

Catalogue of Learning Objectives

"Certified Passive House Tradesperson"

This catalogue of learning objectives is based on the assumption that tradespeople already possess the relevant skills required for construction work due to their basic training. The content is therefore restricted to essential additional knowledge relating to the Passive House. These learning objectives form the primary basis of the "Certified Passive House Tradesperson" examination.

1 Passive House – Interdisciplinary principles

1.1 Passive House Definition

Knowledge of the climate-independent functional definition of a Passive House and the principles it is based on:

“A Passive House is a building, in which thermal comfort (*ISO 7730*) can be provided solely by postheating or postcooling of the fresh air flow which is required for good indoor air quality (*DIN 1946*) - without the additional use of recirculated air.” *{Definition}*

1.2 Passive House Criteria

Heating load	$p_{\text{Max,heat}} \leq p_{\text{Fresh air,max}}$	{generally}
Cooling load	$p_{\text{Max,cool}} \leq p_{\text{supply,max}}$	{generally}
Annual space heating demand	$q_{\text{max,heat}} \leq 15 \text{ kWh}/(\text{m}^2\text{a})$ this value applies for Central Europe	{climate-dependent, this value applies for Central Europe}
Annual space cooling demand	$q_{\text{Max,cool}} \leq 15 \text{ kWh}/(\text{m}^2\text{a})$ this value applies for Central Europe }	{climate-dependent, this value applies for Central Europe }
Airtightness	$n_{50} \leq 0.6 \text{ h}^{-1}$	{generally}
Annual primary energy demand	$e_{\text{Max,prim}} \leq 120 \text{ kWh}/(\text{m}^2\text{a})$	{generally}
Frequency of overheating	$t_{\text{Max},\vartheta > 25^\circ\text{C}} \leq 10\% t_{\text{Use}}$	{generally}

1.3 The 5 pillars of the Passive House principles

- Highly insulating envelope
- Thermal bridge free construction
- Airtightness
- Windows and solar gains
- Ventilation with heat recovery

1.4 Ecology and comfort

- Energy consumption and climate, CO₂, energy saving potential
- Living comfort and a healthy indoor climate

1.5 PHPP and other planning principles

- Orientation of buildings
- Building compactness
- The Passive House as a building standard and not an architectural style
- Passive House Planning Package (PHPP)
- Overall energy balance of the building
- Results of the PHPP calculation

1.6 Economic efficiency

- Current cost of energy and energy price development theories
- Sustainable economic development with reference to buildings, long-term yields
- Comparison of capital costs - saved energy costs
- Life cycle costs of a Passive House in comparison with a standard building, assuming an average energy price for the period under consideration (20 years), residual value of a building at the end of the period under consideration
- Costs incurred in any case and costs of energy conservation measures the principle "if it has to be done, then properly"
- Economic efficiency of individual measures:
Thermal insulation, windows, airtightness, ventilation system in new Passive

House constructions and refurbishment with Passive House components (EnerPHIT)

- Economic efficiency of a set of measures, documentation based on the costs charged (new Passive House construction and refurbishment with Passive House components (EnerPHIT))

1.7 Construction process and quality assurance

- Differences in the construction process of Passive Houses and conventional constructions, allocation to particular disciplines of work relating to Passive House features
- Factual and economic sequence of steps for Passive House relevant work
- Interdependence of disciplines involved in terms of time, space and content
- Quality of work that is necessary and methods for achieving this quality
- Practical quality assurance, on site
- Certificates and their advantages

1.8 User information and user support

- What information should be provided to Passive House occupants?
- Opening windows: influence during winter and summer
- Temporary shading: influence during winter and summer
- Ventilation unit, special features, maintenance
- Prevention of dry air in winter
- Information sources

1.9 Basic principles: Thermal insulation in the Passive House

- The principle of a thermal envelope
- A rough overview of the insulating materials available on the market and their properties
- Thermal conductivity, simple calculation of the U-value
- Typical U-values in the Passive House in Central Europe and the typical insulation thicknesses resulting from these
- Correct installation of insulation materials

1.10 Basic principles: thermal bridge free construction

- What is a thermal bridge?
- Building damage due to thermal bridges, surface temperatures
- Thermal conductivities of various building materials
- Dimensioning of heat losses through various thermal bridge situations
- Fundamental rules for prevention of thermal bridges
- Thermal bridge optimised window installation

1.11 Basic principles. Passive House windows

- Function of windows in general, and in relation to the Passive House: view towards the outside, thermal protection, solar gains, ventilation during day and during night
- Thermal comfort in the Passive House and the resultant requirements for windows, temperatures at the window
- Requirements for windows in general, and for the Passive House in particular: airtight, thermally insulating (U-value), transparent, possibility for opening and providing shade when necessary, installed in a thermal bridge minimised/free manner, installed in an airtight manner
- Glazing and glazing edge, overview of requirements, g-value

1.12 Airtightness

- Necessity of airtightness in a building
- The principle of an airtight layer (red pencil method and single airtight layer)
- Difference between airtightness and wind resistance
- Typical weak points in case of poor airtightness
- Test procedures for airtightness measurement (preparation, execution, magnitudes of error), typical measurement results, methods of detecting weak points
- Assessment of different leaks
- Suitable and unsuitable materials for airtight surfaces and connections (for different construction methods such as solid, lightweight and mixed constructions), suitable airtightness measures for penetrations, special products
- Procedure/sequence of work with reference to airtightness
- Permanence of solutions for airtightness

1.13 Basic principles: Ventilation

- Relationship between airtightness, ventilation, air humidity, air hygiene and the necessity for ventilation systems
- Air quality
- The principle of cross-ventilation – directed air flow
- Build-up of a ventilation system – main components (interdisciplinary)
 - Central unit with heat exchanger
 - Ductwork and insulation of cold ducts, diffusion-impermeable materials
 - Fresh air inlets/extract air outlets
 - Transferred air elements: understanding the necessity and types
 - Outdoor air intake and exhaust air outlet and their positioning
- The principle of heat recovery
- Building envelope interface: airtight and thermal bridge free connection of penetrations for outdoor air and exhaust air ducts
- Necessity and possibilities for installation of ventilation systems in existing buildings

1.14 Basic principles: Heat supply

- Heating demand and heating power required in Passive Houses
- Introducing the required space heating via fresh air
- Positioning of heaters in the Passive House
- Generation of domestic hot water
- Conventional heat generators in the Passive House
- The use of renewable energy sources in the Passive House
- Uncontrolled dissipation of heat from heat generators/pipes
- Airtight house connection
- Combustion furnaces in the Passive House
- Utilisation of old heat generators
- Pipes, heaters in refurbishments of existing buildings

2 Specialisation according to discipline - Building Envelope

2.1 Thermal insulation in the Passive House

The following subject content is of importance in addition to Section 1.9:

- Moisture transport through diffusion (vapour retarders, vapour barriers, moisture-adaptive vapour retarders)
- In-depth information regarding thermal insulation materials available on the market and their properties
- Passive House suitable wall constructions and their superstructures, thermal bridge free/minimised attachment, connections:
 - Solid construction with compound insulation system
 - Monolithic construction method
 - Lightweight constructions: airtightness, moisture protection
 - Ventilated facades
 - Thermal insulation of building components in contact with the ground
- Passive House suitable roof constructions:
 - Suitable materials and structures
 - Possible roof superstructures
 - Pitched roofs, flat roofs in solid constructions, flat roofs in lightweight constructions
 - Insulation between rafters, on rafters, combined constructions
- Passive House suitable constructions of floor slab / basement ceiling:
 - Thermal insulation of the basement ceiling
 - Thermal insulation of the floor slab
 - Possible structures
 - Fire safety, building approval, liability in individual cases

2.2 Thermal bridge free construction

The following subject content is of importance in addition to Section 1.10:

- Constructive and geometric thermal bridges
- Point and linear thermal bridges, the terms χ -value and ψ -value
- What information is provided by the ψ -value, what is meant by "thermal bridge free" in relation to the Passive House?
- Assessment of the extent of thermal conductivities of different materials

- In-depth estimation of the extent of heat losses through thermal bridges
- Effects of thermal bridges on the Passive House Standard
- Avoiding thermal bridges in solid and timber constructions
- Knowledge of solutions for the foundation, plinth, integrated ceilings, eaves, verge, parapets, penetrations of the insulation layer of compound insulation systems and curtain-wall facades and prevention of projections

2.3 Windows and other transparent exterior components

The following subject content is of importance in addition to Section 1.11:

- Insulating characteristics of windows: U-value, various influences on the overall U-value of a window, determination of the window U-value with the tool provided
- Window frame: frame u-value, build-up of Passive House suitable window frames, influence of frame width
- Thermal bridge free installation: frames covered with insulation, shading of the window by the reveal, airtightness of the window, airtight installation, glazing, glazing edge
- Interaction of different influences: optimisation of the glazing U-value and the g-value, frame proportion and solar gains
- Roof surface windows, installation tools for roof surface windows, inclined glazing (change in the U-value)
- Classification and certification of windows, Passive House energy efficiency classes for transparent building components, certification of Passive House windows, certificate uses
- Passive House doors

2.4 Summer comfort

- Criteria for thermal comfort
- Influence on summer comfort
- How to estimate air exchange, what are the possibilities for increasing this?
- Solar load: significance, dependence on orientation, dependence on the size of the transparent surfaces, shading, temporary shading, effectiveness of shading equipment on the inside and on the outside

- Influence of the internal heat sources: how can these be reduced? Influence of the colour of the facade, the thermal insulation, and the thermal mass

2.5 Refurbishment of existing buildings using Passive House components

- Advantages of refurbishment of existing buildings using Passive House components in relation to problems of old buildings: condensation and mould, inadequate thermal comfort, poor air quality, high heating costs, environmental pollution
- Why is the Passive House Standard often not achievable for existing buildings?
- EnerPHit certification, basic requirements and advantages
- Standard of thermal protection for all measures
- Potential for saving energy
- Dealing with specific problems arising in existing buildings:
 - Wall, basement ceiling/floor slab, roof, top floor ceiling, thermal bridges, windows (window installation position, daylight provision), airtightness, interior insulation (risks and disadvantages as well as saving potentials, diffusion-impermeable and diffusion-permeable superstructures)
- Step-by-step refurbishment

3 Specialisation according to discipline – Building Services

3.1 Passive House ventilation

The following subject content is of importance in addition to Section 1.13:

- Why is ventilation essential?
 - Indoor air contaminants
 - Relationship between the relative indoor air humidity and sources of humidity inside the building, the rate of fresh air supply and the outdoor temperature
 - Prevention of mould formation
- Controlled home ventilation with heat recovery
 - Heat recovery, the principle of cross-ventilation
 - Different ventilation concepts (centralised and decentralised ventilation systems)
 - Basic knowledge regarding dimensioning, selection, and setup of units
- Individual components of ventilation systems
 - Outdoor air intake and exhaust air outlet, filters, heat recovery, condensate drain, duct materials, reduced pressure loss of duct network, basic principles for dimensioning of ducts, airtight duct network, choice of extract air outlets and fresh air inlets, transferred air elements, airtight and thermal bridge free penetration of outdoor air and exhaust air ducts
- Heating via fresh air in Passive Houses:
 - Prerequisites
 - Correct installation of fresh air heating coils
- Important protective measures for a ventilation system and its correct implementation
 - Reduction of cross-talk transmission and structure-borne sound
 - Different types of frost protection
 - Fire safety and smoke protection
- Initial operation
 - Necessity for adjustment
 - Carrying out adjustments
- Summer ventilation
- Ventilation system in existing buildings, prerequisites and advantages, space-saving devices and duct installation

3.2 Heating in the Passive House

The following subject content is of importance in addition to Section 1.14:

- Heat generation and heat distribution in the Passive House
 - Prerequisites, setup and functioning of supply air heating
 - Assessment of a conventional heating system in the Passive House
 - Heating demand and necessary heating output for provision of domestic hot water and heating
 - Hot water storage: coordination with heat generator, insulation of hot water storage tanks, measures for prevention of legionella
 - Heat generation and hot water provision in detached houses and multi-storey buildings
 - Unsuitability of conventional heat generators for detached Passive Houses
 - Suitability of renewable energy sources
 - Heat storage and regulation for smaller heat generators
 - Evaluation of different heat generators for use in the Passive House
 - Typical setup of a system in a detached Passive House
 - Setup, function and evaluation of compact heat pump units
 - The principle behind heat pump systems and their setup
 - Setup and function of a ground-coupled compact heat pump unit
 - Safety measures and dependence of combustion processes on outdoor air in the Passive House
 - Gas-based compact units
 - Setup and function of a primary wood-pellet stove
 - Typical installation layout with an integrated pellet stove
- Implementation-relevant details
 - Thermal insulation of pipes and fixtures, useable and non-useable distribution heat losses, installation space required for insulation
 - Basic principles for planning of duct systems for heating/DHW/ventilation
 - Penetration of the airtight level by heating system pipes
 - Reduction of the energy consumption of circulating pumps
 - Reduction of the pressure losses in duct systems
 - Purpose and procedures for hydraulic balancing
- Refurbishment of existing buildings
 - Modernisation of the heating system within the context of overall refurbishment
 - Power and modulation ranges for DHW generation and heating during refurbishment

- Suitability of existing heaters after the refurbishment
- Retrofitting buildings with exhaust air systems

4 Literature

Passipedia – the Passive House resource for everything you need to know about the Passive House: <http://passipedia.de>

[AkkP 5] Energy balance and temperature characteristics, Research Group for Cost-effective Passive Houses, Protocol Volume No. 5, 1st edition, Passive House Institute, Darmstadt 1997

[AkkP 9] User Behaviour, Research Group for Cost-effective Passive Houses Phase II, Passive House Institute, Darmstadt 1997

[AkkP 14] Passive House windows, Research Group for Cost-effective Passive Houses, Protocol Volume No. 14, 1st edition, Passive House Institute, Darmstadt 1998.

[AkkP 15] Passive House summer case, Research Group for Cost-effective Passive Houses, Protocol Volume No. 15, 1st edition, Passive House Institute, Darmstadt 1999

[AkkP 16] Thermal bridge free design, Research Group for Cost-effective Passive Houses, Protocol Volume No. 16, 1st edition, Passive House Institute, Darmstadt 1999

[AkkP 20] Passive House supply technology, Research Group for Cost-effective Passive Houses, Protocol Volume No. 20, 1st edition, Passive House Institute, Darmstadt 2000

[AkkP 21] Example of architecture: Residential Buildings, Research Group for Cost-effective Passive Houses Phase III, Protocol Volume No. 21, Passive House Institute, Darmstadt 2002

[AkkP 24] The Use of Passive house technologies in retrofits, Research Group for Cost-effective Passive Houses Phase III, Protocol Volume No. 24, Passive House Institute, Darmstadt 2003

[AkkP 25] Temperature differentiation in apartments, Research Group for Cost-effective Passive Houses Phase III, Protocol Volume No. 25, Passive House Institute, Darmstadt 2003

[AkkP 26] The new Passive House - Building services with heat pumps, Research Group for Cost-effective Passive Houses Phase III, Protocol Volume No. 26, Passive House Institute, Darmstadt 2004

[AkkP 27] Heat losses through the ground, Research Group for Cost-effective Passive Houses Phase III, Protocol Volume No. 27, Passive House Institute, Darmstadt 2004

[AkkP 29] Highly insulated roof structures, Research Group for Cost-effective Passive Houses Phase III, Protocol Volume No. 29, Passive House Institute, Darmstadt 2005

[AkkP 30] Ventilation in retrofits, Research Group for Cost-effective Passive Houses Phase III, Protocol Volume No. 30, Passive House Institute, Darmstadt 2004

[AkkP 32] Passive House components and interior insulation, Research Group for Cost-effective Passive Houses, Protocol Volume No. 32, Passive House Institute, Darmstadt 2005

[AkkP 33] Passive House schools, Research Group for Cost-effective Passive Houses, Protocol Volume No. 33, Passive House Institute 1st edition, Darmstadt 2006

[AkkP 35] Thermal bridges and supporting frames – The limits of thermal bridge free design, Research Group for Cost-effective Passive Houses Phase IV, Protocol Volume No. 35, Passive House Institute, Darmstadt 2007

[Bisanz 1999] Dimensioning the heating load in low-energy houses and Passive Houses, 1st edition, Darmstadt January 1999

[DIN 1946] Part 6: Indoor air technology, home ventilation requirements, implementation, acceptance; Beuth Verlag Berlin 2009. [EN 10077] Window U-value

[ISO 7730] DIN EN ISO 7730: Temperate ambient climate; Beuth Verlag, Berlin 1987

[Kah/Feist 2005] Economic efficiency of thermal insulation, Passive House Institute, internet publication, to be found at www.passiv.de

[Peper 1999] Peper, Sören: Airtight planning of Passive Houses, Technical Information PHI-1999/6, CEPHEUS Project Information No. 7, Passive House Institute, Darmstadt 1999

[Feist 2007] Feist, W.: Passive Houses in practice, Building Physics Calendar 2007, Verlag Ernst & Sohn, Berlin 2007

[PHPP 6.1] Feist, W.; Pfluger, R.; Kaufmann, B.; Schnieders, J.; Kah, O.: Passive House Planning Package 6.1, Passive House Institute, Darmstadt 2011

[IBO 2008] IBO (Austrian Institute for Healthy and Ecological Building) (publisher). Waltjen, Tobias (Project management); Technology: W. Pokorny, T. Zelger, K. Torghele. Contributions by W. Feist, S. Peper, J. Schnieders. Ecology: H. Mötzel, B. Bauer, P. Boogmann, G. Rohregger, U. Unzeitig, T. Zelger. Consultants: F. Kalwoda, J. Seidel, H. Geza Ambrozy, W. Luggin. Passive House Component Catalogue, Ecologically evaluated constructions. Springer Vienna, New York. Second extended edition Vienna 2008. ISBN 978-3-211-29763-6

Other short reports and technical literature about the Passive House published on the internet can be found at: <http://www.passiv.de/>