelope

Documentation of a thermal bridge calculation for a connection detail adjacent to the **outside air** and to the **ground** – see the 'example documents' section.

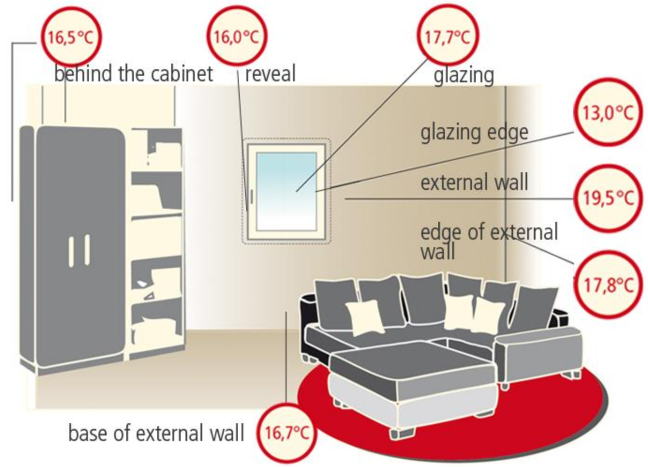
Thermal bridges catalogue can be found at:
www.passipedia.org → Basics → Building physics – basics → Thermal Bridges

Old situation: cold surfaces can lead to humidity-related damages



Conditions: external temperature -5°C | indoor temperature 20°C

New situation: refurbished with Passive House Components



Conditions: external temperature -5°C | indoor temperature 20°C

Verification of protection against moisture

For most typical Passive House constructions, proof of protection against moisture is not necessary. Verification will be required by the Certifier only in rare cases where there are doubts regarding the flawless functioning of the building component assembly.

Verification of moisture protection for interior insulation (in climates requiring heating)

In the case of interior insulation it is often difficult to provide verification of protection against moisture. A **hygrothermal simulation** is ideal for this purpose. It provides comprehensive information about the processes taking place within a building component and is therefore suitable for evaluating the functional efficiency and durability of constructions. The prerequisites for a positive evaluation of a construction in the context of building certification are fulfilled if:

- **durability** is not diminished by the insulation measure, and
- health impairment due to the measure is not likely to occur or a construction that was previously problematic is positively influenced by the interior insulation.

These Criteria will be deemed to have been met if:

- **moisture accumulation** does not occur
- the critical moisture content of the building materials is not exceeded
- the **risk of mould growth** in the building component layers of the old interior plaster, the interior insulation and the new interior surface is considered to be small.

Verification of moisture protection in other cases

Other cases in which verification of moisture protection may be required are e.g. insulation measures in hot, humid climates and certain flat roof constructions in climates requiring heating.

Windows and doors

In the PHPP, the characteristic values are calculated separately for each window element or curtain wall façade from the product data of the individual components (see following table).

Verifications which state only the characteristic values for an entire window of a standard size (U_w-value) are not enough for certification.
Besides the characteristic values of window in the façade, verification for curtain walls, entrance doors, roof windows, light domes, smoke exhaust flaps etc. are also necessary. The following remarks apply also for these products.

Overview of the window components and the characteristic values that are to be verified

	Verification required			
Component	Product	Characteristic value		Hints
Glazing	Manufacturer and product name	Thermal transmission coefficient (U_g-value)	Passive House Certificate or manufacturer's calculation in accordance with EN 673 (U_g) and EN 410 (g-value) → example verification – see the "example documents" section	To two decimal places for values below 1.0; only modelled values; not values from physical testing
		Solar energy gain coefficient (g-value)		To two decimal places
Frame	Manufacturer and product name of the frame	Thermal transmission coefficient (U_f-value)	Passive House Certificate or mathematical verification in accordance with EN ISO 10077-2 → example verification – see the "example documents" section	To two decimal places for values below 1.0; only modelled values; not values from physical testing
		Facing frame width	From the Passive House Certificate or drawings of the frame profiles	
	Manufacturer and product name of the spacer	Glazing edge thermal bridge	Suitable tabular values from PHI spacer certification, window frame Passive House Certificate (only if same combination of frame and spacer), or → example verification – see the "example documents" section → www.passivehouse.com → Component Database → Glazing edge bond	
Installation in the wall		Installation thermal bridge	Passive House Certificate (if installation situation matches), example installation situations from the PHPP User Manual or other thermal bridge catalogues (if matching) or thermal bridge calculation → example verification – see the "example documents" section	
Shading elements	Possibly manufacturer and product name	Reduction factor for temporary solar protection such as blinds or roller shutters	E.g. tabular value from PHPP User Manual, Section on "Shading; information on regulation of solar protection" (manual / automatic)	
Overall window	Window schedule from manufacturer with dimensions and product information about the frames, glazing and spacers for each different window			

Window schedule

Make sure to use the same naming convention on the drawings and in the PHPP

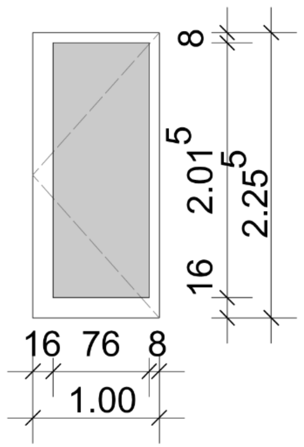
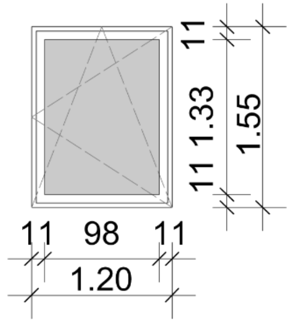
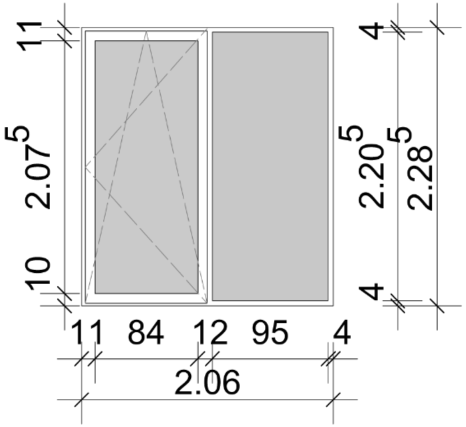
Dimensions

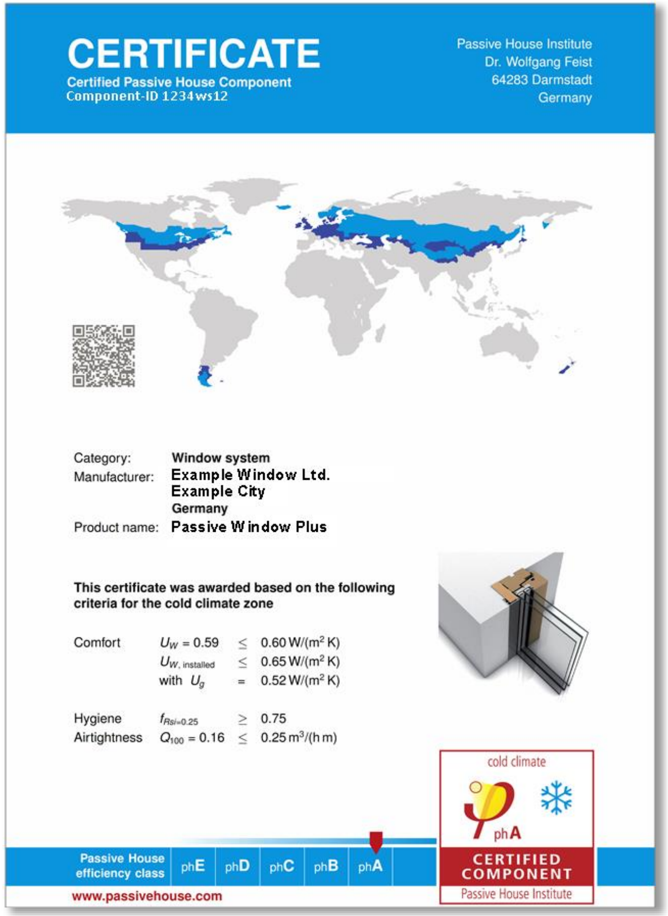
Type of glazing and frame (U-values, lambda)

Area

Materials

Scale: 1:50 or 1:100

Name	Door 1	Window 1	Window 2
Quantity	2	6	2
			
Dimensions	1 x 2.255 m	1.2 x 1.55 m	2.06 x 2.285 m
Area	2.255 m²	1.86 m²	4.707 m²
Glazing	„PH Glazing“	„PH Glazing“	„PH Glazing“
	U_g = 0.60 W/m²	U_g = 0.56 W/m²	U_g = 0.56 W/m²
	g-value= 0.55	g-value= 0.50	g-value= 0.50
Frame	„PH Frame, SWISSPACER Ultimate“	„PH Frame, SWISSPACER Ultimate“	„PH Frame, SWISSPACER Ultimate“
	U_f = 0.59 W/m²	U_f = 0.59 W/m²	U_f = 0.59 W/m²
	PU on wood	PU on wood	PU on wood
Facing frame width	L 0.16m; r 0.08m; t 0.08m; b 0.16m	L 0.11m; r 0.11m; t 0.11m; b 0.11m	L 0.11m; m 0.12m; r 0.04m; t 0.11m/0.04m; b 0.1m/0.04m
Glazing edge thermal bridge	$\Psi_{glazing\ edge}$ = 0.049 W/mK	$\Psi_{glazing\ edge}$ = 0.029 W/mK	$\Psi_{glazing\ edge}$ = 0.029 W/mK
Installation thermal bridge	$\Psi_{installation}$ = 0.02 W/mK	$\Psi_{installation}$ = 0.005 W/mK	$\Psi_{installation}$ = 0.005 W/mK



Note: Sometimes special requirements for sound insulation, safety, privacy etc. apply for specific windows. This often has a significant negative influence on the U_g and g-values. For the certification, these values must be verified for each window and used in the PHPP, already during preliminary planning.

Explanation of terms

Thermal transmission coefficient of glazing (U_g-value)

This value describes the thermal insulation effect of the glazing (without the glazing edge). The lower this value is, the lower the heat losses will be in winter and heat gain will be in summer. With values below 1.0 W/m²K, verification must always be given to two decimal places. If this is not possible, the Certifier will use a less favourable value rounding up.

Verification through:

- Passive House Certificate
- Calculation in accordance with EN 673 or ISO 15099 made available by the manufacturer

Energy transmission (g-value)

This value gives the percentage of solar radiation striking the outer surface of the window which passes into the building through the glazing and acts as a heat source (heating period) or as a heating load (cooling period) here. This is between 1 (all radiation passes through) and 0 (no radiation passes through).

Verification through:

- Passive House Certificate
- Calculation in accordance with EN 410 or ISO 15099 made available by the manufacturer

Thermal transmission of the frame (U_f-value)

This value describes the thermal insulation effect of the window frame. Only calculated values may be used for Passive House certification (not values from physical testing). In the case of plastic frames, any reinforcements that are present must be taken into account.

Verification through:

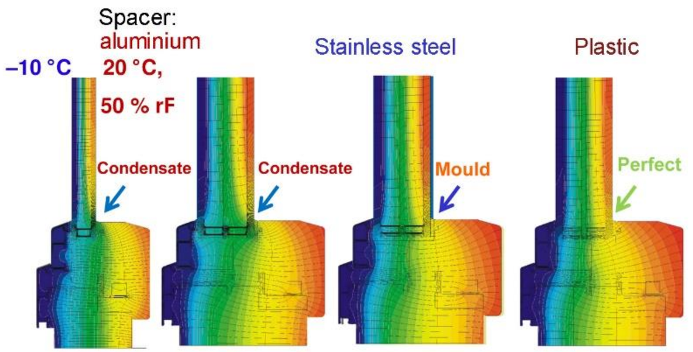
- Passive House Certificate
- Calculation in accordance EN ISO 10077-2

Glazing edge thermal bridge ($\Psi_{glazing\ edge}$)

The value for the glazing edge thermal bridge represents the additional heat losses caused by the spacer at the glazing edge. It is determined by the thermal characteristics of the particular spacer, the glazing, and the installation situation of the glazing in the frame.

Verification through:

- The glazing edge thermal bridge is stated in the certificate for the Passive House suitable window frame. If the same spacer is used as that stated in the certificate, then this value can be used for the certification.
- For certified Passive House spacers, values for the glazing edge thermal bridge are available for a large number of frame types. The values for the frame type that matches best with the frames used in the building can be used



A_W [-]	1	1	0,83	0,74
$f_{Rsi=0,25}$ [-]	0,43	0,54	0,68	0,75
$\theta_{si,min}$ [°C]	5,84	8,53	12,00	13,61
Ψ_g [W/(mK)]	0,078	0,103	0,071	0,028

Glazing edge, cool, temperate climate

Component Database:
www.passivehouse.com → Component Database

Window frames

Spacers (glazing edge bond)

Glazing

- Tabular values can be used if these are sufficiently on the safe side. Generally the glazing edge thermal bridge becomes smaller if the glass unit is thicker or if the frame covers more of the glass and if this part of the frame is insulated better. These rules can be applied to find out if the tabular value for the respective situation is justifiable
- Thermal bridge calculation for the specific combination of frame and spacer based on ISO 10077-2

Installation thermal bridge ($\Psi_{installation}$)

Additional heat losses (winter) and gains (summer) occur where the window frame connects to the wall. PHPP accounts for these as "installation thermal bridges". The installation thermal bridge is smaller if the window is installed in the insulation layer and the frame is covered with insulation on the outside.

Caution: PHPP contains an example installation thermal bridge value of 0.040 W/(mK) which can be used as a preliminary value to save time when beginning design of a building. This value is not a default value. It represents a window installation that has been reasonably thought out. Poorly detailed installations can have considerably higher psi-values. Certification requires verification of the precise installation thermal bridge psi-value.

A detailed drawing must be prepared for each different installation situation for each window side (top, bottom, sides) as well as for any implementation variants with and without shading elements etc. The distance between the outer reveal edge and the glazing edge must also be identifiable on the drawing – this is relevant for calculating the shading in the PHPP.

Verification through:

- For certification as a Passive House suitable component, installation thermal bridges are also calculated for different installation situations. These can be used if the certificate's installation detail matches that of the actual project
- Verified catalogue values (if the catalogue's installation detail matches that of the current project)
- Other example details that can be used are included in the PHPP User Manual
- If no values can be determined in any other way, then it will be necessary to calculate the installation thermal bridge for the window details that exist in the building. Simplified calculations in which the thermal conductivity of a substitute panel is determined using the window U-value and used as a substitute object in the heat flow calculation may lead to incorrect results and may only be used after consultation with the Certifier

Shading

Movable shading elements

A product data sheet should be submitted for **movable shading elements** which states the type of element, and if relevant, its geometry. There are three possibilities for verification of the shading factor:

- Standard factors from the table in the section on "Temporary solar protection" in the PHPP User Manual
- Using the values calculated by the manufacturer. In doing so, the U-value of the glazing installed in the building must not be greater than that used in the manufacturer's calculation
- Calculation according to EN 13363

Fixed shading elements

For **fixed shading elements** a detailed section drawing should be submitted stating the shading characteristics that are relevant for the PHPP. Usually this is the horizontal and vertical distance from the outermost shading edge of the element to the upper edge of the glazing.

Calculation

The results of separate programs / tools may not be used for building certification. Here, the standard shading algorithms of the PHPP must always be used.

A distinction is made between three frequently occurring shading situations:

- Shading by horizon
- Shading due to window reveal
- Shading due to cantilevered element / overhang

Please refer to the PHPP manual for more detailed information on the shading calculation.

Alternatively, the shading calculation of designPH from version 2 onwards may be used for building certification. Complex shading scenarios can be analysed precisely and exported as shading factors to the PHPP. The calculation accuracy of the analysis must be adjusted according to the complexity of the shading situation (see designPH manual).

More details about designPH at:
www.passivehouse.com → PHPP → designPH

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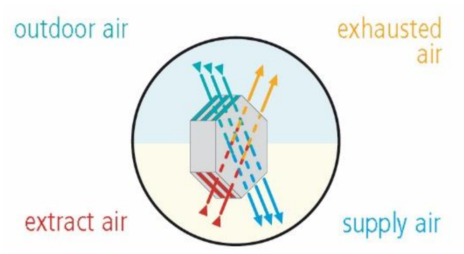
-

Ventilation

Picture: Aerex Haustechniksysteme



Ventilation heat recovery

Component database for certified ventilation systems: www.passivehouse.com → component database → Building services

In order to ensure excellent indoor air quality, Passive Houses always have a **comfort ventilation system mechanically ventilating all rooms in the building**. In most climates, a heat recovery unit ensures that the ventilation heat losses remain extremely low.

Ventilation unit

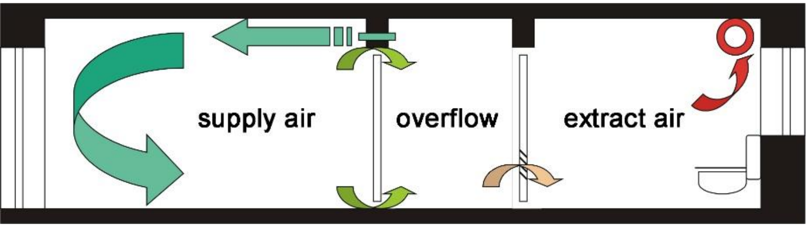
The efficiency of the ventilation system heat recovery unit plays an important role for the energy demand of a Passive House. The **heat recovery efficiency** indicates the percentage of the heat from the stale air extracted from the rooms and exhausted from the building that is transferred to the fresh air from outdoors that is supplied to rooms. Modern devices have efficiency of up to 90°% or higher so that very little heat desired in winter is lost (or undesirable heat in summer is gained.

For realistic calculation of the ventilation heat losses in the PHPP, it is essential that the heat recovery efficiency of the device used is determined by means of a test bench **measurement** of the temperatures in the two ducts connecting the device with the outside (outdoor air and exhaust air).

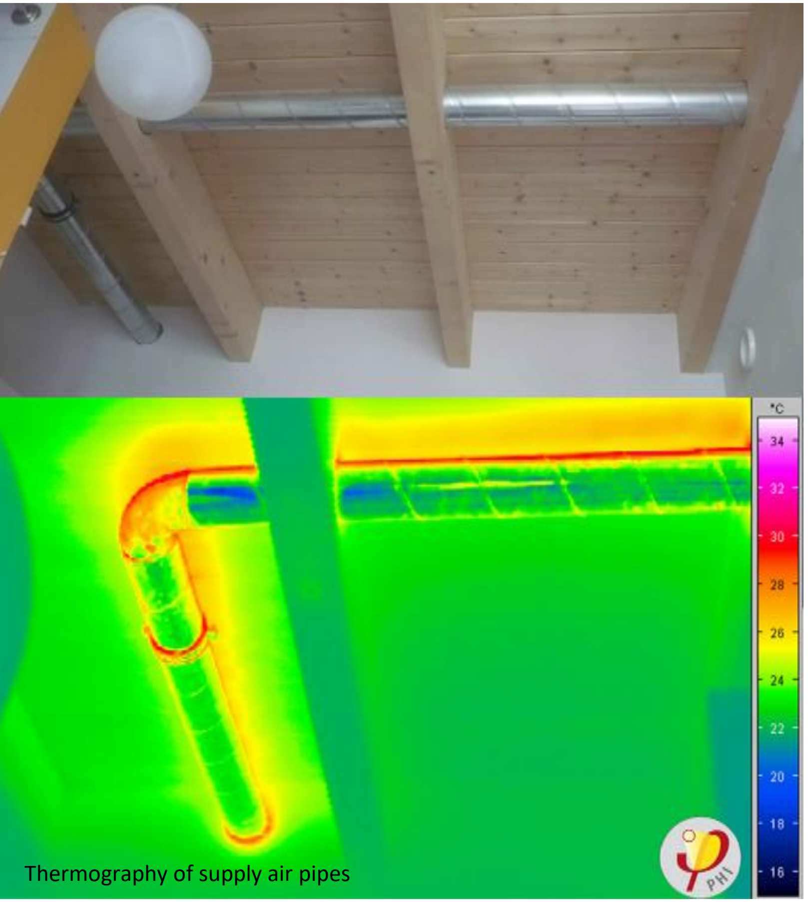
Apart from this, condensation must not form inside the heat exchanger during the measurement. In most evaluation procedures, the temperature difference is measured at the ducts on the room side (supply air and extract air). These values are unsuitable for accurate energy balances for buildings and are therefore not permissible for use in the PHPP.

For devices with a **Passive House Certificate** the efficiency values were correctly ascertained and can be used directly for the PHPP and certification, as long as the device is operated at the output range stated in the certificate.

For non-certified devices it may be difficult to determine permissible efficiency values. If so, then a safety factor may need to be applied in order to ensure the building will actually function as a Passive House. In the case of non-certified devices, the applicable heat recovery efficiency should definitely be clarified with the Certifier at an early stage. In the case of large orders, e.g. for a multi-storey building, manufacturers of ventilation units can often be convinced of the advantages of product certification.



Zoning of the comfort ventilation systems with supply and extract air and heat recovery



Thermography of supply air pipes

Secondly, the **electricity demand** of the ventilation unit in watt-hours per cubic metre of supply air should be verified. This is determined at the standard volumetric flow that is planned for the building and must include the demand for the device control unit. This value can also be taken from the Passive House Certificate. For non-certified units the values calculated by the manufacturer for the volumetric flow and pressure loss present in the respective building are acceptable.

Dimensioning the ventilation system

For certification, the Designer must submit complete dimensioning of the planned system including at least the following information:

- Dimensioning of the **total volumetric flow** and the **individual volumetric flows** at each valve and at overflow openings
- A **pressure loss calculation for the ventilation duct network** must be submitted for non-residential buildings as well as for ventilation units with an air flow rate greater than 600 m³/h in order to prove the power efficiency of the ventilation unit.

Requirements for volumetric flows specified in the Criteria:

- **Residential buildings:** Average air flow rate at least 20 m³/h per person and at least a 0.3 1/h air change rate according to the PHPP calculation. For the energy balance in the PHPP, the average air flow rate and not the maximum is relevant.
- **Non-residential buildings:** Determine the air flow rate for the specific project:
  - at least 20 m³/h per adult
  - at least 15 m³/h per child up to 12 years
  - at least 17 m³/h per child from 12 to 18 years

  Different operating times and stages should be taken into account; written confirmation by the building owner / user regarding the planned mode and schedule of operation should be submitted as verification.
- **All rooms** must be mechanically ventilated directly or indirectly (overflow).
- **Avoid dry air:** During the heating period, avoid excessively high air change rates causing relative humidity levels of less than 30% for at least one month (according to the PHPP worksheet "Ventilation").
- In order to maintain the satisfaction of the user, the ventilation volume flow rate must be adjustable for the actual demand. In residential buildings, it must be possible for the user to **regulate the volume flow** for each residential unit individually and permanently (not just as a short-term boost). Three settings are recommended: standard volume flow / standard volume flow +30 % / standard volume flow -30 %.
- The ventilation system must not cause unpleasant draughts. This is considered to be

PH Luft – Tool that aids Designers of Passive House ventilation systems: www.passipedia.org→ Tools / PHPP

Example documentation of a flow rate adjustment – see the 'example documents' section

fulfilled for supply air rooms with less than a 2 1/h air change rate if the supply air is not blown directly into the occupied zone of persons (but e.g. along the ceiling or wall). If the air change rate is more than 2 times in normal operation, a description of the measures to prevent draughts must be submitted.

Ventilation plans

Complete plan of the ventilation system must be submitted that include at a minimum the following information:

- **Ventilation ducts:**
    - position
    - length
    - cross section dimensions
    - if necessary insulation material thickness, thermal conductivity, and vapour tightness (cold air carrying ducts only)
- **Ventilation outlets:**
    - position and type of the supply and extract air outlets
    - position of the outdoor and exhaust air openings
    - air transfer openings: position and cross-section
- **Built-in parts of ducts:**
    - sound absorber: position and type
    - additional sound protection measures for the ventilation unit are necessary in the installation room if 25 db (A) in living areas or 30 db (A) in non-residential buildings or in extract air rooms in residential buildings are exceeded
    - filter: position and filter class in outdoor air and extract air ducts
    - frost protection mechanisms
    - heating coils
    - other built-in parts of ducts (fire safety dampers etc.)
- **Ground-coupled heat exchanger**
    - length
    - installation depth and method
    - material of tubes and diameter

Verification and technical data sheets of ventilation components

Besides the ventilation unit, product data sheets should also be submitted for the following components (if present):

- Frost protection mechanism (e.g. pre-heating coil)
- Post-heating coil
- Ground-coupled heat exchanger:
    - calculation of the heat recovery efficiency
    - in case of brine heat exchangers: data sheets for the pump and other components if necessary

Checklist: Ventilation system correctly installed?
www.passipedia.org → Mechanical systems → Ventilation

Documentation of flow rate adjustment

After installing the ventilation system the **air volume flow** must be adjusted at all valves to the planned levels. This is the only way to ensure that the ventilation system will work as intended and that the energy consumption corresponds with the calculations.

This procedure will be documented by the ventilation engineer in the documentation of flow rate adjustment. The values in the final PHPP version must match the documented measured standard operation volumetric flows.

The PHPP files contain a blank template for flow rate adjustment documentation, called the "**FINAL PROTOCOL WORKSHEET for Ventilation Systems**". However, other templates may also be used as long as the flow rate adjustment documentation includes at least the following information:

- Object name – description of the property
- Location/address of the building
- Name, address and signature of the tester
- Time of adjustment
- Manufacturer and model type of the ventilation system
- Adjusted volumetric flows for standard operation
- Calibration (mass or volumetric flows) of outdoor air and exhaust air (10% is the maximum allowable imbalance)
- Measuring device

It is strongly recommended that for measuring the volume flows, devices should be used which utilise the method known as zero-pressure compensation. Only in this way will it be possible to ensure reasonable accuracy of the measurement.

Most measuring devices for determining small volume flows, such as those which occur at individual supply air or extract air valves in Passive Houses, are only suitable to a limited extent as the volume flows to be measured lie in the lowest measurement range of the devices.

The measurement inaccuracy here is often much more than 10% of the measured value. In any case, it should be ensured that measuring devices are used that have a measurement range which matches the volume flow to be determined.

Documented adjustment of all supply air and extract air valves must take place.

If this is not possible technically in the case of individual non-residential buildings, then at least the volumetric flows in the ventilation unit (outdoor air / exhaust air) and in the main ducts of the ventilation system should be measured.

There are three possible methods of **calibration**:

- Recommended: measurement of the central volumetric flows at the **outdoor air intake and the exhaust air outlet** - opening must be easily accessible
- Alternative 1: the central device has a sufficiently accurate **internal volumetric flow measurement system**
- Alternative 2: calibration using the **sum of the adjusted supply air and extract air volume flows** (only suitable for systems with only a few valves)

Kitchen ventilation

In view of the higher energy efficiency requirements and comfort requirements of Passive House buildings it has become increasingly important to consider the correct planning aspects of kitchen extractor hoods in the energy balance of the building.

Kitchen Exhaust Systems for Residential Kitchens in Passive Houses can be found at www.passivehouse.com → Literature & Tools → Free literature → Research work → Ventilation

More information about energy-efficient cafeterias and commercial kitchens can be found at www.passipedia.org → Non-residential Passive House buildings

For buildings **without active cooling**, the documentation of the **summer comfort strategy** must be signed by the building owner, stating that the summer ventilation strategy given in the PHPP will and can actually be implemented.

For example, the concept of summer ventilation could be questioned if night-time window ventilation is entered for a residential building on a busy road. Due to the noise pollution, it can be assumed that the user does not want to open the windows permanently at night for night-time cooling.

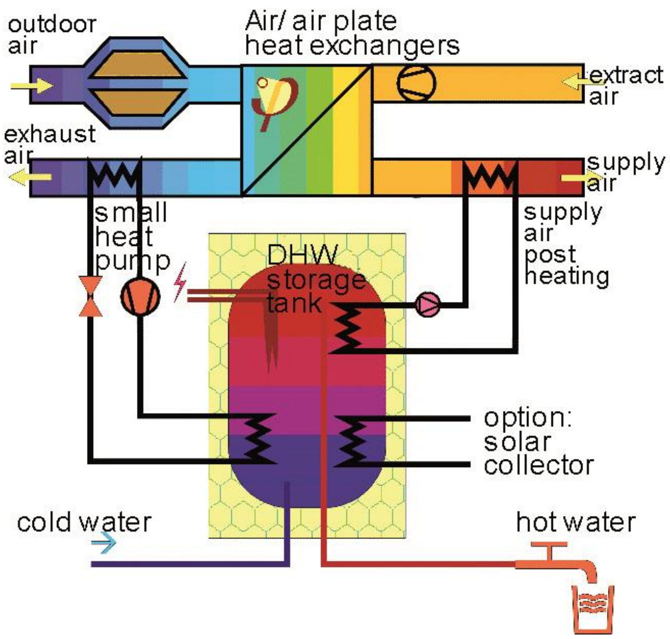
Passive House schools Riedberg / FFM

Foto: PHI

Passive House schools Riedberg / FFM

Foto: PHI

Heating and domestic hot water



Function diagram of a Passive House compact unit with exhaust air heat pump

Compact heat pump unit

The remaining, extremely small heating demand of a Passive House can be met using **simple, cost-effective technology**. Because the energy demand for hot water generation is of a scale similar to that for heating the building, attention should be given to efficient technology also for hot water generation.

Heat generators

Compact heat pump units

These devices are modelled in the PHPP "Compact" worksheet. All relevant data for **certified Passive House compact heat pump units** can be found in the certificate.

In the case of **non-certified devices**, the parameters of the integrated ventilation with heat recovery are important for adequately accurate calculation in the PHPP worksheet "Compact". Evidence of these must be provided similarly to the parameters of ventilation units (section "Ventilation Unit").

Apart from that, the values for heating capacity and efficiency (COP - coefficient of performance) for different operating points are required for assessing the heat pump. For heating operation, the heating capacity and the COP value must be known for different outdoor air temperatures (typically for -7 °C, 0 °C and +7 °C) for this purpose.

For hot water generation (heating up and reheating), the heating capacity and the COP value for an outdoor air temperature of 20°C must also be known in addition in order to be able to assess hot water operation in the summer. Measured values for at least three operating points and for hot water at 20°C outdoor temperature must be provided. It is desirable to have values that have been measured by an independent test laboratory.

Certified heat pump compact units:
www.passivehouse.com → component database → Building services

Heat pumps

Space heating with heat pumps

Heat pumps are modelled in the PHPP worksheet "HP". For a sufficiently accurate calculation, values for the performance and efficiency (COP - coefficient of performance) of the heat pump for different heat source (outdoor air, ground, water) and heat sink (hot water) temperatures are required. Measured values must be available for at least three testing points. It would be desirable to have values that have been measured by an independent test laboratory; however, data from the manufacturer's product data sheet is also admissible.

Hot water generation with heat pumps

For heat pumps that utilise indoor air as a heat source, the actual efficiency in climates requiring heating depends on the type of space heating being used (heat pump, gas boiler etc.).

Note regarding air-to-air heat pumps for heating systems and stand-alone heat pump water heaters:

Often, the technical data of the heat pump is not available in the form required for input into the PHPP calculation. In such cases, as a makeshift solution the necessary input values can be determined using a simplified estimate from the available manufacturer's data.

For further information please get in contact with the building Certifier of the project.

Borehole heat exchangers and ground collectors

If a ground source heat pump is used (vertical or horizontal loops) the PHPP worksheet "HP Ground" must also be completed. The **design documents** prepared by the engineer or the contracting company should be submitted. At least the length and number of borehole heat exchangers must be evident from this. The pre-set values may be used for the other entries in the "HP Ground" worksheet. For more accurate calculation, project specific values may also be entered for the other input if these are evident in the submitted configuration planning as well.

Verification is also required for the **soil type** selected in the PHPP, e.g. from national guidelines on utilisation of geothermal energy.

Boiler

The PHPP worksheet "Boiler" provides the calculation of the boiler efficiency and the final energy demand with **standard values** for certain boiler types. Alternatively user-defined inputs can be used. A product data sheet for the boiler should be submitted in both cases. For the user-defined calculation, all parameters entered in the PHPP must be apparent from this data sheet.

District heating

The primary energy factor is calculated in the PHPP worksheet "District heating".

If the primary energy verification for the building is carried out according to the **PER method**, we recommend ticking the reference district heating in the "District heating" sheet. A mix of renewable energy sources is then used for the calculation, as can be expected in district heating systems supplied with renewable energy in the long term. Further input or verification is therefore not required.

A detailed calculation is also possible in principle, but the required input data is usually not available in full.

If the requirement for the **primary energy demand** is to be met according to the conventional **PE method**, then evidence of the PE factors for the used heat source must be provided.

- As a rule, one of the power plants specified in the PHPP must be used.
- If the heat generator is not included in the PHPP, the PE factor from a certificate of the grid operator issued by an independent third party may be used.
- PE factors below 0.3 from (PHPP) calculations or certificates must be replaced by the factor 0.3.
- If no information on the district heating network is available, the PE factor 1.5 must be used.

The **utilisation factor of the district heating transfer** station should be verified with the relevant product data sheet that should be made available by the building services engineer (typical values are between 90% and 95%). If no data is available, the table values from the PHPP manual may be used.

Solar thermal collectors

Solar thermal collectors are modelled in the "SolarDHW" worksheet (other calculation software is not permitted for certification). The characteristic values should be verified using the relevant product data sheet or test report. If no data is available it is permitted to use the **standard characteristic values** given in the PHPP for one of the three types: flat collector, improved flat collector or vacuum tube collector.

Solar energy storage: see section "Hot water storage tank" (further on this page).

Wood stoves

Wood stoves in passive houses must always be operated independently of the indoor air. In addition, safety mechanisms that may be necessary for any malfunctioning of the ventilation system are required.

> Additional information about wood stoves:
> www.passipedia.org → Planning and Building a Passive House → Building services → Heating and DHW

Storage and distribution

The following aspects are entered in the "DHW+Distribution" worksheet.

Pipes

Building services plans should be submitted that provide the following information for all space **heating distribution pipes**, as well as for **hot water circulation pipes** and **distribution pipes**:

- Position
- Length
- Nominal width of pipe
- Thermal insulation: type, thickness and thermal conductivity

Thermal bridge free installation particularly of hot water pipes has a big influence on the energy demand. In the PHPP worksheet "DHW+Distribution", if 'moderate' or 'good' is selected under 'insulation quality of fittings, pipe fasteners etc.' then evidence of the corresponding implemented quality should be provided by means of example photographs. The measures required for this are described in the PHPP User Manual.

Pumps

The **standard values** given in the PHPP may be used for the **electricity demand** of the heating circulation pump and for the hot water circulation and storage tank charging pump. If lower values are to be used, then verification of the power consumption should be provided by means of the appropriate product data sheets.

Hot water storage tank

A product data sheet containing the **heat loss rate** in W/K should be provided for the hot water storage tank. If only information relating to the EU efficiency class is available, then as an alternative the heat loss rate can be calculated using an auxiliary calculation in the PHPP worksheet "DHW+Distribution". For performance ratings outside the European Union, consult with your Certifier. For solar storage tanks, in addition to information about the **storage tank volume** in litres the **standby proportion** as a percentage should also be included in the data sheet.

Heat recovery from shower waste water

If heat recovery from the draining shower water takes place, then for **certified devices** this can be taken into account simply by selecting the appropriate component.

Non-certified devices can also be taken into account. The following assessment without more exact verification will be accepted for this: efficiencies which are measured in accordance with NEN 7120 (Dutch KIWA certificate), CAPE/RECADO-PQE (French measurement in accordance with CSTB, measured value for hot and cold water connection) or CSA B55 (Canadian test standard) are entered as steady-state efficiencies. The effective dead time of 10 seconds per litre of fresh water content of the device can be assumed.

> Certified drain water heat recovery systems:
> www.passivehouse.com → component database → Building services

Waste water pipes (and rainwater downpipe within the envelope)

Externally vented pipes that travel vertically through the building contribute to heat loss through the stack effect that occurs when the temperature of the air in the ground pipe is higher than external air.

To avoid the stack effect, if possible, waste water downpipes within the building envelope should be equipped with a pipe air admittance valve aerator instead of a roof vent.

To mitigate positive pressure build-up, some jurisdictions require that the piping system still retain one pipe vented to the outside. In such cases, the main ground pipe may be vented to the outside prior to entering the building. Similarly, rain water downpipes within the thermal envelope should have a P-trap installed near the top of the pipe.

If this one or more of these solutions are not possible or permitted, or in the case of rainwater downpipes on the inside, the additional heat losses must be taken into account in the PHPP (see PHPP User Manual, worksheet "Areas").

In such cases, it is recommend to insulate the entire vertical network of pipes with 50 mm insulation. The position, length, type of venting, of the pipes and the type, thickness and thermal conductivity of the pipe insulation must be recognisable in the submitted technology planning.

Hot water demand

The hot water demand for **residential buildings** is specified as 25 l per person and day (translated to a water temperature of 60°C). This standard value must not be deviated from. Water saving fittings for residential buildings cannot be taken into account at present.

For **non-residential buildings** the hot water demand in the PHPP should be calculated specifically for the respective building. For typical office use, a demand of 3 l/(P*d) can be set if detailed calculations are not undertaken.

Cooling

Rocking Horse Kindergarten, Aberdeen Scotland

Picture: Mirko Hertel Fotografie, Labor, Nossen

Passive cooling measures such as shading elements and night-time ventilation are adequate for many Passive House buildings in the summer.

Depending on the climate, building, and usage, additional **active cooling** measures and equipment may be necessary. In this case, limits on useful energy demand for cooling and dehumidification apply, and the numerical value for those limits depends on the climate, the internal heat and moisture loads and (in the case of non-residential buildings) the air change rate. The requirements for a specific application are given in the "Verification" worksheet in the PHPP.

Complete construction plans of the cooling system will be required for the certification.

Documentation of the **mode of operation** including the following information:

- Operating times
- Fan continuously on, even if compressor is off?
- Relation of recirculation air volume flow and cooling power
- Is there a dehumidification mode? How is it operated?
- Is there a post-heating system for dehumidification? With what capacity and how is it operated?

Furthermore, verification of the efficiency of the specified **cooling devices** must be submitted.

- Manufacturer
- Type
- Product data sheets
- Proof of electricity demand

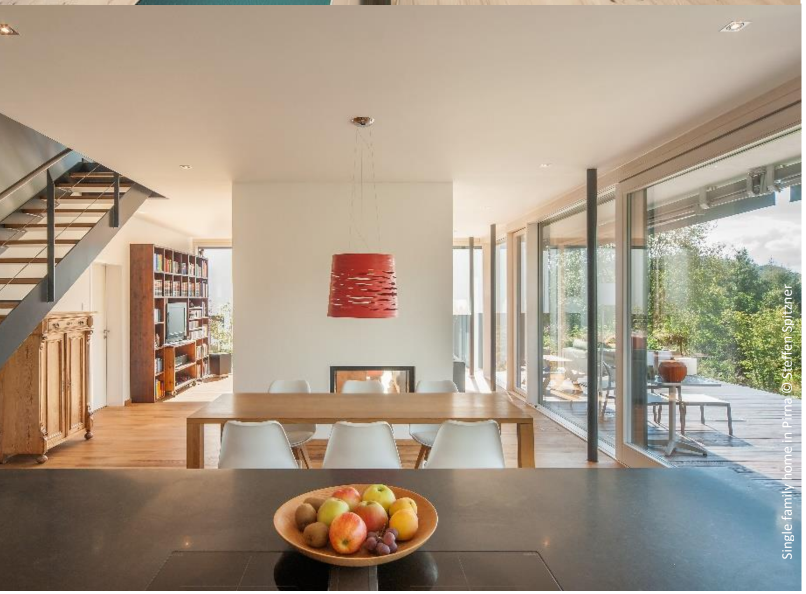
For passive house certified cooling units, the characteristic values defined in the PHPP can be used. For non-certified units, the characteristics of the units must always be verified using the manufacturer's data sheets.

For all types of cooling, the performance and efficiency at different temperature differences between inside and outside are required. If available, it must also be stated when the unit starts cycling and what the partial load coefficient Cc is (cf. PHPP manual).

For **Split devices** (ducted and unducted): the recirculation air volume flow of the indoor part is also required.

With free cooling, for instance through borehole heat exchangers in cool, temperate climates, the pump power consumption must be


LCT One Dornbirn Picture: Norman A. Müller


Single family home in Pirna © Steffen Spitzner

verified and taken into account in the PHPP calculation.

Separate dehumidifier: Information regarding the efficiency at 26.7°C and 60°% air humidity, as is common in the USA can be used directly after conversion from l/kWh into kWh/kWh (multiplied by 0.7 kWh/l). European data is often based on 30°C/80°% and is therefore unsuitable; such values can be converted to common boundary conditions by division by a factor of 1.4.

The Certifier will require further documentation proving that the **cooling and dehumidification load** calculated in PHPP can be covered by the existing building services. If the cooling and dehumidification modes are not separate, it will also be checked whether the **sensible heat ratio** (SHR) of the installed units is sufficient for dehumidification in general.

Cooling distribution

Losses from any cooling distribution system will only occur if pipes lie outside of the thermal envelope of the building, or if pipe networks on the inside are operated in the warm season even when cooling is not necessary. In this case **building services plans** should be submitted showing the following information for all **cooling distribution pipes**:

- Position
- Length
- Nominal width of the pipe
- Thermal insulation: type, thickness and thermal conductivity
- Design forward flow temperature (i.e. distribution supply temperature)

Refrigerant pipes of split devices that are inside the building are not taken into account in the PHPP, therefore verification does not have to be submitted for this.

Electrical appliances and lighting

Single family home in Pirna © Steffen Spitzner

Bonifatius-School Frankfurt am Main

Because heating and cooling demands are very small for Passive House buildings and EnerPHit retrofits, the energy demand for other purposes is a larger percentage of the total primary energy demand. Therefore, **efficient use of electricity** is even more important.

Balance boundary

In the PHPP only the electricity consumption that occurs **within the heated building envelope** is considered. This corresponds to the balance boundary, which also applies for all other characteristic values of the energy balance. The lighting for the underground car park or the circulating pump for the pool in the garden thus will not be taken into account. There are exceptions to this rule for appliances which are commonly located both inside and outside of the heated envelope. For example, energy demand of washing machines must also be taken into account even if they are located outside of the heated building envelope in the unheated basement. The exact rules are described in the Criteria in the section on "Boundary conditions for the PHPP calculation".

Residential buildings

For residential buildings, the **standard values** pre-set in the "Electricity" sheet may be used. Verification of the characteristic values of individual devices is not necessary.

Note: the example PHPP calculation in the files that come with the PHPP contains lower characteristic values for household appliances. These may not be used as standard values!

If appliances that are more efficient than those specified are used in the building, device specific values can be entered in PHPP. In this case, provide the appropriate data sheets showing their standard electricity consumption to the Certifier.

Non-residential buildings

In contrast with residential buildings, there are no standard values for the electricity demand for non-residential buildings, therefore **individual verification** is always necessary in the PHPP worksheet "Electricity non-res".

Frankenberg School, Michael Tribus Architecture

Single family home Entenmann in Korb, Martin Wamsler

A tool for calculating the electricity demand for elevators:
www.passipedia.org →Tools / PHPP

Lighting

If detailed planning for lighting is not available, then a value for the installed lighting and the full load hours will be calculated in the PHPP based on the usage profile in the worksheet "Use non-res". Alternatively, user-defined values can be used if these can be verified with the appropriate lighting planning.

Office applications

All applications with a significant electricity demand such as PCs with monitors, photocopiers, printers, servers etc. must be taken into account in the PHPP. Data sheets should be submitted which show the **power consumption** in the normal and energy-saving (standby) modes.

Kitchen

As a rule, **standard values** for the energy demand per warm meal can be used for cooking and washing. Separate verification for cooking equipment will not be necessary in this case.

Alternatively, **detailed verification** can be provided with which lower characteristic values can be achieved, in which case technical data sheets should be submitted showing the consumption information of the cooking and dishwashing appliances.

For refrigerators and freezers, and for other relevant appliances which are not directly used for preparing meals, separate verification of the electricity demand is always necessary because these are not included in the standard value.

Other electricity demands

Many elements that impact the electricity demand of the building are not considered in assessment of standard buildings (e.g. for building code compliance) and are, consequently, often ignored. Examples include elevators, domestic cold water pumps, extract fans in auxiliary rooms (garbage rooms, elevator machine rooms).

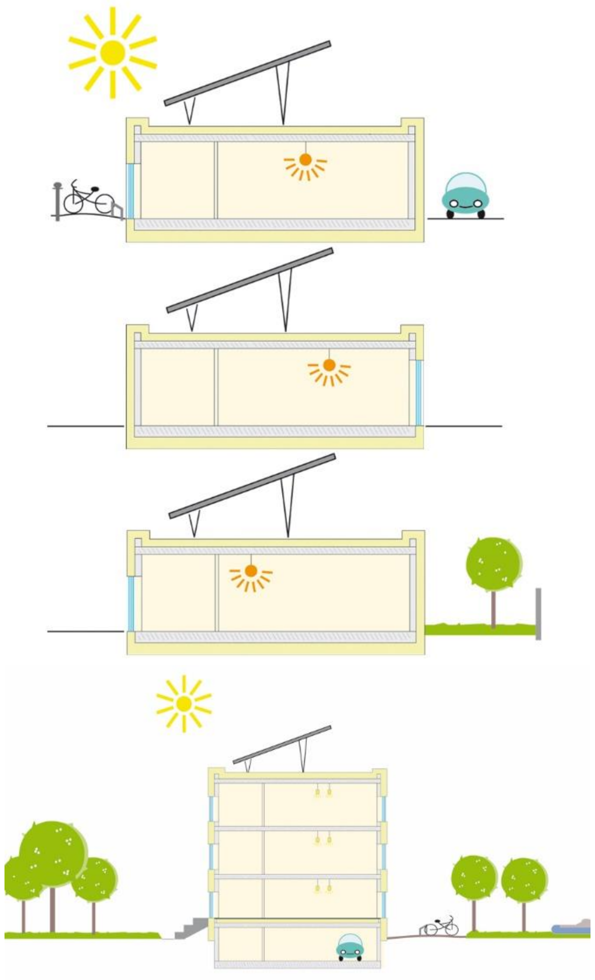
The Project Team should work with the appointed Certifier early in the design process to identify these elements and agree how they should be assessed.

Appropriate data sheets verifying the characteristic values entered in the PHPP should be submitted for all these electricity loads with significant demands.

Usage profile

The usage profiles used in the PHPP ("Use non-res" worksheet) must be verified through **written confirmation by the building user**.

> Tips for energy efficient server: www.passipedia.org → Passive House Certification → Building Certification



The Passive House with the "Plus"

Energy efficiency and renewable energy generation

The energy revolution can only succeed with the simultaneous advancement of high energy efficiency and the use of renewable energy. Due to their small energy demand, Passive Houses and EnerPHit retrofits offer optimum conditions for the cost-effective supply with renewable energy. In order to achieve the Passive House / EnerPHit classes Plus and Premium, **proof of renewable energy generation** is necessary. Without energy generation, a building can achieve only the Classic Standard.

The generated renewable energy can in principle not be deducted from the energy demand. However, the PER limit will be increased to a limited extent if more renewable energy is generated than is necessary to meet the renewable energy generation requirement. Conversely, the renewable energy generation requirement is reduced if the PER demand is smaller than the limit value.

Note: In the same way, for verification with the PHPP it does not matter how much of the generated electricity is used on site. There is no differentiation between the electricity that is fed into the public grid and can then be buffered or used directly by others, and the electricity used on site!

Calculation of the projected building footprint

Area reference for renewable energy

In the PHPP, the energy demand for heating, cooling, primary energy etc. is based on the Treated Floor Area (roughly corresponding with the living or useful area). This makes sense because the energy demand can be depicted per square metre of useful area in this way.

This is different in the case of renewable energy generation. If a building parameter or limit value based on the living/useful area was also used here, then single-storey bungalows would be preferred over multi-storey buildings because for the former, the potential generation area (e.g. a roof for mounting solar thermal or photovoltaic systems) is relatively large compared to a small living area.

However, single storey buildings have higher space consumption and use of natural resources, and therefore shouldn't be preferred over multi-storey buildings in the PER evaluation. That is why in the PHPP the generated renewable energy is based on the "**projected building foot-print**". This is equal to the largest exterior dimensions of the thermal building envelope, which roughly equates to the roof area that is useable for a photovoltaic system and also equates to the base area that is occupied by the building. Thus a similar renewable energy generation requirement applies for all buildings regardless of the number of storeys.

Note: Because the specific renewable primary energy demand [kWh/(m^2_{TFA}a)] and renewable energy generation [kWh/($m^2_{foot\text{-}print}$a)refer to different areas, they cannot be directly compared with one another.

What kinds of renewable energy can be taken into account?

Generation of renewable energy typically takes place **on site or near the building** mostly by means of photovoltaic modules on the roof. The cost / benefit ratio is not always optimal in the case of small systems. With some buildings the conditions are also unfavourable, e.g. with strong shading or unfavourable orientation.

Therefore, as an alternative the building owner or (long term user) may satisfy the requirement by investing in new renewable energy generation systems which are **not spatially associated with the building**, e.g. by participating in the financing for the construction of a wind farm. It is only possible to satisfy the requirement by investment in new systems; purchase of existing renewable energy generation systems does not count. The amount of electricity that can be counted will be determined according to the ownership share of the owner / user in the total investment.

Many kinds of renewable energy can be taken into account, e.g. **photovoltaic systems, solar power plants, wind power, and hydro power**.


Photovoltaics on the roof

Picture: Wamsler Baumgärtner


Vertical photovoltaics on the facade

Picture: Thomas Graumann

The following **may not be taken into account**:

- **Biomass utilisation** (is already taken into account in the PHPP in the biomass budget, more information at www.passipedia.org → Passive House Certification → The New Passive House Classes)
- **Waste-to-energy plants and geothermal energy use** (are not sustainably "renewable“)
- **Solar thermal energy** (is considered part of the heat generator, thus it reduces the PER demand in the PHPP and therefore cannot additionally be taken into account as renewable energy)

Necessary verification for renewable energy generation

The characteristic values of **photovoltaic systems which are installed on the building or on the building plot** are entered in the PHPP in order to calculate the annual electricity yield after the power inverter. The following documents must be submitted for verification of the characteristic values entered in the PHPP:

- **Module data sheet** with:
    - rated current, rated voltage and rated power
    - temperature coefficient of the short-circuit current and the open-circuit voltage
    - module dimensions
- **Efficiency of the inverter** taken from the data sheet
- **Number of the modules,** proof of this e.g. through purchase receipts
- **Alignment, inclination and shading** from the corresponding planning

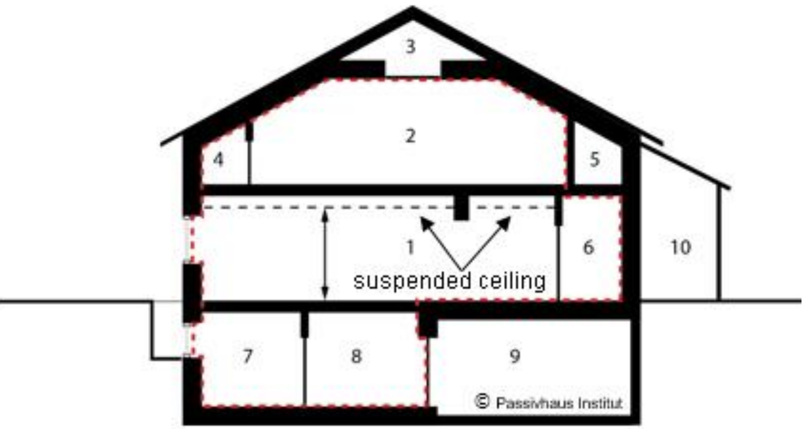
The following verification must be submitted for renewable energy generation **systems that are not installed on the building**:

- appropriate **proof of ownership**
- possibly with evidence of the **ownership share** as a percentage of the overall system
- Verification of the forecasted **annual electricity generation** of the system (simulation)

Boundary conditions for the **PHPP calculation**:
Calculations for PV and solar thermal as well as shading may only be carried out with the PHPP. External software is no longer permitted for this (except designPH from version 2 for shading).

An example for a confirmation sheet for renewable energy generation systems that are not installed on the building – see the ‘example documents’ section

Airtightness Testing



Room	Within airtight envelope?	Volume calculation
1	Yes	Clear height up to the (planned) suspended ceiling; joist is not deducted from the volume
2	Yes	Full volume (taking into account of ceiling slopes)
3	No	Volume is not taken into account (outside of envelope)
4	Yes	Full volume (taking into account of ceiling slopes)
5	No	Volume is not taken into account (outside of envelope)
6	Yes	Clear height up to ceiling
7	Yes	Basement: full volume
8	Yes	Basement: full volume
9	No	Basement: volume is not taken into account (outside of envelope)
10	No	Porch/ conservatory: volume is not taken into account (outside of envelope)

Figure 1: Information for calculating the air volume within the airtight layer of a building. The dotted red outline represents the airtight layer.

An excellent level of airtightness of the building envelope is essential for low energy consumption, thermal comfort and structural integrity. Therefore airtightness must be verified by means of a measurement (known as the **Blower-Door-Test**). For certification, a completed **test report** signed by the tester is to be submitted (as a scan) which proves compliance with the limit value.

The airtightness measurement must be performed in accordance with **ISO 9972 (Method 1)** with the following deviations:

- Air volume V_{n50} according to the annex of the criteria for the calculation of the n_{50}-value.
- one measurement series each for overpressure AND for underpressure (the n_{50} limit value must be met with the mean value from both measurements)

An article on Differentiation between Vv and Vn50 values can be found at: www.passipedia.org → Mechanical systems → Ventilation

Single Family Home TFA and Vn50 calculation - see the 'example documents' section.

Volume calculation

The air volume Vn_{50} within the heated building envelope which is to be used for calculating the n_{50} air leakage value should be determined **separately for each room**. The calculation must be clearly documented in the report and should correspond to the value entered in the PHPP. The **total air volume** within the thermal envelope should be taken into account (including staircases). A more exact explanation of special features is given in Figure 1.

Regardless of the degree of completion of the building, the **dimensions as at completion** should always be used (e.g. if screed has not been applied). Volumes above suspended ceilings do NOT count towards the air volume. This is irrespective of whether the ceiling already exists, is airtightly connected with the wall, or has various holes in it ("acoustic ceiling"). The reduction in the volume due to plaster layers does not have to be taken into account.

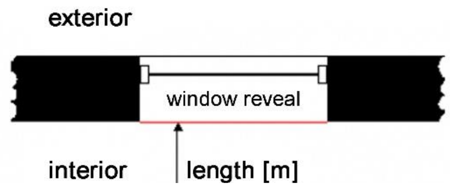
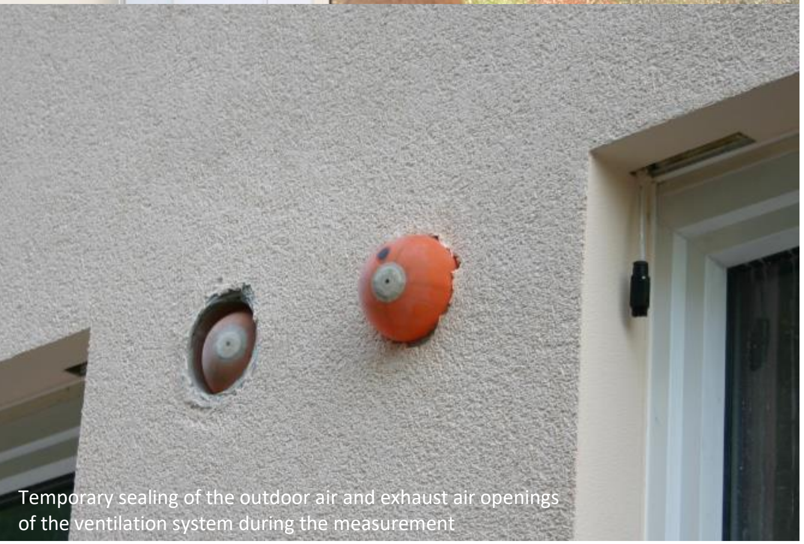


Figure 2: The volume of window reveals, doors and passages are not taken into account in the volume calculation.


Measurement of the air speed during the pressure test at one not yet correctly adjusted window using an anemometer


Temporary sealing of the outdoor air and exhaust air openings of the ventilation system during the measurement

Time of the measurement

Airtightness of the fully completed building controls, so test after the building is completed. However, all work for fittings, screed, cladding etc. is already completed at this point and therefore many important connections and penetrations of the airtight layer can no longer be accessed in a non-destructive manner. Remaining leaks in the airtight layer can then no longer be rectified. This would not be appropriate.

For this reason, air leakage should be measured immediately after the **completion of the airtight layer** (e.g. window installation, airtightness membrane in the roof, etc.) so that leaks are easily located and repaired. Missing building envelope components at the time of the measurement will complicate and compromise this result, and if you rely on this testing before construction is complete, a result where components are missing is acceptable for certification in only exceptional cases.

After this “construction-stage" air leakage measurement, the building management in charge should ensure that subsequent construction does not damage the airtight layer. If for any reason there are concerns in this regard, then another measurement should be carried out. **In normal cases, one airtightness measurement is sufficient.**

Carrying out the measurement

Method A or B?

For the energy balance of a building in the PHPP, the utilisation conditions during normal building operation are of significance. Intended openings that have to be sealed for the measurement are usually only the outdoor and exhaust air openings of the ventilation system. It is crucial that **all temporary seals** created for the measurement are accurately recorded.

In non-residential buildings with intermittent operation of the ventilation unit, **installed dampers** (e.g. HRV vents, dryer vents) must be closed during the airtightness measurement, however they must not be additionally taped.

Other sealing work

No other sealing work for the building envelope should be carried out for the measurement (key-holes, non-airtight windows, cat-flaps etc.).
The only exceptions are temporary taping over for missing **building components** which can affect the airtightness (e.g. missing door threshold, missing odour trap in a water pipe). Again, this taping over should be documented in detail.

Report of the airtightness test complete?

Is all general information included? - Tester: name, address and signature - Object - Date of test - Device - Measurement standard (norm) - Inside and outdoor temperatures - Wind velocity - Flow coefficient C_{env} - Leakage coefficient C_L
Is the airtightness measurement performed in accordance with ISO 9972 (Method 1)?
Is room-by-room calculation of the building air volume according to the annex of the criteria included? Is the calculation correct?
Has the installation location of the fan been documented?
Has temporary sealing of the building envelope been recorded (sealing of outdoor air and exhaust air ducts at least)?
Has a series of measurements at positive pressure AND negative pressure been performed?
For each series of measurements, were 5 measuring points used at different pressure differences (highest value ± 50 Pa at least)?
Is the flow exponent "n" between 0.5 and 1.0 (otherwise indicates measurement error due to a change in the envelope e.g. window opening)?
Average value of the natural pressure difference between -5 and 5 Pa (measurement of the pressure difference before and after each measurement series)? Note: If the wind speed is greater than 6 m/s OR the wind force is higher than 3 Beaufort, the stated limiting values for the pressure difference will usually be exceeded.
In general, the positive and negative pressure values n50 are relatively close to each other. If there are significant differences between the two results, a plausible explanation should be given in the measurement report.

The Checklist for download can be found at: www.passipedia.org → Planning and building a Passive House → Airtight construction

Recommendation: Prior to the series of measurements, carry out a leak detection with negative pressure, repair large leaks and document this.

Exception: For the measurement of tall buildings (e.g. high-rise buildings) special boundary conditions apply. Please contact your Certifier or building.certification@passiv.de

Guide for Airtightness Measurement of High-Rise Buildings: www.passipedia.org → Planning and building a Passive House → Airtight construction

Photographs

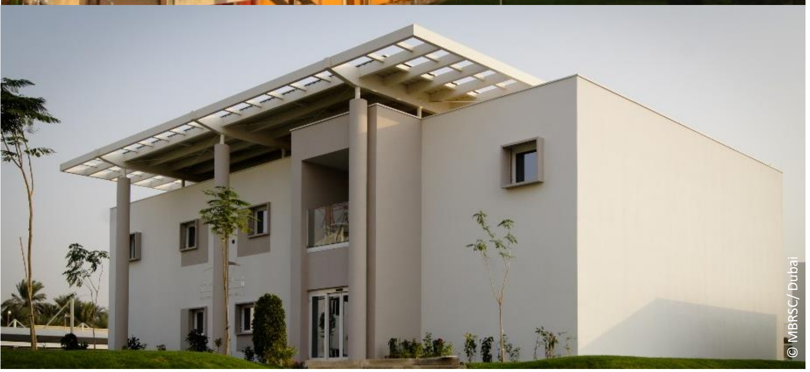
Example illustrative photographs

The construction progress should be documented with **illustrative photographs**. However, full photographic documentation of all measures is not necessary. Photos should be taken preferably at a time when the installation situation is not yet covered by cladding etc. Typically, photographs of the following areas should be taken:

- **Thermal insulation** of the building envelope (preferably with a measuring ruler in the picture to show the insulation thickness)
  - floor slab or basement ceiling
  - perimeter area
  - wall insulation
  - roof insulation
- Product data labels of
  - windows frames and glazing
  - heating and cooling units
  - ventilation unit
- Insulation and attachments of the **air ducts**
- Insulation and attachment of heating, hot water and cooling **pipes** and fittings
- Other energy-relevant construction details, e.g. **thermal bridges**

Checklist of the building site pictures to be submitted for building certification – see the ‘example documents’ section.

Construction manager's declaration



In order to limit the costs for the certification, supervision of the construction work by the Certifier is not required for the building certification. Instead, with the construction manager's declaration the person appointed by the building owner for supervising the construction work assumes the legal responsibility for ensuring that the work has been carried out in accordance with the documents submitted for the certification. A template for the construction manager's declaration can be found at www.passipedia.org → Passive House Certification → Building Certification → Examples of documents that need to be submitted for certification. It suffices to submit the signed declaration as a scan.

4. Appendix

Other sources of information

Passive House and EnerPHit - general information

Passipedia

The continually growing database of knowledge relating to energy efficient construction and building modernisation based on more than two decades of experience with research and application of this knowledge.

www.passipedia.org

Active for More Comfort: The Passive House

Free information brochure with basic information about the Passive House Standard and retrofitting with Passive House components.

www.passivehouse-international.org

Criteria for the Passive House, EnerPHit and PHI Low Energy Building standards

Building Criteria of the Passive House Institute and description of the certification procedure.

www.passiv.de/downloads/03_building_criteria_en.pdf

Built projects

Passive House Database

Database with pictures and descriptions of several thousand built Passive House buildings and EnerPHit retrofits.

www.passivehouse-database.org

Detailed project documentations

Detailed technical documentations for a large number of built Passive House buildings and EnerPHit retrofits.

www.passivhausplaner.eu

Events

International Passive House Open Days

Passive Houses around the world open their doors to the public on these days.

www.passivehouse-international.org

International Passive House Conference

The most important international Passive House event where about 1000 international experts come together.

www.passivhaustagung.de/en

Passive House Award

The Passive House Institute is the organiser of the Passive House Award. An international jury examines the entries and judges them on criteria such as design, cost-effectiveness, innovation, energy supply and sustainability.

www.passivehouse-award.org

Certification and further training

Passive House and EnerPHit certification

Information about the quality assurance programme of the Passive House Institute.

www.passivehouse.com/03_certification/02_certification_buildings/01_benefits-of-certification/01_benefits-of-certification.htm

Component Database

Comprehensive database of certified Passive House suitable products.

www.componentdatabase.org

Passive House Designer

Information about the further training programme of the Passive House Institute and the largest database with thousands of certified Passive House Designers.

www.passivhausplaner.eu

Passive House Tradesperson

Information about the further training programme of the Passive House Institute and the largest database with thousands of certified Passive House Tradespersons.

www.passivehouse-trades.org

Organisations

Passive House Institute

Independent research institute which has played a key role in the development of the Passive House Standard.

www.passivehouse.com

International Passive House Association

A global network connecting Passive House experts around the world.

www.passivehouse-international.org

General

Can I call my building a Passive House even if it is not certified?

The Passive House Standard has been defined by the Passive House Institute but purposely has not been protected as a trademark. Even without certification it is possible for e.g. an energy consultant to prepare Passive House verification using the PHPP. If all the Criteria have been met then the building can be labelled as a "Passive House" even without certification. Nevertheless, the Seal "Certified Passive House" with the Passive House Institute logo cannot be used in connection with the building in that case.

May only Certified Passive House Consultants and Designers prepare the PHPP calculation for building certification?

The Passive House Institute recommends that a Passive House Consultant or Designer should be entrusted with the PHPP calculation. However, basically anyone who is sufficiently qualified may prepare and submit this calculation to the Certifier.

What is the difference between a certified Passive House Designer and a Passive House Certifier?

Certified Passive House Designers or Consultants have attained an approved qualification through the Passive House Institute for calculating or planning a Passive House building. There are several thousand certified Designers worldwide.

Search for Certified Passive House Designers on www.passivhausplaner.eu → Search for Certified Passive House Designers

Passive House Certifiers are contractually authorised by the Passive House Institute to certify Passive House buildings in its name and in accordance with its methodology. In most countries there is only one Certifier or only a few Certifiers.

You can find a list of accredited building Certifiers on www.passivehouse.com → Certification → Buildings → Building Certifiers

Is it only permitted to install certified Passive House components or building parts which meet the requirements for certified components?

No, but extensive use of Passive House components all throughout facilitates planning and certification because independently tested energy relevant characteristic values are available for the PHPP calculation. However, installation of non-certified products is also permitted, but it may be time-consuming or difficult to provide reliable proof of the performance values in that case.

For Passive House standard, EnerPHit standard according to the energy demand method, and for the PHI Low Energy Building standard, components may also be installed which do not meet the Criteria for Passive House suitable components. The prerequisite is that thermal comfort and protection against moisture are not impaired.

Is there an annual fee for the Passive House plaque and certificate of my building?

The certification costs are only one-off and there are no further fees.

Boundary conditions

Can I have a new extension to my existing house certified?

Yes, new extensions can be certified individually if they include at least one external wall, one roof area and one floor slab or basement ceiling.

Can parts of a building be excluded from certification, e.g. retail spaces on the ground floor of a building with residential and commercial use?

Yes, in certain situations. Fundamentally, it is always the entirety of an insulated and airtight building envelope that is certified, e.g. a row of terraced houses, apartment block or office building. It is not permitted to exclude parts of a building from the energy balance. In deviation from this fundamental rule, certification is possible for the following building parts:

- Individual houses in a row of terraced housing (see Appendix of the Criteria)
- Annexes of existing buildings as long as they have at least one exterior wall, a roof and a floor slab/basement ceiling
- The upper floors of a building with mixed use without the business or retail floor spaces on the ground floor, under the conditions described in the Appendix of the Criteria.
- If individual apartments in an apartment block are being modernised, then precertification on the basis of an EnerPHit Retrofit Plan is possible

Additional information on staged retrofits with the EnerPHit Retrofit Plan can be found at: www.passivehouse.com → Certification → Buildings → Process

For certification, must each separate house in a row of terraced housing comply with the requirements individually?

The verification can be done either with an overall calculation for the row of terraced houses as a whole or with individual calculations for each terraced house (see Appendix of the Criteria).

Is it possible to certify buildings with special uses, such as swimming pool, supermarket or hospital as Passive House buildings?

Passive House certification is also possible for special use buildings. The requirements may differ slightly from the normal Passive House Criteria, therefore consultation with the Passive House Institute at an early stage of planning is essential. For some uses certification can only be carried out by the Passive House Institute but not by other accredited Certifiers.

Guidelines for indoor swimming pools can be found at: www.passivehouse.com → Literature & Tools → Free literature and project reports → Research work – Indoor swimming pools

My building has a very high electricity demand due to the type of usage. Is compliance with the limit value for primary energy still necessary for the building?

For densely occupied residential and office buildings, there is an alternative limit value calculated particularly for the individual building. This can be selected in the PHPP sheet "Verification" ("Project settings" area).

If a very high electricity demand arises in the case of special use buildings (e.g. a hospital) then in consultation with the Passive House Institute the primary energy demand may also be exceeded. Verification of efficient utilisation of electrical energy for all large electrical applications will be necessary for this purpose. Which uses are considered to be "efficient utilisation" in each case will be agreed with the Certifier.

Glossary

Air change rate [1/h]

This indicates how often the volume of air inside the building is replaced with fresh air from outside the building in one hour. In residential Passive House buildings this value is usually between 0.3 and 0.5 1/h.

Airtightness

An excellent level of airtightness of the building envelope is necessary for achieving the ad-vantages of a Passive House: a low energy demand, thermal comfort, a damage-free construction. It is also a prerequisite for efficient and reliable functioning of the ventilation system. The airtightness of a building is determined by means of a differential pressure test (Blower-Door test).

Airtight layer

The building component layer of the building envelope which prevents air from entering or escaping through the envelope. To achieve an excellent level of airtightness of the building envelope, there should be only one airtight layer which encloses the entire heated / cooled building volume without any breaks. The airtight layer may be created using sheeting, plaster layers or building components consisting of impervious materials (e.g. reinforced concrete).

Balance boundary

For verification using the Passive House Planning Package, the balance boundary constitutes the insulated and airtight building envelope which encloses the heated or cooled building volume. The energy flows which occur at this envelope surface (e.g. heat losses due to thermal conductivity or air exchange) are taken into account in this balance calculation.

Construction manager's declaration

Building certification by the Passive House Institute is predominantly based on a review of the planning documents and PHPP. To verify that the work is executed and the building is constructed in accordance with the reviewed planning documents, the construction manager responsible for the project signs a declaration to this effect. The Certifier will provide you with a template.

Cooling and dehumidification demand [kWh/(m²a)]

The useful energy which is necessary to maintain the desired indoor air conditions for cooling (PHPP standard design temperature maximum 25 °C and 12 g/kg air humidity). This does not take into account the efficiency of the equipment removing heat and humidity from the air.

Cool colours

Cool colours are colours that have a low absorption coefficient in the infrared range of the solar spectrum. As a result of this, exterior surfaces that are coated with these colours absorb less heat in sunlight. In the EnerPHit building component procedure there is a requirement that cool colours should be used in hot and very hot climates.

Cooling load [W/(m²a)]

The cooling load is the heat load that must be removed out of the building in order to maintain the specified indoor air conditions even in the most unfavourable case (high outdoor temperature and solar irradiation).

Climate zone

Every location in the world belongs in one of the seven climate zones defined by the Passive House Institute. In order to achieve the Passive House Standard, similar efficiency measures are usually necessary in those locations which lie in the same climate zone. The requirements of the EnerPHit building component method are based on the respective climate zone. In the Passive House Planning Package (PHPP) the climate zone is ascertained from the climate data of the building location.

Documentation of flow rate adjustment

After installation of the ventilation system, the volume flows should be adjusted at all supply air and extract air valves according to the planned flows. Apart from this, it should be checked whether the overall mass flow of the air which enters the building via the ventilation system corresponds with that which leaves the building. This procedure is also known as commissioning. For building certification by the Passive House Institute, a signed and completed protocol of adjustment must always be provided to verify that adjustment has taken place.

Efficiency of a ground-coupled heat exchanger: η_{GHE} [%]

Ground-coupled heat exchangers are used for pre-heating the outdoor air in winter or for pre-cooling in summer before it enters the building. In the simplest case, the outdoor air passes through tubes laid in the ground. This efficiency is a measure of the efficiency of the ground-coupled heat exchanger and indicates to what proportion the temperature difference between the outdoor air and the annual average ground temperature is compensated.

EnerPHit

EnerPHit is a building standard that was developed by the Passive House Institute for existing buildings which would only achieve the Passive House Standard with great difficulty. Passive House components are used for EnerPHit buildings so that except for the slightly higher energy demand, these buildings can benefit from almost all the advantages of a Passive House.

EnerPHit Retrofit Plan

The EnerPHit Retrofit Plan (ERP) is a document for building owners which contains a well thought-out overall concept for step-by-step energy-efficiency modernisation of the building. It takes into account important interrelationships be-tween the different energy saving measures. In this way, an optimal final result can be achieved reliably and with manageable effort throughout the steps. The ERP file included in the PHPP files generates a basic outline for the EnerPHit Retrofit Plan when a completed PHPP calculation is imported.

Frequency of overheating

This describes the percentage of hours in a year on which the average indoor temperature exceeds 25 °C in buildings that are not actively cooled. For the building energy standards of the Passive House Institute, this may not be higher than 10%. Values below 5% are recommended.

Frequency of excessive humidity

The number of hours in the year when the absolute humidity of the indoor air is higher than 12 g/kg.

f_{RSI}: temperature factor

The temperature factor is a dimensionless measure for the ratio of the outdoor air temperature and the minimum indoor surface temperature and can be used as an indicator for the risk of mould and condensation formation. The following applies for this: the higher the temperature factor is, the warmer the indoor surface and the less the risk of mould or condensation will be.

g-value

The total solar energy transmission factor, the g-value for short, refers to the energy transmission of a transparent building component, such as glazing. The g-value is the sum of the direct transmission of solar radiation plus the secondary inward emission of heat through radiation and convection. A g-value of 1 thus corresponds to a heat gain of 100%. In modern triple-layer glazing, this value is about 0.55.

Heating demand [kWh/(m²a)]

The heating demand is the useful energy which is necessary for keeping the rooms inside the thermal envelope of the building at the desired indoor temperature (standard design temperature

20 °C). This does not include the losses of the heat generator (e.g. boiler) and the auxiliary electricity necessary for heat generation and distribution.

Heating load [W/m²]

The heating load is the heat emitted by the heating system which must be supplied to the heated rooms in order to maintain the desired indoor temperature even under unfavourable conditions (cold outdoor temperatures/ no solar irradiation).

Heat recovery efficiency [%]

Put simply, the heat recovery efficiency of the ventilation unit describes the percentage of the heat energy contained in the stale air extracted from the building that is transferred to the supply air by the heat exchanger and therefore is not lost. The method for determining the heat recovery efficiency that is used for Passive House verification ensures correct calculation of the energy flows in terms of physics. Values determined in other ways are generally unsuitable for Passive House verification.

The effective heat recovery efficiency of the ventilation system is calculated using the heat recovery efficiency of the ventilation unit and a deduction for heat losses through the ventilation ducts between the unit and the thermal envelope of the building.

IHG: internal heat gains

The internal heat gains consist of the total heat emitted by persons and appliances inside the building. In the winter these gains contribute to heating of the building, while in the summer they increase the cooling demand in the form of undesirable heating loads. For residential buildings and some types of non-residential buildings (e.g. office/administrative building, school) standard values for the IHG are specified in the PHPP, which must be used for the certification.

Minimum thermal protection

The minimum thermal protection describes the standard which a building or the building envelope must comply with in order to meet the minimum requirements for structural integrity of the building (condensation/mould) and for thermal comfort. As a rule, Passive House buildings and EnerPHit modernisations automatically meet these relatively minimal requirements due to their excellent standard of thermal protection. The building Criteria of the Passive House Institute contain specific requirements for the minimum standard of thermal protection.

Moisture recovery efficiency [%]

Some ventilation units also have moisture recovery in addition to heat recovery. The moisture recovery efficiency indicates the ratio of the transferred absolute humidity to the maximum transferrable moisture.

Passive House

Passive House buildings are extremely energy efficient, comfortable, affordable and environmentally friendly at the same time. "Passive House" is not a brand name, it is a building concept that is accessible for all. With tens of thousands of buildings worldwide, the Passive House Standard has proved itself in practice for more than 25 years.

Passive House standard

The Passive House Standard is a clearly defined, transparent and proven pathway to better buildings. The international performance-based standard takes an efficiency first approach to building design, achieving durable, resilient buildings that reduce heating and cooling demand by as much as 90%. This dramatically reduces building-related carbon emissions and running costs. Passive House buildings combine high levels of thermal comfort and indoor air quality with low energy consumption, creating a healthy and comfortable indoor climate at low cost.

Passive House Classes

A Passive House Classic is very energy efficient in itself. With the classes Plus and Premium, the building is optimised even further for the efficient use of renewable energy and also generates renewable energy, e.g. by means of photovoltaic modules on the roof. Similar classifications apply for the EnerPHit Standard.

Passive House components

These are building products such as windows, thermal insulation, ventilation systems etc. which are suitable for use in Passive House buildings or EnerPHit retrofits. The Passive House Institute defines the requirements for Passive House components and certifies products that comply with them. Reliable characteristic values are available for the now more than 1000 certified Passive House components, which enable a calculation of the building's energy demand that corresponds to reality.

PER: Renewable primary energy [kWh/(m²a)]

The availability of renewable energies fluctuates in dependence on solar radiation, wind force, and precipitation quantity. For a 100% renewable energy supply in the future, some of the generated power must therefore be stored intermediately. This storage is inevitably associated with losses. Only a third of the original amount of generated electricity will be available ultimately, particularly in the case of seasonal long term storage, e.g. due to generation of storable methane gas. The PER demand expresses the amount of renewable energy that must be generated originally in order to meet the total energy demand of a building. Thus it also includes the storage losses. The PER method was developed by the Passive House Institute so that buildings can already be optimised during the planning for the use of renewable energy.

PHI Low Energy Building

The PHI Low Energy Building Standard is suitable for buildings that do not quite achieve the Passive House Standard for various reasons. The requirements for the energy efficiency are less stringent than for Passive House buildings. As for Passive House buildings, verification takes place using the Passive House Planning Package (PHPP).

PHPP: Passive House Planning Package

The PHPP is a clearly structured and easy to use energy balance software program. It is used for energy relevant planning and verification for the energy standards defined by the Passive House Institute. Excellent correlation of the calculation and the actual energy consumption measurements in the building has been proved for a large number of projects. The PHPP can be ordered from the Passive House Institute's website.

Pressure test air change rate n_{50} [1/h]

Series of measurements at negative pressure AND at positive pressure with a pressure difference of at least 50 Pascals between the surroundings and the inside of the building that is being measured. If this is divided by the net indoor air volume, this will result in an air change rate n at 50 Pascal: this is the n_{50} value. In a Passive House this value may not exceed 0.6 1/h.

Projected building footprint

Orthogonal projection of the heated or air-conditioned building envelope on a horizontal plane. This is used to describe the ground surface occupied by the building. The projected building footprint serves as a reference area for assessing renewable energy generation as it basically corresponds to the area that is usable for the production of solar energy.

Psi-value: thermal bridge coefficient [W/(mK)] or [W/K]

For Passive House verification according to ISO 10211, the thermal bridge coefficient or Ψ-value (Psi value) is calculated based on the exterior dimensions (it must be identical to the reference dimensions of the building envelope area). It describes the additional heat losses in comparison to the uninterrupted regular building component at a component connection (linear thermal bridge) or a punctiform penetration.

Solar heat gains / solar load

During the heating period, desirable solar radiation through windows reduces the heating demand. In the cooling period, undesirable solar incidence on windows, roof and walls increases the cooling demand in the form of the solar load. In the EnerPHit Criteria according to the building component method, for actively cooled buildings there is a requirement for the maximum solar load that enters the building through the glazing surface.

SRI: Solar reflection index

The SRI is a parameter for the exterior surfaces of the building which describes the extent to which exposure to sunlight heats them. It takes into account the absorption as well as the emissivity of the surface. The higher the SRI value is, the less the surface will heat up. In the EnerPHit building component method there is a requirement for the SRI for hot and very hot climates.

Thermal comfort

Thermal comfort is a subjective perception of the body and is based on whether or not a person feels comfortable in the surroundings. Among other things, the indoor air temperature, the surface temperature of the building components and the air velocity affect the perception of comfort (or absence of discomfort). The building Criteria of the Passive House Institute contain the minimum requirements for thermal comfort, particularly for the U-value of windows.

Thermal conductivity [W/(mK)]

The thermal conductivity (also called the lambda value) describes how well a material conducts heat. Insulation materials have a very low thermal conductivity and therefore prevent unwanted heat conduction e.g. through the wall of a heated building towards the outside.

Transmission heat losses

This is the heat flow through the exterior building components depending on the temperature difference in degree kelvin. The smaller this value is, the better the insulation effect of the building envelope will be.

Treated Floor Area [TFA]

This is the net floor area of a building which is to be heated or air-conditioned. The TFA is approximately equivalent to the gross internal floor area, the main difference being that the TFA excludes the areas occupied by internal walls. It is therefore a measure for use of the building. The areas are weighted differently depending on the use of the rooms – with 100% or 60%. The rules for determining the TFA are explained in the PHPP User Manual.

U-value [W/(m²K)]

The thermal transmission (U-value) is a measure for the heat flow through one or more layers of materials if different temperatures prevail on both sides. The unit for the U-value (W/m²K) defines the amount of energy per time unit which flows through an area of one square metre if the air temperature on both sides differs by one kelvin. The smaller this value is, the better the insulation effect of the building envelope will be.

U_f: U-value of a window frame [W/(m²K)]

The U-value of a window frame indicates the energy losses through the window frame.

U_g: U-value of glazing [W/(m²K)]

U-value of glazing indicates the energy losses through the window glazing. For Passive House verification this value must be given to two decimal places.

U_w: U-value of a window [W/(m²K)]

The U-value of a window (U_w) indicates the energy losses through the entire window, therefore it does not automatically provide exact information about the quality of the frame. This must be examined more closely.

$U_{w\ installed}$ [W/(m²K)]

The U_w-value when installed in a particular situation under consideration of the installation thermal bridge.

Ventilation heat losses

The heat losses which result from air exchange with outdoor air during the heating period – either due to specific exchange via the ventilation system or window ventilation or from unintended exchange due to the escape of warm indoor air through leaks in the building envelope. In Passive House buildings, ventilation heat losses are reduced to a minimum due to ventilation system heat recovery and a very airtight building envelope.

The Passive House Institute introduces itself

The Passive House Institute (PHI) is an **independent research institute** founded by Dr. Wolfgang Feist with a continuously growing interdisciplinary team of employees. The PHI has played a particularly important role in the development of the Passive House concept.

Since then, the Passive House Institute has assumed a leading position with regard to research on and development of construction concepts, building components, planning tools and quality assurance for particularly energy efficient buildings.

The Passive House Institute makes its knowledge available to everyone. Findings relating to the Passive House Standard, certification and training programmes, as well as the marketing of planning tools such as the Passive House Planning Package (PHPP) and designPH thus cannot be considered a monopoly of any local institution in any country. The Passive House Institute does not enter into exclusive contracts. Provided that all prerequisites are met, the Passive House Institute is happy to collaborate with suitable partners at any time and in any country. The Passive House Institute may be contacted directly in case of questions regarding the certification of professionals, buildings and building components as well as all relevant consultancy services.

Example documents

The following are links to examples of the most important documents that must be submitted for certification. They serve as an illustrative supplement to the documentation requirements described in the guide.

All example documents can be found at: www.passipedia.org → Passive House Certification → Building Certification → Examples of documents that need to be submitted for certification

- Completed Passive House Planning Package (PHPP) for a residential building as PDF
- Single family home detailed TFA and Vn50 calculation
- Documentation of a thermal bridge calculation for a connection detail adjacent to the outside air
- Documentation of thermal bridge calculations for connection details adjacent to the ground
- Glazing data sheet
- Documentation of a window frame U-value calculation in accordance with EN ISO 10077-2
- Documentation of a window installation thermal bridge calculation
- Documentation of a glazing edge thermal bridge calculation in accordance with EN ISO 10077-2
- Completed documentation of flow rate adjustment based on the "ventilation specification sheet"
- Record of a airtightness test
- Template for the construction manager declaration
- Checklist Building site photographs
- Completed EnerPHit Retrofit Plan for a staged renovation to the EnerPHit Standard
- Confirmation sheet for renewable energy generation systems that are not installed on the building site

The Building Certification Guide in other languages can be found at: www.passipedia.org → Passive House Certification → Building Certification → Building Certification Guide