Passive House Institute

Appendix I b
Catalogue of Learning targets
“Retrofit”

Valid as of 15 July 2022

Introductory remarks

The Passive House Institute (PHI) has extended the existing training and certification system for designers and tradespeople to acknowledge the further education of other professional groups and the activities that are important for the construction of Passive Houses. In addition, more focus will be placed on "lifelong learning" and the gradual acquisition of Passive House knowledge.

The policy envisages that additional training will be certified as an "add-on" to the existing seals of Passive House Designer / Consultant or Tradesperson. The new “add-on seals” are therefore used in conjunction with the associated "main seal" (Designer / Consultant or Tradesperson seal).

With the additional certificate "Retrofit" the PHI has developed a further education programme which aims at ensuring the realisation of high quality deep energy retrofits, particularly EnerPHit buildings. The goal is to support the transformation of the existing building stock to meet the urgent climate protection challenges of our times. The add-on certificate is available to already certified Passive House Designers / Consultants and Tradespersons. The contents include in-depth knowledge of the most relevant topics regarding deep energy retrofits, with particular focus on the thermal envelope and building services of both full and staged retrofits, and the EnerPHit building certification, as well as general knowledge about the EnerPHit Retrofit Plan (ERP).

For Passive Designers / Consultants, additional knowledge regarding the design of retrofit projects with the PHPP (Passive House Planning Package) is contemplated, including the calculation of variants, staged retrofits and the EnerPHit Retrofit Plan (ERP). Furthermore, detailed understanding about the economic aspects of high energy retrofits and further in-depth knowledge relevant to retrofit design and quality assurance is necessary.

I. Module for both Certified Passive House Designers/Consultants and Tradespersons

1. General concepts

- Knowledge of the main general aspects regarding deep energy retrofits with Passive House components, including the importance and relevance of energy efficient retrofits, the Passive House general concept (the five principles) and its application to retrofits, and potential of highly efficient building retrofit [EE+]
- Understanding the concept of renovation in the utilisation cycle of buildings: coordinated, full and staged retrofit. Knowledge on the interdependencies of individual measures and target-oriented recommendations for retrofits as well as on the coordination of all measures in the overall context and user disruption [EE+], [Bastian 2012], [Bastian 2022]
- Acquaintance with the specific goals and contents of the EnerPHit certification: criteria, certified EnerPHit and staged EnerPHit certification.
- Understanding of the possibilities and requirements of energy-saving retrofits in listed buildings [EE+], [3encult]
- Review the importance of retrofitting of energy-efficient supply systems, sustainability principles and RES potential [EE+]

2. Energy retrofit measures

Understand the main challenges of full deep energy retrofits, both from the perspective of the building envelope and building services. Particular focus is given to the following topics:

2.1. Building envelope

- Generalities regarding building physics basics and moisture risk in retrofits [EuroPHit]

- Optimising building performance for optimal retrofit of building envelope components: roof, floor slab/basement ceiling and insulation skirts. [EE+]
- Thermal insulation, including interior insulation [EuroPHit]
    - Which thermal protection level is more reasonable? [EuroPHit]
    - Thermal insulation for retrofits: economic feasibility and other requirements for retrofits [EuroPHit]
    - Difference between exterior & interior insulation:
        - Exterior insulation for retrofits: general aspects
            - Construction and materials EIFS, ventilated facades, brick wall facades with insulated cavity walls, retrofitted core insulation in existing masonry cavity walls [Bastian 2012], [3encult]
        - Interior insulation for retrofits:
            - Properties of interior insulation [PHI 2021]
            - Avoidance / reduction of thermal bridges when using interior insulation, typical connection details for windows, ceilings, roof, and interior walls [EE+]
            - General recommendations for design and execution and examples [3encult]
- Thermal bridges in retrofit buildings:
    - Main challenges for retrofits
    - Thermal bridges: cantilevered reinforced concrete ceiling slabs, low thermal bridge attachment of small loads to the façade [Bastian 2012]
    - Solutions for reducing heat losses to the basement and ground in larger buildings [AkkP 48]
    - Thermal bridge calculation: general considerations for retrofits [EE+]
- Windows: glazing and frames
    - Basics, construction and materials, thermal bridges, airtightness aspects [Bastian 2012]
    - Historical buildings: challenges and chances [3encult]
    - Shading: special challenges and solutions for retrofits
- Airtightness
    - Introduction to airtightness: air leakage in buildings, definition of airtightness and airtightness in Passive Houses (new and EnerPHit) [EuroPHit]
    - Basic principles to improve airtightness in buildings [Bastian 2012]
    - Airtightness detailing: materials (what to use and what to avoid) and influence on ventilation, interior plaster as airtight layer, sealing of old wooden beams in existing buildings, airtight layer on outside of solid existing wall [Bastian 2012]
    - Airtightness testing: general aspects and relevance for retrofit
    - Construction site issues, including installation of airtightness materials for retrofits

2.2. Building services

Understand the following relevant aspects regarding building services of full retrofits:

- Heating and DHW [Bastian 2012]
    - Basics
    - Heat generation and distribution
    - Heating systems
    - Design
- RES: special features of existing buildings

    Particularities of retrofit for non-residential buildings: general knowledge on the issues regarding internal heat gains, lighting, shading and ventilation concepts for the retrofit of non-residential buildings

3. Staged retrofits

Knowledge about the concept and main challenges of staged deep energy retrofits, both from the perspective of the building envelope and building services. Particular focus is given to the following topics:

3.1. Basics of staged retrofits [EuroPHit]

- Particularities of staged retrofits
- Staged retrofitting according to plan
- General information about the EnerPHit and the EnerPHit Retrofit Plan (ERP)
- Special construction solutions
- Connection details
- Mechanical equipment implementation concepts
- RES implementation
- Special contracting concepts for more reliable, faster and cheaper renovations.
- Consideration of side-effects of measures

3.2. Building envelope in staged retrofits – general principles [EuroPHit]

- Thermal bridge avoidance in staged retrofits
- Airtightness concept for staged retrofits
- Minimal requirements for thermal comfort and prevention of mould in staged retrofits

3.3. Building envelope in staged retrofits – Connections in detail [EuroPHit]

Familiarity with the most relevant connections including challenges and possible solutions for deep energy retrofits from the perspective of staged retrofits:

- Wall insulation on the outside
- Exterior wall with interior insulation
- Windows and door
- Insulation of a pitched roof
- Flat roof insulation
- Insulation of the basement ceiling and floor slab
- New balconies and conservatories
- Use of certified PH Components

3.4. Building services of staged retrofits [EuroPHit]

- Ventilation
- Heating and DHW systems
- Cooling and dehumidification
- Active utilisation of solar energy

II. Module for Certified Passive House Designers/Consultants only

4. Economic aspects of retrofits

Knowledge about the following topics regarding economic aspects and cost-efficiency of deep energy retrofits:

- Economic efficiency of energy saving measures in building retrofit: useful economic valuation methods (net present value) vs. less useful ones (e.g. amortisation period) [AkkP 42], [EuroPHit 1]
- Evaluation and communication of low-investment measures [AkkP 42], [EuroPHit 1, [EE+]
- Systematic approach to retrofit energy audits and evaluation [EE+], [Bastian 2012]
    - Analysis of current state of building [Bastian 2012]

    - Classification and evaluation [Bastian 2012]
        - Building characteristic values
        - Component characteristic values
- Advising the client on cost-optimised solutions,
- Systematic planning of retrofit measures and their sequence [EE+]
- Economic efficiency and life cycle assessment [AkkP 42], [3encult], [EuroPHit 1], [Bastian 2012]
    - For full retrofits
    - For staged retrofits

5. In-depth design knowledge and quality assurance aspects and other relevant aspects of deep energy retrofits

5.1. In-depth design aspects of retrofit, full and staged

Knowledge on the following in-depth aspects of retrofit, both for full or staged retrofit, is expected:

- Thermal insulation (exterior and interior) for retrofits:
    - Building physics principles of damage-free thermal insulation, moisture protection concepts: construction and moisture, moisture sources, condensation, convection, vapour diffusion, liquid water transport, capillary-active insulation materials. 2 concepts: vapour open or vapour tight, particularities for interior insulation [EE+], [3encult]
    - Assessment tools and criteria, unproblematic cases, the Glaser method, dynamic hygrothermal simulations and assessment criteria [3encult]
- Cooling and dehumidification: special features of existing buildings [AkkP 48]
- RES: special features of existing buildings
- Particularities of non-residential buildings. Detailed knowledge of the following topics:
    - General considerations for the retrofit of non-residential buildings
    - Internal heat gains [AkkP 48]
    - Possibilities of optimised use of daylight and artificial lighting systems in the modernisation of non-residential buildings [AkkP 48]
    - Summer case and cooling strategies in refurbished non-residential buildings [AkkP 48]
    - Retrofitting of high-efficiency ventilation in non-residential buildings [AkkP 48]

5.2. Quality assurance aspects

Recognise quality assurance aspects, both for design and construction of retrofits, including the particularities and considerations for full and/or staged retrofit projects. Special attention should be given to the following aspects:

- Airtightness test and ventilation, particularities of full and staged retrofit [EuroPHit].
- Evaluation systems for highly efficient building retrofits [EE+]
- Special features of quality assurance for retrofits [EE+]
- Retrofit process, quality assurance and monitoring [Bastian 2012]
    - Integral design for retrofit
    - Special features for the design process of retrofits
    - Time planning
    - Cost calculation
    - Quality assurance
    - Building operation
    - Minimal monitoring [EuroPHit].

6. Review of examples

Though not part of the Retrofit examination, it is highly recommended that the analysis of existing built examples is part of any curriculum regarding deep energy retrofits.

7. PHPP for retrofit

Acquaintance with the relevant aspects of the use of PHPP particularly for the design and certification of EnerPHit projects and deep energy retrofits, including practice through exercises and examples on PHPP. The following aspects are considered:

- Relevance and features of the PHPP as a calculation tool for retrofit:
  - Full retrofit
  - Staged retrofits (ERP tool)
- Accuracy of PHPP results for refurbished and un-refurbished old buildings
- The importance and relevance of variations of the boundary conditions, as well as the input, selection and comparison of variants in the 'Comparison' worksheet are discussed
- Knowledge of the possible deviations from PHPP calculation and consumption before and after retrofit due to deviating boundary conditions (indoor temperature, air exchange, etc.).
- Importance of consistency of the PHPP calculation and building retrofit examples including typical difficulties in the retrofitting of buildings
- Quality requirements to be met for the individual components with an optimal retrofit.
- EnerPHit certification and its criteria on PHPP
- Relevance of the rebound effect in high-efficiency retrofits
- Thorough explanation of the advantage of the use of variants for calculation of retrofits and the use of the 'Variants' worksheet in PHPP, including how to convert a regular PHPP into a variant PHPP
- Input of existing building components in the PHPP (U-values)
- Input of window ventilation in the PHPP
- The certification steps of a step-by-step retrofit are reviewed and discussed, as well as the different worksheets of the ESP (scheduler, overview, description and notes on components).

8. Sources

The following list contains the source literature and course materials from the Passive House Institute that was used for the preparation of the current learning targets. Please note that some of the cited German sources may already be available on English on the Passipedia at www.passipedia.org

- [EE+] EE+ Course materials. Passivhaus Dienstleistung 2018
- [Bastian 2012] Bastian, Zeno et al. 2012: EnerPHit-Planerhandbuch. Altbauten mit Passivhaus-Komponenten fit für die Zukunft machen. Passivhaus Institut, Darmstadt, 2012 [EnerPHit Design Handbook. Making existing buildings fit for the future with Passive House components. Passive House Institute, Darmstadt, 2012]. (German only)
- [Bastian 2022] Bastian, Zeno et al. 2022: Retrofit with Passive House components. Energy Efficiency, Springer Nature B.V. 18 January 2022 https://rdcu.be/cFgCo
- [3encult] Troi, Alexandra and Bastian, Zeno 2015. Energy Efficiency Solutions for Historic Buildings. A Handbook. 3encult. Birkhäuser Verlag GmBH, Basel 2015
- [AkkP 24] Research Group for cost-effective Passive Houses, Protocol volume No. 24: Retrofit with Passive House components. Passive House Institute, Darmstadt 2003.
- [AkkP 32] Arbeitskreis kostengünstige Passivhäuser, Protokollband Nr. 32: Faktor 4 auch bei sensiblen Altbauten: Passivhauskomponenten + Innendämmung. Passivhaus Institut, Darmstadt 2005.
- [AkkP 42] Research Group for cost-effective Passive Houses, Protocol volume 42: Economic evaluation of energy efficiency measures. Passive House Institute, Darmstadt 2013
- [AkkP 48] Research Group for Cost-effective Passive Houses, Protocol Volume No. 48: Use of Passive House Technologies in the Modernistaion of non-residential buildings Passive House Institute, Darmstadt 2012.
- [EuroPHit 1] Bastian, Zeno et al. Step by Step retrofits with Passive House components. EuroPHit. Passive House Institute 2016 https://europhit.eu/sites/europhit.eu/files/EuroPHit_Handbook_final_Optimized.pdf

- [EuroPHit 2] EuroPHit Training Materials https://europhit.eu/downloads#Training%20matetrials
- [Pfluger 2019] Pfluger, Rainer, Housing ventilation in existing buildings. Highly efficient and cost-effective solutions for the modernisation of old buildings. VDE Verlag GmbH. Offenbach, 2019 [Wohnungslüfutung im Bestand. Hocheffiziente und kostengünstige Lösungen für die Altbausmodernisierung (German only)]
- [PHI 2021] Passive House Institute. Interior insulation. Comfortable, safe, cost-effective LEA LandesEnergieagentur GmbH on behalf of the Ministry of Economic Affairs, Energy, Transport and Housing of Hesse, May 2021 [Innendämmung. Behaglich, sicher, kostengünstig LEA LandesEnergieagentur GmbH im Autrag des Hessichen Ministeriums für Wirtschaft, Energie, Verkehr und Wohnen Hessen (German only)]