KNOW HOW HP

D5.1

Concept of the courses for installers

Public Report

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Principal Authors

Dr. Isabel Wendl (eza! Energie- und Umweltzentrum Allgäu gGmbH)

Martin Sambale (eza! Energie- und Umweltzentrum Allgäu gGmbH

Contributors

Dietmar Siegele (Fraunhofer Italia, FHI) – chapter 3.3

Julius Emig (Fraunhofer Italia, FHI) – chapter 3.3

Sebastian Obermaier (TH Rosenheim, THRo) - Review

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Energieinstitut Vorarlberg

Project partner

Rosenheim Technical University of Applied Sciences

universität innsbruck

eza! Energie- und Umweltzentrum Allgäu

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About the project

The objective of the three-year project KnowHowHP is to upskill installers and professionals with an integral planning process to increase the use of heat pumps (HP) in existing multi-storey buildings. HP is increasingly used in single-family homes rather than in existing apartment buildings.

Increased use of HP in this field helps to fulfil the EU‘s climate and energy goals and the European Green Deal. The training and qualification of planners and installers are crucial to ensure that HP and refurbishment concepts are optimally aligned; otherwise, these refurbishments and the transition to HP are just not realised with the argument that it is not -feasible.

The special KnowHowHP training and upskilling consists of a knowledge-based software-supported process. That means planners, energy consultants, and installers get upskilled with an integral planning and implementation process for climate-friendly and socially acceptable refurbishments of multi-family houses with HP.

Such planning offers the following advantages: better quality, simpler, faster, more robust planning, better planning documents, more planning reliability (lower risk, error prevention) and better scalability (higher renovation rate). The basis for these planning instruments is the latest research results deducted from various projects and through in-depth investigation. The project consortium consists of three scientific and four knowledge dissemination partners, all with many years of experience in training courses.

In this composition, the existing training offers and planning processes are first analysed (WP2), and then the new KnowHowHP training and digital toolbox are developed (WP3+4). The dissemination partners will then pass this knowledge to the target groups of installers and professionals (WP5). At the same time, strong communication with all stakeholders involved, including the owners of the buildings, will be ensured to disseminate the content beyond the project area and duration.

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SUMMARY

D5.1 is part of Work Package 5 (WP5). It sets out the course concept for upskilling heat-pump installers for the refurbishment of existing multi-storey buildings, the project's main field of action. The deliverable is the companion to D5.2 (course concept for planners).

The grant agreement (Annex 1, Part B 2.2) foresees three training schemes for installers: "Sachkunde Wärmepumpe VDI Oberbayern" (THRo), "Course for installers Schwaben" (eza!) and "Course for installers northern Italy" (Klim). Together they amount to 10 trainings: eza! 2, Klim 2, THRo 6. The EIV course "Fachkurs Heizungstechnik Installateure" (Austria) is offered in addition.

The concept follows from the project's own analysis: The WP2 gap analysis (D2.1, D2.2, D2.4) identified a need for modular, role-specific and scenario-based training. It also found that existing training offers are extensive but fragmented, and that joint learning formats are rare. Based on this, the partners developed the concept in stages: a preliminary modular design (November 2025), a first concept at the project meeting in Kempten (March 2026) with mandatory and optional topics, and the final concept (July 2026).

The resulting course concept is designed as a two-day course of 800 minutes in 10 modules, taught in the classroom or live online, with a growing share of hands-on work. The first day covers the basics: regulations, heat pumps in multi-storey buildings, integral planning, efficiency, heat sources and heat load calculation. The second day covers application: dimensioning, heat dissipation and domestic hot water, a planning example, hands-on commissioning on a real heat pump, and communication with customers and colleagues.

In Germany the concept follows VDI 4645, so participants can take the exam for the recognised qualification "heat pump systems specialist". The concept is general enough to be adapted to Austrian and Italian requirements.

Training material from WP3 and WP4 is pooled in a shared material database. In addition, the KnowHowHP training platform (training.knowhowhp.eu, in German, English and Italian) was developed. It links a 3D building model, hydraulic views, calculations and variant comparison with a Wiki of 132 guides and a conversational assistant. The platform supports both trainer-led and self-paced learning. It records learning progress at the levels of understanding, application and transfer.

Since the first planned course had to be cancelled due to lack of participants, the first courses are scheduled for 23/11/2026 (Klim), 26–27/11/2026 (THRo) and 01–02/12/2026 (eza!). More courses are planned for 2026 and 2027.

Parts of the WP3 material (slides, web-based heat load tool) are not yet fully ready for teaching. They are being finalised alongside the first courses.

All courses are evaluated with a standardised feedback form in German, English and Italian. The results feed into revising the content, structure and teaching methods, as documented in milestone M13.

The platform and its Wiki are updated continuously during the project.

1. BACKGROUND INFORMATION

This deliverable has to be considered as part of the pair of D5.1 and D5.2., each focusing on course concepts but for different target groups: D5.1 focuses on the course concept for installers, D5.2 on that for planners. However, some of the content is valid for both groups, therefore some duplication can be found.

1.1. Target group of installers

In order to address the target group of the installers, one needs to understand that this is a group which is hard to reach for upskilling. In Austria and Germany no mandatory upskilling is required to work as an installer for heat pumps apart from the basic job training. In Italy the situation differs a little: installers for heat pumps need to be registered at a Chamber of Commerce. To be legally authorised to carry out this work, it is compulsory to complete a course (for the company's technical manager). Consequently, the regulations are determined by the regions or provinces where the Chamber of Commerce is based. In practice, the manufacturers run the course, which is then certified by the Chamber of Commerce.

In general, trainings for installers almost always compete with trainings offered by manufacturers at no or very low costs. Furthermore, trainings by manufacturers provide training on specific features of a specific heat pump brand or type rather than a general overview.

With all of this in mind, it was very important to keep the course concept within a certain limit: short enough to attract the target group as well as long enough to cover all essential topics needed in the context in the renovation of multi-storey houses. It should focus on practical relevance and contain as many use cases as possible.

For Germany the project partners agreed on the fact that the voluntary but widely known and recognised label of the VDI 4645 should be included in the courses to provide an additional incentive for the installers.

1.2. Connection to grant agreement

1.2.1. Training schemes

As given in the grant agreement (Annex 1 Part B 2.2) three different training schemes for installers were to be developed: the course "Sachkunde Wärmepumpe VDI Oberbayern" by THRo, the "Course for installers Schwaben" by eza! and the "course for installers northern Italy" by Klim. The length varies between 2 and 5 days (see Table 1 for details). The overview displays that the trainings planned were supposed to include both newly developed content as well as content that should be integrated in existing courses. The preferred training method is also given.

Table 1 Overview of planned training schemes for installers by the project partners.

Project partner	Trainings	Duration	New (N) or integration (I) in existing course	Training method
eza!	Course for installers Schwaben	2-5 days	N & I	Classroom, on-site, e-learning
Klim	Course for installers northern Italy	2-3 days	N & I	1-2 online (e-learning), 1 classroom
THRo	Course „Sachkunde Wärmepumpe VDI"	2 days	N & I	Classroom, e-learning, lab
EIV	Course "Fachkurs Heizungstechnik Installateure (für Meisterprüfung)"	20 of 240 hours KnowHowHP related content	N & I	Classroom, e-learning, lab

1.2.2. Realised and planned trainings

A total number of 10 trainings for installers was promised in the grant agreement by the three project partners eza! (2), Klim (2) and THRo (6). The course "Fachkurs Heizungstechnik" by EIV wasn't explicitly mentioned in the grant agreement and is to be considered as an add-on.

To date (04/11/2026) no training for installers has been realised, apart from the 3-hour-workshop in the frame of an eza!-partner networking event on 23/09/2026. However, this workshop "Mehrfamilienhaussanierungen mit Wärmepumpen – Konkrete Schritte – Lösungsmöglichkeiten" included all three target groups (installers, energy consultants and planners). It is also considered as an add-on training that isn't represented in the overview of promised training schemes in the grant agreement.

The two trainings "Fachkurs Heizungstechnik Installateure" (EIV) and "Sachkunde Wärmepumpe Oberbayern" (THRo) planned until September 2026 had to be cancelled due to a lack of registrations. New dates have partly been set for the end of 2026 and 2027, respectively. Further trainings are under development and planned to be implemented in November or December 2026 as well as in 2027. Table 3 gives an overview of the planned trainings during the project period, with an approximate timeframe for the implementation.

Moreover, it was decided to shorten the length of the trainings for installers to 2 days in the case of eza!. This is on the one hand due to the target group, which is difficult to motivate for trainings in general and has little time, on the other hand due to the fact that the training is to meet the requirements of the VDI 4645.

Table 2 Realised and cancelled trainings for installers up to 20/10/2026. Number of teaching units (TU = 45 min) given.

Partner	Country	Course name	Target group	Date	No. of partici-pants (expec ted)	No. of partici-pants (real)	Length (TU)
EIV	AT	Course Fachkurs Heizungstechnik Installateure (für Meisterprüfung)	Installers	Cancelled	15	0	20
eza!	DE	Workshop: Mehrfamilienhaus -sanierungen mit Wärmepumpen – Konkrete Schritte – Lösungsmöglichk eiten	Installers, energy consultants , planners	23/09/2026	40	17	4
THRo	DE	Course Sachkunde Wärmepumpe VDI Oberbayern	Installers	(17/09-18/09/2026) Cancelled	15		2 days (800 min)

Table 3 Planned trainings for installers within the project (2026 and 2027); planned: date already fixed, open: no fixed date.

Partner	Country	Course name	Target group	Year (and month) planned	No. of participants (expected)	Status (planned or open)
EIV	AT	Course Fachkurs Heizungstechnik Installateure (für Meisterprüfung)	installers	2027	15	open
eza!	DE	Course for installers Schwaben	installers	01/12-02/12/2026	25	planned
eza!	DE	Course for installers Schwaben	installers	2027 (06)	25	open
Klim	IT	Course for installers northern Italy	installers	2026	15	open
Klim	IT	Course for installers northern Italy	installers	2027	15	open
THRo	DE	Course Sachkunde	installers	26/11-27/11/2026	15	planned

		Wärmepumpe VDI Oberbayern				
THRo	DE	Course Sachkunde Wärmepumpe VDI Oberbayern	installers	2026	15	open
THRo	DE	Course Sachkunde Wärmepumpe VDI Oberbayern	installers	2027	15	open
THRo	DE	Course Sachkunde Wärmepumpe VDI Oberbayern	installers	2027	15	open
THRo	DE	Course Sachkunde Wärmepumpe VDI Oberbayern	installers	2027	15	open
Klim	IT	Kurs Wärmepumpen LVH	Installers	23/11/2026		planned

2. DEVELOPMENT PROCESS OF THE CONCEPT

2.1. Gap analysis (WP2)

Work Package 2 (WP2) covered a thorough analysis to 1) identify obstacles, knowledge gaps and role-specific frustrations, 2) map the planning instruments, software tools and training offers, 3) shed light on stakeholder engagement, and 4) define the KnowHowHP integrated refurbishment approach for heat-pump refurbishment in existing multi-family buildings, reported in deliverable D2.1 – 2.4. The main inputs from WP2 for this deliverable (D2.1, D2.2 and D2.4) are summarised in the following paragraphs.

D2.1 recommended training measures for the three target groups of planners, energy consultants and installers, of which the first two were grouped together, based on the gap analysis. The group of installers in the context of multi-storey refurbishment are highly experienced professionals, often with more than a decade of practice.

In general, it was found that modular, role-specific, and scenario-based training formats were needed. Above that, further recommendations were divided into 1) cross-cutting recommendations – valid for all target groups, and 2) specific recommendations for installers. Those were mainly interdisciplinary training formats and modular blended

learning structure, regionally adapted content and post-training support. Additionally, the trainings designed for installers, in particular, were recommended to include: on-site commissioning laboratories, modules on hybrid and peak-load management, training in noise and vibration mitigation techniques, digital controls and monitoring workshops as well as joint “refurbishment reality” workshops with planners.

Deliverable D2.2 then mapped the planning instruments, software tools and training offers. The deliverable concluded that tools or training offers are not missing in general, but that they are not yet configured and combined in a way that systematically addresses the specific challenges of HP-based refurbishment in multi-storey buildings. Tools were found to be available in a great variety but to be often used in simplified modes. Furthermore, trainings typically introduced tools and concepts in isolation rather than along an explicit, shared process. Existing trainings in all three regions (Germany, Austria, Italy) were found to be extensive but fragmented. Some important content when dealing with the integrated refurbishment workflow developed in WP2 was stated to be still missing. Joint learning formats in which planners, installers, energy consultants and property managers work together on HP retrofit scenarios were found to be rare in all three regions as well.

D2.4 defined the KnowHowHP integrated refurbishment approach for heat-pump refurbishment in existing multi-family buildings. The integrated refurbishment approach was for installers thought to have the main learning focuses of recognising practical constraints early, contributing to concept comparison, ensuring reliable installation and handover. D2.4 also recommended to be used for WP5 in the way that the integral refurbishment approach can be used to structure cross-professional learning activities, workshops and feedback. The latter is needed to continually improve the learning material and the trainings themselves. D2.4 is seen as the methodological bridge between the WP2 analysis and the subsequent training, digital-support and upskilling activities.

2.2. Preliminary design

The outcome of D2.1 already hinted to a modular structure of the trainings with parts taking place on-site as well as including joint workshops with planners.

This led to a preliminary course design with modular structure developed by the project partners mainly involved in running trainings for installers (THRo, eza!, Klim, EIV) in an online meeting in November 2025.

The modular structure offers the possibility for trainings to be tailored to participants’ prior knowledge and circumstances. The training provider can further choose which module(s) to focus on and which ones to combine and arrange in terms of length and depth of knowledge.

2.3. First concept

Based on the first preliminary design, further development on the course concept mainly took place at the workshop within the project meeting in Kempten on 19/03/2026. The results of D2.2 were included.

Given the fact that the three training schemes proposed in the grant agreement all suggested a training length of about 2-3 days, the trainings for installers didn't need further cluster.

Table 4 Training scheme for installers, teaching units (TU) = 45min.

Duration	Method	Content
2 (+1) days (max. 20 TU)	Classroom (min. 1 day), e-learning, lab/on-site	understanding heat pumps, their integration in existing buildings, analysis and elimination of application obstacles and the interaction of heat pumps with other renovation measures (goal in AUT: "Meisterprüfung") + add-on course on HP in multi-storey refurbishments

Target-group-specific topics were afterwards defined as mandatory (MUST-HAVEs) and optionally (OPTIONAL) for trainings for each group (installers, planners, energy consultants). Moreover, the preferred teaching methods (classroom, online, self-study) were discussed and noted (see also Figure 1).

For installers the mandatory content was defined as the following:

- Regulations
- Integral refurbishment – basics
- Communication "pro HP"
- Heat dissipation
- Hot water supply
- Dimensioning of HP
- Commissioning and monitoring
- Demand-based/ realistic heating load calculation
  (theory is prerequisite knowledge)

Optional topics for installers were defined to be integral planning approach (detailed), selective envelope refurbishment and the range of U-values in existing buildings and refurbishments.

The preferred teaching format was defined as a mix of classroom, live-online or self-learning video format. Additionally, the trainings for installers were found to need practical training in the lab/on-site and externally.

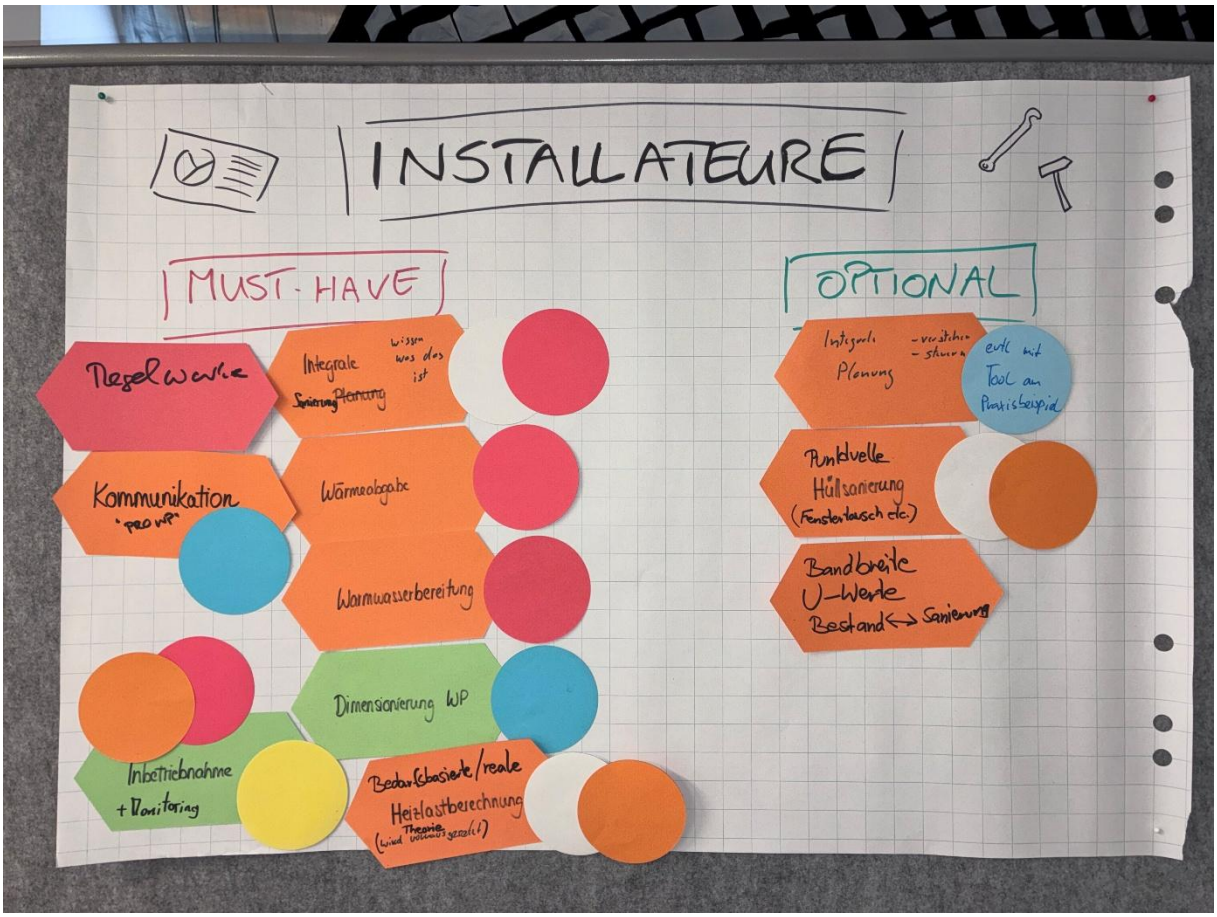

Figure 1 Overview of content considered as "MUST-HAVE" and "OPTIONAL", respectively, for installers at the project meeting in Kempten, as well as preferred teaching method (in round notes; red: classroom, orange: live-online, white: e-learning self-study, blue: practical training in the lab/on-site, yellow: practical training externally). Original in German.

In addition to the training formats for installers that last at least 2 days, also shorter formats can be used to deploy individual parts of the full content. Generally, the project partners agreed on the fact that trainings would always vary in length and depth of content, depending on the specific need of the partner, country and situation (timewise, audience). However, for installers a training length of two days was considered as ideal.

The following basic principles for KnowHowHP trainings were defined for the integration of content into existing and new independent training formats. These are mandatory to be fulfilled:

1) Integration in existing formats, embedded in larger training courses: 1 teaching unit is sufficient
2) New independent training formats: 2 teaching units or more required
3) Formal requirements
   a. KnowHowHP & EU LIFE logo on slides (on all slides where possible, exception for universities)
   b. Relevant title (it must be clear that the content relates to KnowHowHP)
   c. Specialist audience

2.4. Concept of courses for installers

The first concept was further refined by eza! in July 2026. It is based on the time-length of two days, as common feature of the planned training schemes and considered as sufficient to raise the EQF level of the participants to a level of 4 or 5.

To ensure the learning progress, assessments of the learning outcomes (e. g. quizzes) can be added. However, for installers a constant support with room for questions, discussions and guidance by the experienced trainers is even more important.

The elements previously defined as essential for a course for installers by the project consortium were put together to a 2-day (800 minutes) training for installers. The concept described in chapter 2.4.1 is based on the requirements of the German VDI 4645 in order to give the participants the possibility to take the exam of the VDI to become a “heat pump systems specialist in accordance with VDI 4645”. However, the concept is also formulated in sufficiently general terms to work in other countries, such as Austria and Italy, as well. It just needs to be adapted in accordance to the relevant regulations and standards.

2.4.1. Two-day training for installers

The course is designed as a 2-day training (800 minutes), mainly taught in classroom or live-online format.

The first day consists of six parts and covers a total of 455 minutes, whereas the second day has another four parts which sum up to 345 minutes.

In total, the training consists of ten modules and includes the previously defined essential elements for installers.

Table 5 Description of the modular-structured 2-day training for installers. HP: heat pump.

Module No.	Topic	Dura -tion	Content	Learning goal	Material
1.	Introduction	45 min	• General introduction • Relevance of HP • Classification in accordance with VDI 4645 (Germany)/ other regulations	• Understanding the purpose and the structure of the course • Relevance of HP in general • Knowledge and understanding of the national regulations	• PowerPoint slides (WP3)
2.	HP in general and in multi-storey buildings	60 min	• Function of a HP • Basic knowledge	• Understanding of the characteristics of HPs in multi-storey buildings	• PowerPoint slides (WP3) • Schemes (WP3 and 4)
3.	Integral planning/ system concept 1	135 min	• Basics of energy-efficient buildings	• Understanding of energy-efficient buildings	• Training platform (FHI)

			• Envelope refurbishment • Integral planning approach	• Understanding the basics of the integral planning approach	• Interactive optimisation tool (EIV) • Test cases (WP4)
4.	Balance and efficiency	20 min	• Balance sheet limits • Efficiency considerations	• Understanding and interpreting calculations	• Off-line calculations (e. g. on whiteboard) • Online tools
5.	Heat sources	60 min	• Overviews of heat sources • Specifications	• Understanding the differences and advantages of different heat sources, their specifications and use cases	• PowerPoint slides (WP3)
6.	Consumer	135 min	• Demand-based heat load calculation (theoretical knowledge required)	• Understanding heating load calculations and being able to interpret them	• Calculation tools • Exercises with partly given numbers • Heat load tool (D3.2 confidential appendix) • Test cases (WP4) • Training platform (FHI)
Total day 1		**455 min**			
7.	System concept 2	180 min	• Dimensioning of HPs • Heat dissipation • Hot water supply	• Understanding of the dimensioning of HPs • Understanding and overcoming challenges with heat dissipation and hot water supply in multi-storey buildings	• PowerPoint slides (WP3) • Practical training (hands-on) • Test cases (WP4) with practical training of calculation and dimensioning • Training platform (FHI)
8.	Planning guide	90 min	• Example for overall planning • Calculations	• Understanding the advantages of integral planning • Ability of applying and interpreting calculations	• Test cases (WP4) • Training platform (FHI) • Calculation tools
9.	Commissio-ning & monitoring	45 min	• Reality-based commissioning and monitoring	• Ability to carry out commissioning process correctly • Understanding of monitoring	• Hands-on (real HP model) • Practical training
10.	Communica-tion	30 min	• Arguments towards customers	• Reliable, well-founded communication	• Practical training

			(inhabitants, house owners, owners' associations) • Arguments towards colleagues (planners, energy consultants etc.)	skills toward different target groups	
Total day 2		**345 min**	•	•	
TOTAL		**800 min**	•	•	

The course concept for installers (Table 5) comprises ten modules spread over two training days, 800 minutes in total (455 minutes on day 1, 345 minutes on day 2). The first day lays the theoretical foundations: after an introduction to the course, the relevance of heat pumps and the relevant national regulations, the modules cover the characteristics of heat pumps in multi-storey buildings, the basics of energy-efficient buildings and the integral planning approach, balance boundaries and efficiency, the different heat sources and demand-based heat load calculation. The second day focuses on practical application: dimensioning heat pumps, heat dissipation and hot water supply, a planning guide based on an overall planning example, hands-on commissioning and monitoring on a real heat pump model, and communication skills for dealing with customers and colleagues.

The modules use a mix of material: 1) PowerPoint presentations, new material being mainly developed in WP3, 2) calculation exercises, 3) online tools, partly being developed within the project, 4) test cases as described and processed by WP4, and 5) the training platform (FHI) described in detail in chapter 3.3. The proportion of practical training increases on the second day, so that participants move from understanding the principles to applying them confidently on site.

2.5. Feedback and evaluation

For all trainings feedback is requested from the participants. First, the feedback form historically used by the project partners was used. Then, a standardised feedback form was created by eza! in September 2026. This form, designed with Microsoft Forms, is now available in German, English and Italian in order to address the target group in all countries (further description can be found in Milestone 13 (M13)). The feedback collected is used to evaluate training formats, their structure, way of teaching and content. It will be used to re-evaluate training and teaching formats and help improve the quality of the trainings.

A first evaluation of the feedback is given in milestone M13 and will be used to improve future trainings.

3. TRAINING MATERIAL

The following chapters describe the teaching material developed to date. Due to the training material for installers being described in detail in D3.1 and D3.2 only a short summary is given. On the contrary, the training platform developed by FHI in the process of WP2 is described in detail because it is not described anywhere else but D5.2. Although some duplication may occur in the basic chapters (3.3.1 – 3.3.3), D5.2 then focuses on the platform as used by planners, whereas this deliverable D5.1 focuses on the platform as used by installers.

3.1. Material database

At the project meeting in Kempten in March 2026, it was agreed by all project partners to create a database for all material already available. This database is organised by topic, thus providing a broad collection of mainly PowerPoint slides but also other material for the project partners to arrange and adjust for their purpose.

Subsequently, all existing and newly developed material has been uploaded to the project cloud, structured according to topic and depth of content (basics and deeper understanding). Thus, gaps of essential training material could be identified and are on the way of being filled. The idea was to create a shared material-database which all project partners could use to compile their training material for the specific training planned.

3.2. Training material for installers (WP3)

Based on the gap analysis in WP2, training material for installers was supposed to be updated or developed within WP3. D3.1 stated the progress in the beginning of 2026. In June 2026 milestone M6 stated that the collection of trainings material had been completed. However, some of the material was not yet teaching-ready. D3.2 delivered in October 2026 describes the training material for installers in detail. It summarises the existing material that includes PowerPoint slides, diagrams, worked examples, calculation tools and interactive files. Additionally, D3.2 describes the newly developed material that covers the gaps identified by both WP2 and T3.1, ranging from more precise dimensioning/planning of HPs, heat distribution systems, heat dissipation systems to the integral planning approach and soft skills. The new material comprises PowerPoint slides, schemes, digital tools (e. g. web-based heat load tool by THRo, interactive optimisation tool by EIV) and the link to the training platform (FHI) and the digital toolbox (WP4, UIBK). The material has been completed and undergone a first round of evaluation by trainers. However, not everything is teaching-ready yet, especially the slides. The web-based tool is not yet finalised either. Nevertheless, the material for installers can be used in trainings, being further evaluated and adapted based on the feedback of both the train-the-trainer workshops and the first courses.

As an addition or alternative to the “classic” material of slides, schemes and digital tools, the training platform described in the next chapter can be used in trainings for installers.

3.3. The KnowHowHP training platform (WP2, FHI)

3.3.1. The training platform

Purpose and place in the project

KnowHowHP develops skills for heat-pump refurbishment in existing multi-family buildings. The training platform at training.knowhowhp.eu brings the building, its heating system and the refurbishment process into one learning environment. Participants can explore a building, examine its evidence, develop measures and discuss the consequences of their choices. The intended learning outcome is an informed refurbishment decision that can be explained to other project participants.

The platform grew from the analysis and process development in WP2. D2.3 and D2.4 provide the project context for considering technical conditions, stakeholder needs and the sequence of refurbishment decisions together. The platform translates this approach into a building-based learning experience. It is an additional project result, documented here in sufficient detail for incorporation into the WP5 course concepts because a separate platform deliverable is not foreseen.

The platform was built on the training materials developed in the project and continues to develop with them. WP3 provides material for installers, while WP4 provides material for planners, professional planning calculations and the planning toolbox. These materials supply the technical content for explanations and practical exercises. WP5 brings them into a shared learning environment where participants apply their knowledge to buildings and refurbishment decisions.

The shared description in chapters 3.3.1 - 3.3.3 supports both WP5 course concepts, D5.1 and D5.2. Chapter 3.3.4 explains the different applications for installers, the equivalent chapter for planners can be found in D5.2. As the project training materials are expanded and refined, the platform content and related learning activities continue to be developed on that basis.

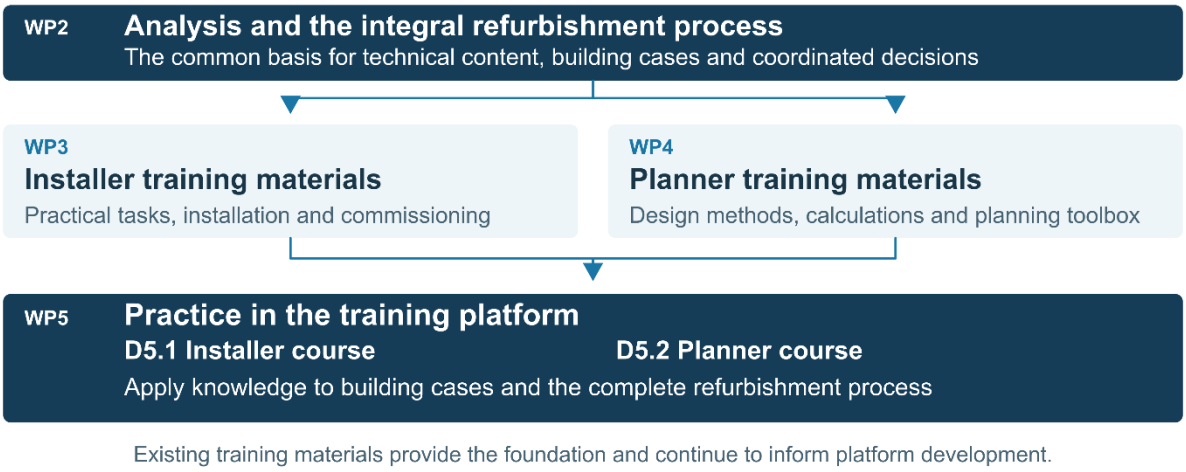

Figure 2 The platform builds on the WP2 process basis and the training materials from WP3 and WP4. WP5 uses this shared foundation in the installer and planner courses.

Entry points and navigation

The platform is available at https://training.knowhowhp.eu/. The homepage offers several ways to approach the subject. Training starts from the learner's current knowledge and learning goals. Demo projects provide access to reference buildings. A free project supports work on an individual building. The renovation journey introduces the complete process through an occupied apartment building. Knowledge gives access to the Wiki and the conversational assistant. These entry points serve different needs while sharing the same technical language and building context.

A new participant can first explore the renovation journey and consult the Wiki. A participant with practical experience can proceed to a building case and use explanations when a particular decision requires them. This avoids forcing every participant through the same introductory material. The interface is available in German, English and Italian; language selection is visible in the main navigation.

Inside the building workspace, the principal views are Building, Hydraulics, Input basis and Results. Further tasks connect technical work to the wider process. The selected project and variant provide the working context. Moving between views should therefore be understood as examining different aspects of the same refurbishment proposal, rather than starting independent exercises.

Access also affects what can be saved. Public explanatory material can be explored without a personal project. Personal projects and learning records use an account. A demo is a shared starting point; it should not be mistaken for the participant's own completed work. The homepage and the detailed workspace make this distinction visible.

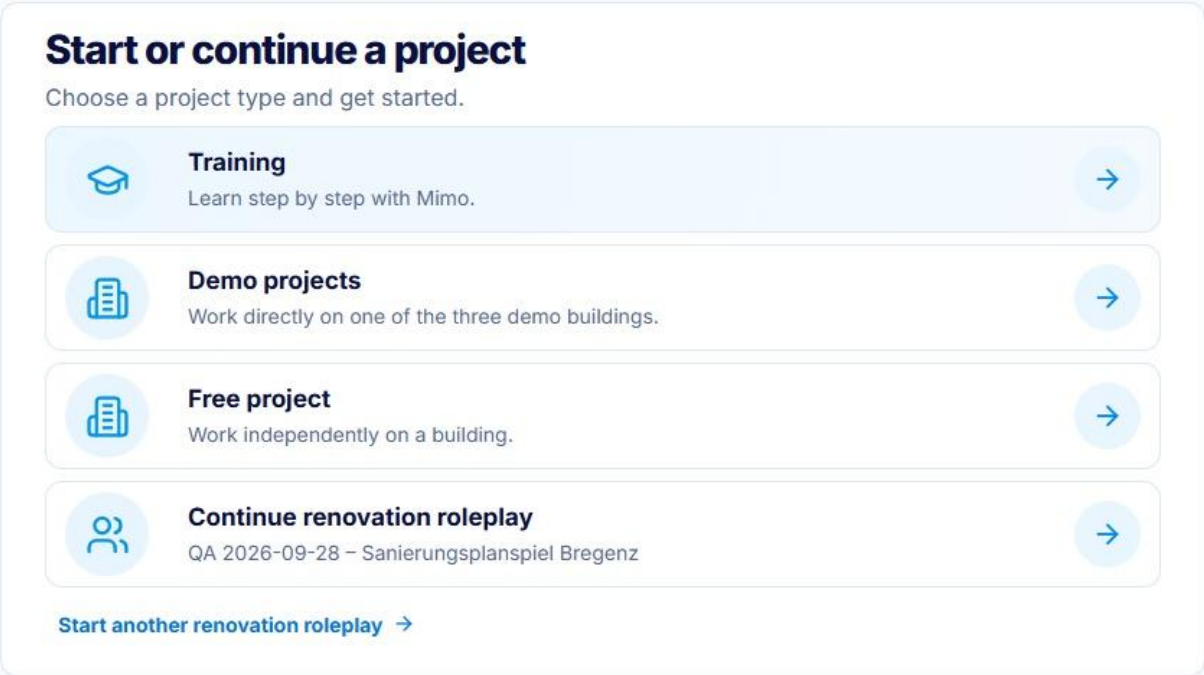

Figure 3 Homepage entry points for building training projects and role-play activities. Enlarged excerpt from the desktop interface.

How the platform connects learning and planning

The platform has three connected layers. The learning layer presents explanations, questions and activities. The project layer stores the building context, the existing system, alternative measures and the decisions attached to them. The calculation and evidence layer evaluates defined inputs and retains the basis on which a result was produced. The user interface brings these layers together around the participant's task.

This separation matters for learning. A clear explanation can improve understanding, but it does not establish that a particular building is suitable for a proposed installation. That conclusion depends on project data and the relevant technical checks. Likewise, a visible three-dimensional object shows where a component is represented; it does not by itself demonstrate its capacity, hydraulic connection or installation feasibility.

The building model provides a common spatial reference. Measures act on selected parts of that model. Hydraulic information represents connections and operating conditions. Calculation results refer to the corresponding input and variant state. The Wiki supplies reusable explanations, while the assistant helps the learner interpret concepts and ask follow-up questions. Responsibility for a technical decision remains explicit throughout this chain.

The implementation uses a browser interface, application services, a shared project data model and calculation services. Authentication controls access to personal records and authorised teaching functions. This structure supports the educational workflow without requiring participants to understand the underlying software components. The diagram below summarises the functional relationships rather than a server deployment.

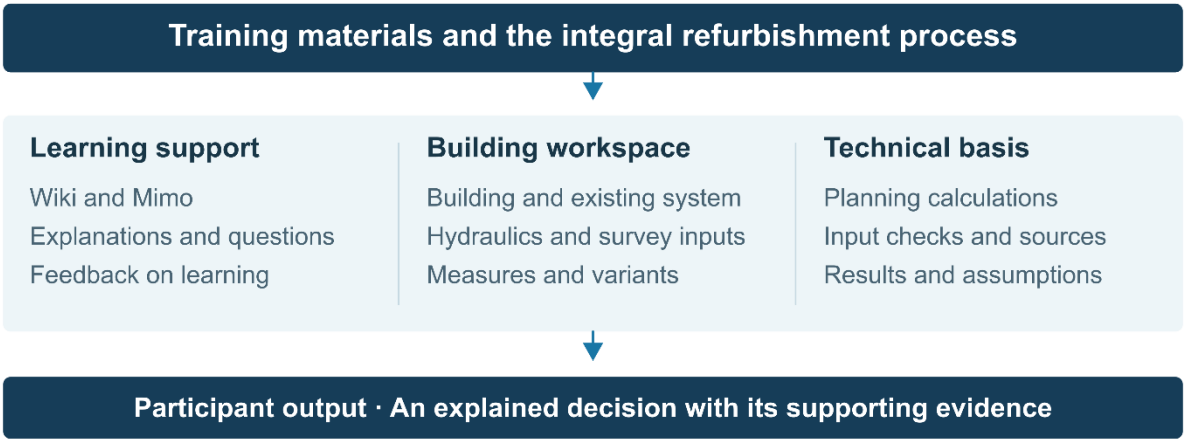

Figure 4 Functional architecture of the training platform. Project evidence, calculations and learning support have distinct roles and meet in the participant's workspace.

Building geometry and spatial exploration

The Building view is the spatial starting point for technical work. It presents the existing building and provides three-dimensional, floor-plan and section views. Participants can change the viewing direction, zoom, adjust transparency and inspect building layers. These tools help connect an abstract refurbishment measure to the affected spaces and surfaces.

A building is organised through its spatial hierarchy: building, floor, apartment and room. This hierarchy is relevant to both teaching and calculation. A whole-building result can conceal a critical room, while an apartment-level view can reveal how a measure affects one household. Selecting the appropriate scope is therefore part of the task, not merely a navigation preference.

The project model can originate from available digital building information and subsequent survey work. Imported geometry must be checked for completeness and correct interpretation. A floor plan may describe boundaries while omitting actual pipe routes, emitter types or the condition of a construction. The learning case makes these gaps discussable instead of allowing visual detail to stand in for evidence.

For example, a learner investigating a cold room first identifies that room and its external boundaries. The learner then checks the associated construction properties, use conditions and heat emitter. This creates a traceable route from a spatial observation to a technical question. It also makes communication easier: a planner and installer can discuss the same room and the same proposed change.

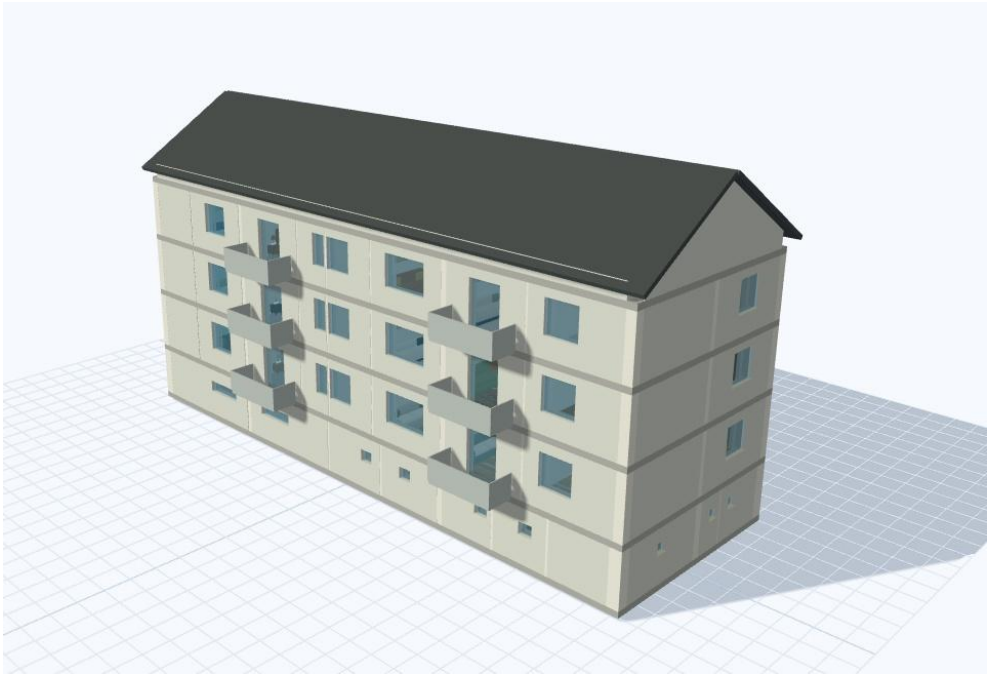

Figure 5 The Bregenz building model in the Building workspace, showing the apartments and external envelope. Enlarged excerpt from the desktop interface.

Creating and reviewing an individual building model

The free-project route extends the platform beyond a prepared reference case. The documented implementation supports a building setup based on map and manually described geometry, with an additional photo-assisted route. This allows the training to discuss how a usable building description is assembled when complete digital information is not available at the outset.

The photo-assisted workflow uses exterior photographs together with information about where they were taken and the viewing direction. An optional plan and apartment information can help describe the building. The generated geometry is a proposal for review. It does not turn photographs into a verified survey automatically, and uncertainty in camera positions or hidden parts of the building remains relevant.

Review is a separate activity. The implementation provides comments and targeted revisions to a proposed model, followed by an explicit decision to adopt accepted geometry into the project. Unchanged parts and source information are retained. Interior assistance can propose room and floor changes against a selected plan basis, while the normal project workflow controls whether those changes are saved.

For training, this route is useful because model creation becomes part of the reasoning. Learners compare what can be seen, what can be inferred and what needs measurement. They can explain why a visually convincing model may still lack the thermal, hydraulic or use information needed for calculation. The implementation also includes exchange through native project XML and IFC-related workflows. Exchange capability should be checked for the actual model and intended receiving workflow; it is not evidence of geometric accuracy.

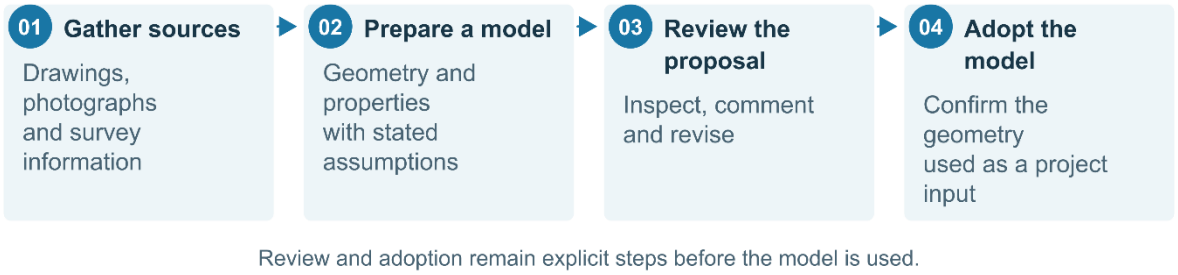

Figure 6 Individual building setup as a review process. Imported or proposed geometry becomes the project basis through an explicit review and adoption step.

Survey inputs and the basis of a decision

The Input basis view brings together the information needed to understand and calculate a building case. The relevant inputs include geometry and areas, construction properties, boundary conditions, room use, weather assumptions and the description of the existing heating system. Depending on the chosen analysis, additional evidence is needed for products, domestic hot water, costs, environmental impacts or acoustics.

The educational purpose is to make participants ask where a value comes from and whether it is suitable for the decision. A measured value, a value imported from a model, a catalogue value and a teaching assumption have different meanings. Their source and scope should remain identifiable. A plausible default is useful for an exercise only when the learner can recognise it as an assumption.

Survey and concept development are iterative. Initial information may be sufficient to compare broad approaches but insufficient to select equipment. A missing radiator dimension, uncertain wall construction or unknown circulation arrangement can therefore become a specific survey task. The participant should identify which uncertainty could change the preferred option and obtain that evidence first.

The platform's project records and review states support this distinction between information that is present and information that is reliable enough for a particular use. The practical output is a usable baseline with visible gaps, rather than a fully populated form with unexplained numbers. Training exercises can deliberately retain one uncertainty and ask learners to explain its effect on the next decision.

Table 6 Examples of input evidence and its use in training.

Input	Evidence to inspect	Learning question
Room geometry	Model or survey dimensions and boundaries	Does the geometry describe the space being assessed?
Envelope properties	Construction description and source of thermal values	Which assumption could change the refurbishment comparison?
Heat emitters	Type, dimensions, connection and performance data	Can output be evaluated at the proposed temperatures?
Existing system	Observed topology, settings and equipment records	What is known and what still requires inspection?
Costs and impacts	Quantity, unit basis, period and source	Are alternatives being compared on the same basis?

Reviewing room inputs and their sources

The Input basis workspace provides a practical starting point for a building exercise. The navigation on the left follows floors and apartments. The central table lists the selected input for the chosen scope, and the inspector on the right shows the value, unit and source or reason. Participants can therefore move from a whole-building overview to a specific room without losing the context of the value they are reviewing.

The example shows daytime room temperatures for the Bregenz case. Bedrooms, living spaces and bathrooms have different recorded assumptions. Selecting a row exposes the editable value and its allowed range. The Apply to selector distinguishes a single room from an apartment, floor or the whole building. A learner must choose that scope deliberately: changing one room and applying the same temperature everywhere have different consequences.

The source field is part of the technical input. Here the displayed value is labelled as a manual project assumption. The Used for information links it to heating-load and annual calculations. In a course, the participant can explain where a temperature comes from, whether it represents an agreed requirement and which other rooms should share it. The Save value action records an intentional change; the screenshot was taken while reviewing the existing values.

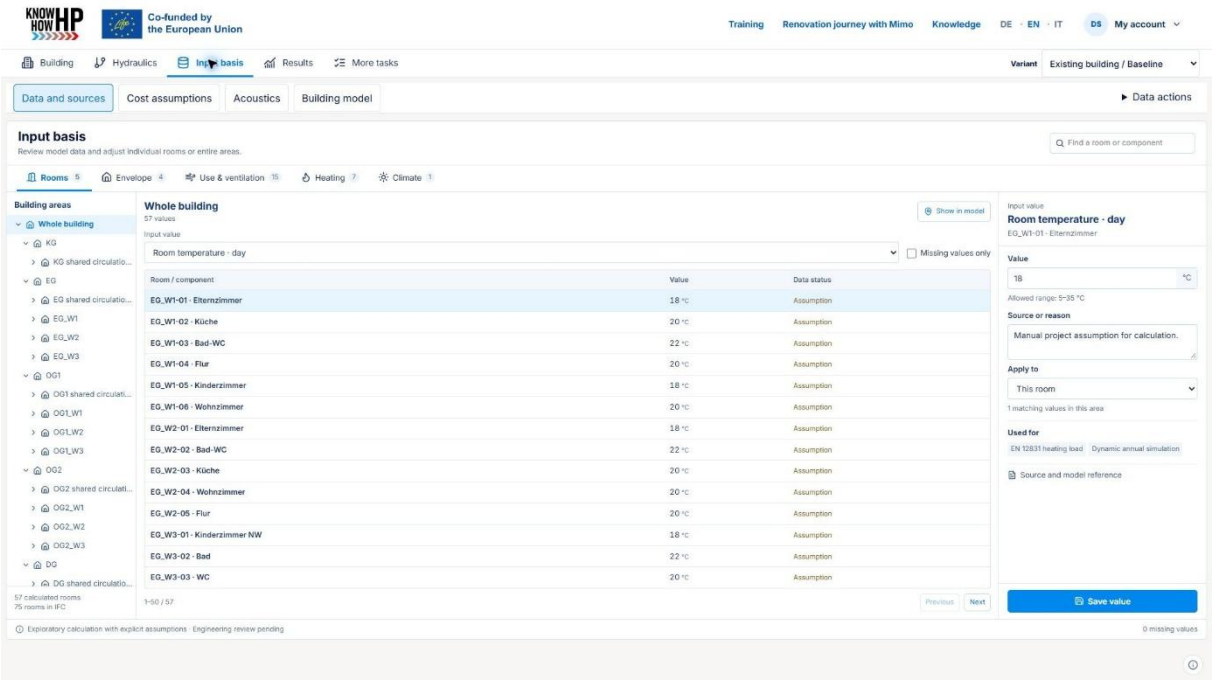

Figure 7 Room-temperature inputs with building hierarchy, data status, source field and application scope. The displayed values are assumptions in the selected training project.

Reviewing room inputs and their sources in detail

The following excerpts enlarge the relevant parts of the preceding desktop view. Each excerpt retains the original values, labels and status information.

Inspecting the selected room input

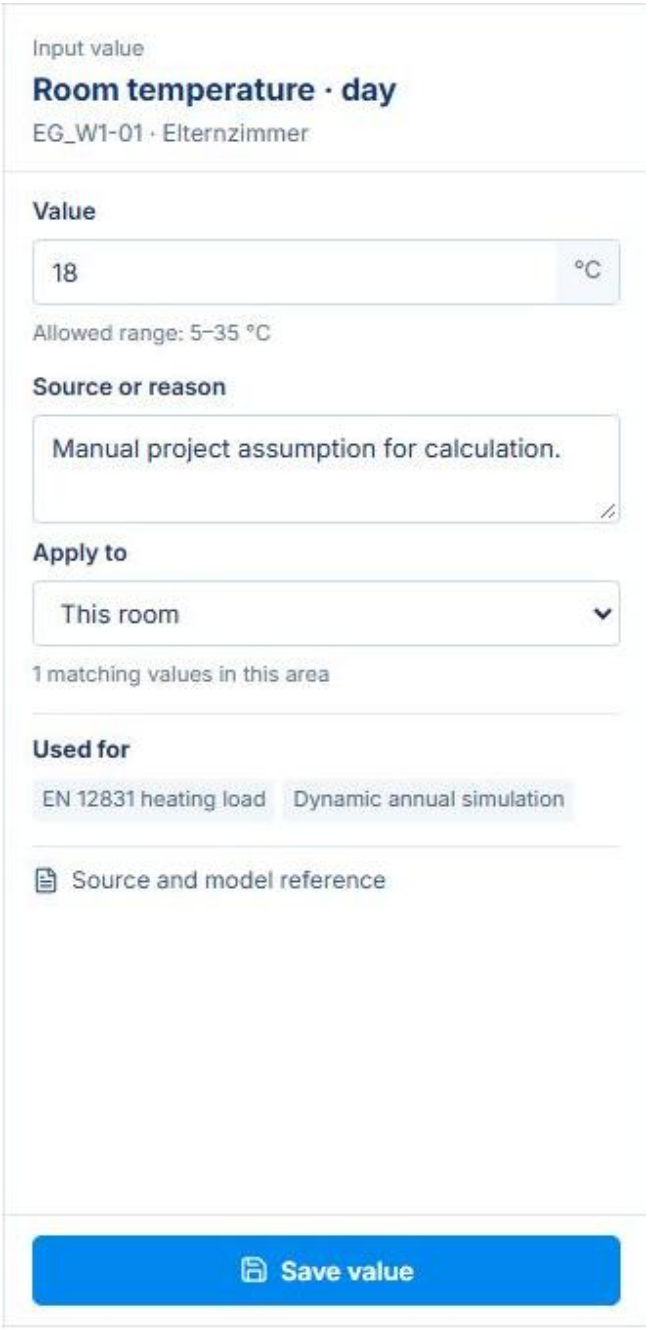

Figure 8 Inspecting the selected room input. Enlarged interface excerpt.

Connecting envelope properties to building elements

The Envelope category uses the same input workflow for walls, windows, doors and slabs. Each row retains its room and component reference. The screenshot shows U-values in W/(m²K), with the selected element identified in the inspector. This makes the connection between a thermal property and a physical part of the building explicit.

Participants first select the required input and building area, then inspect the relevant elements. The data-status column helps identify assumptions. The source or reason field explains the basis of an individual value, and the model-reference disclosure supports a closer check. A filter for missing values helps focus a review on incomplete information rather than treating an apparently complete geometry as complete calculation input.

A useful training activity is to compare an external wall with a window and explain their contributions to heat loss. The participant should establish which elements bound the heated space and whether the recorded property describes the existing construction. Refurbishment measures are then introduced through the measure workflow, keeping the baseline and the proposed intervention understandable. This sequence connects the project training materials on building physics to identifiable components in the case.

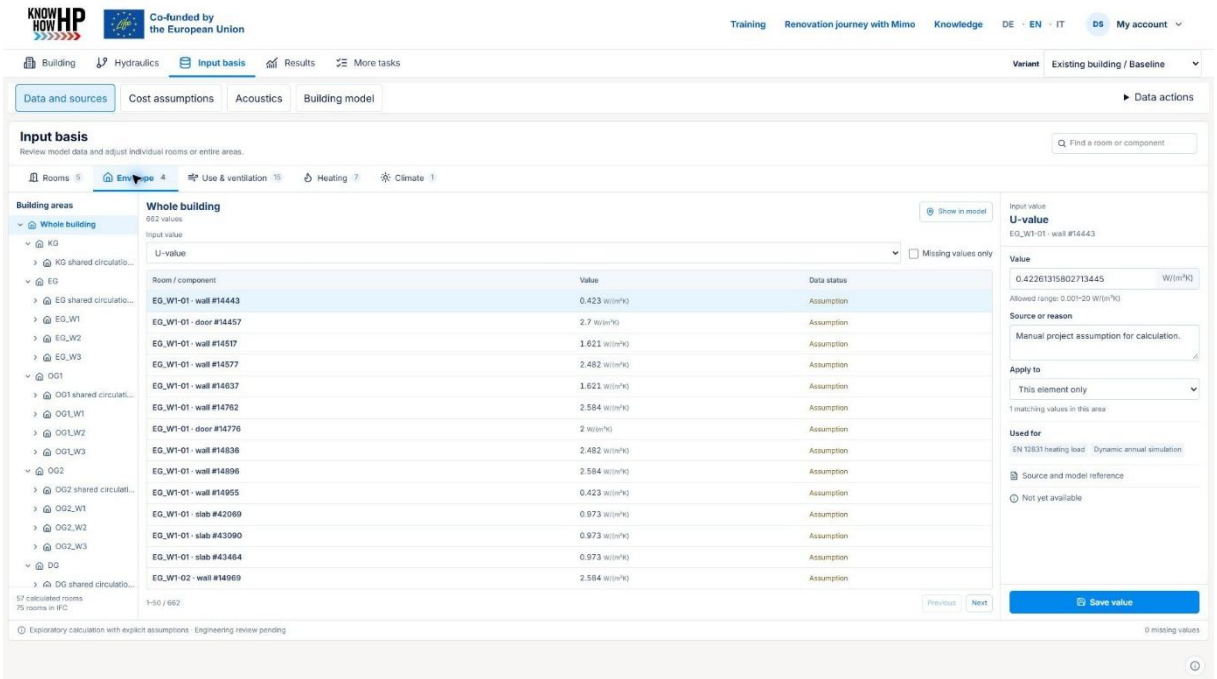

Figure 9 Envelope inputs linked to individual building elements. The U-value editor retains the unit, source and selected application scope.

Connecting envelope properties to building elements in detail

The following excerpts enlarge the relevant parts of the preceding desktop view. Each excerpt retains the original values, labels and status information.

Inspecting the selected envelope input

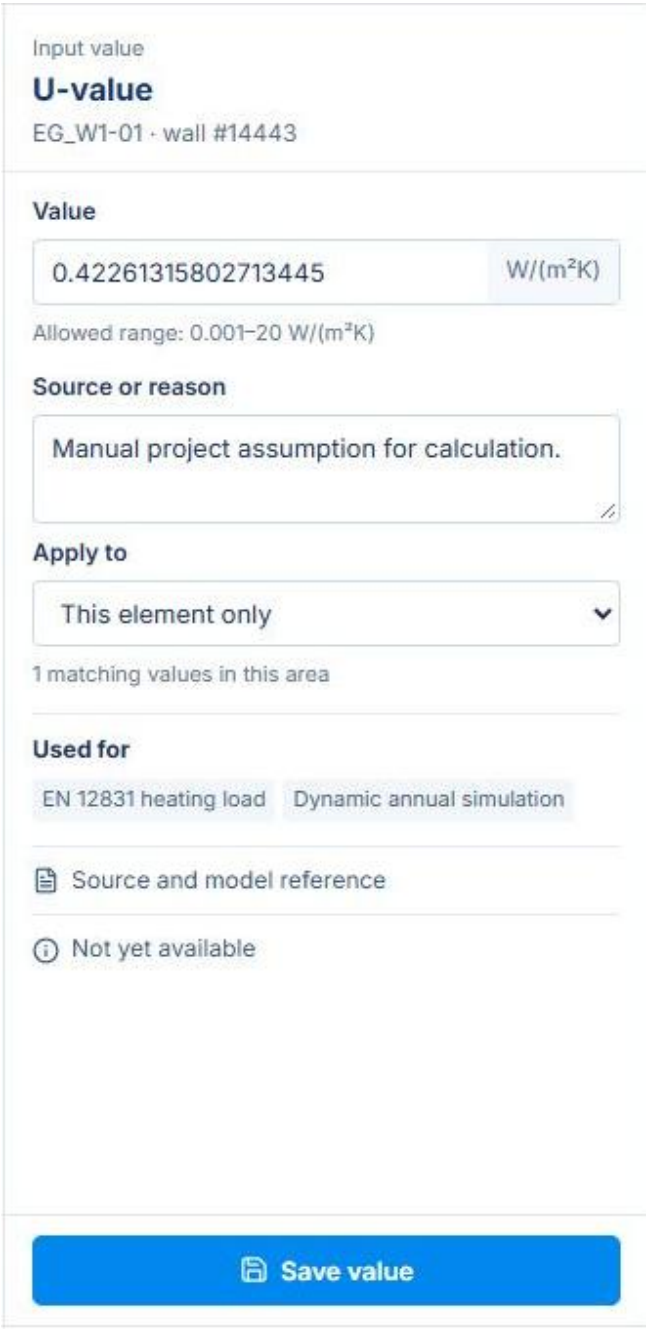

Figure 10 Inspecting the selected envelope input. Enlarged interface excerpt.

Measures and refurbishment packages

The measure catalogue turns a refurbishment idea into an explicit change to the building case. The interface groups measures so participants can work with the envelope, heating system and other relevant interventions. Examples visible in the catalogue include wall insulation, window replacement and roof or attic insulation. A measure has a defined spatial scope and parameters; it is more than a label attached to a scenario.

The wall-insulation editor illustrates this approach. The learner can specify a thermal target directly or derive the effect from an insulation build-up. The scope can be the building or a more limited spatial selection. Geometry, thickness, quantities and cost evidence then need to describe that same intervention. This supports a discussion of why changing one façade is different from treating the whole envelope.

The workflow separates previewing a measure from adding it to a package and saving a variant. Participants can examine a proposal before making it part of their comparison. A preview is provisional; it must not be presented as a completed calculation or an implemented refurbishment. The existing building remains the reference against which alternatives are interpreted.

Packages combine related interventions. Envelope work can affect the heat load and the temperature needed by existing emitters. Changes to emitters can affect the suitability of a heat-pump concept. Plant selection, controls and domestic hot water introduce further dependencies. The learning task is to develop a coherent package and explain those dependencies, rather than select the largest number of measures.

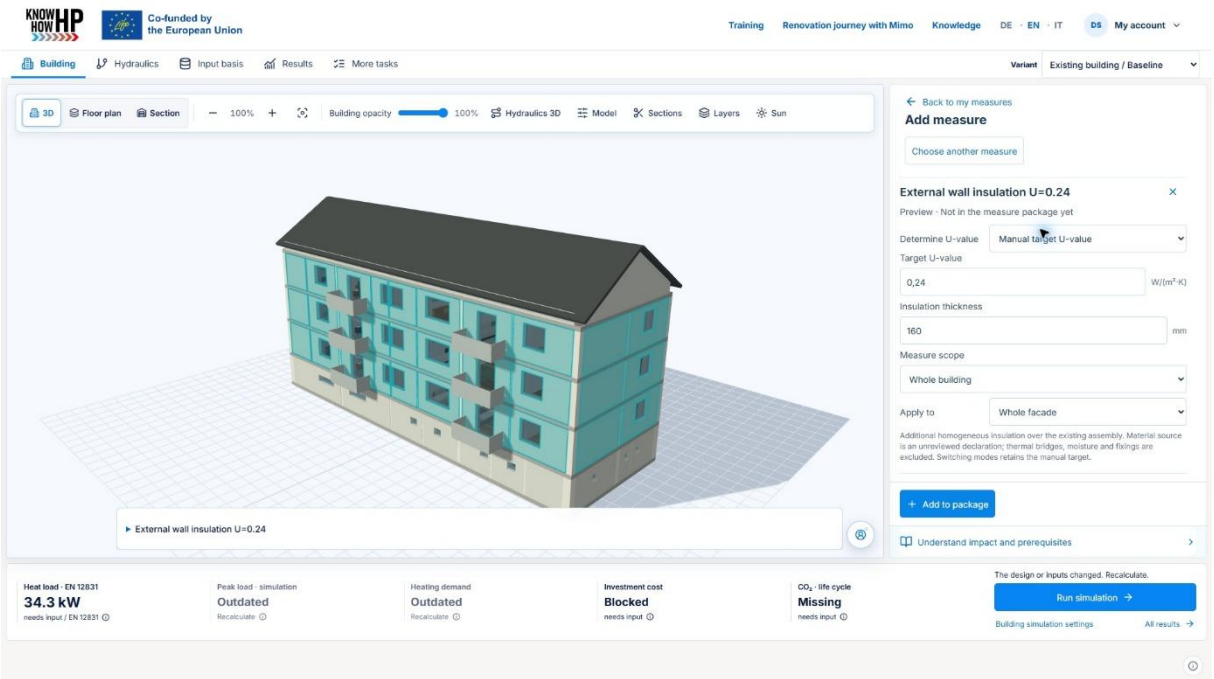

Figure 11 Wall-insulation preview with parameter and scope controls. This capture documents the editing interface; the preview shown had not produced a verified impact result.

Measures and refurbishment packages in detail

The following excerpts enlarge the relevant parts of the preceding desktop view. Each excerpt retains the original values, labels and status information.

Entering an external wall insulation measure

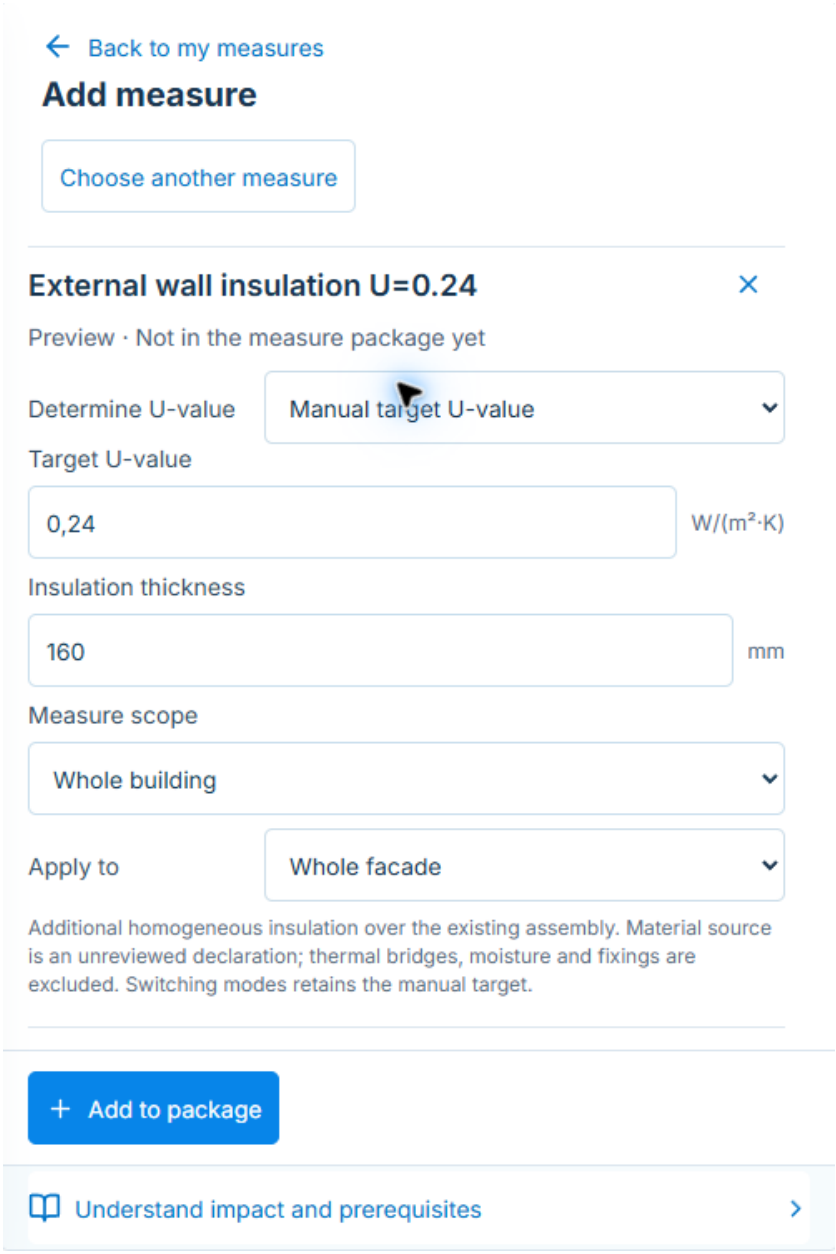

Figure 12 Entering an external wall insulation measure. Enlarged interface excerpt.

Hydraulic systems and equipment relationships

The Hydraulics workspace represents how heat generation, storage, distribution and heat emitters are connected. It distinguishes the existing system from the proposed variant. The interface provides schema, sizing, operating-mode and three-dimensional context views. Together, these views help relate a system concept to both its functional connections and its location in the building.

The Existing system view makes these relationships visible before a refurbishment is proposed. The illustrated basement area contains the existing boiler, circulation pump, distribution and risers, with connections to the ground-floor branches. Red supply lines and blue return lines distinguish the two paths. A building-area selector reduces the complete network to a manageable part, while adjacent components preserve the connection to the wider system. Selecting a component opens its properties and model references in the right-hand inspector.

For learners, the central question is how the whole system behaves. The required flow rates, pressure losses, pump duties and control states depend on the selected topology and operating conditions. Heating, hot-water charging and other operating modes may require different paths or priorities. A diagram becomes useful when these relationships are explained and connected to the available evidence.

The workspace also exposes checks and source evidence. A visually complete schema should not be treated as a completed design if connections, circuit data or product characteristics remain unresolved. In an installer exercise, the schema can be used to explain what must be verified on site. In a planner exercise, it can support comparison of alternative concepts and identification of the information needed before procurement.

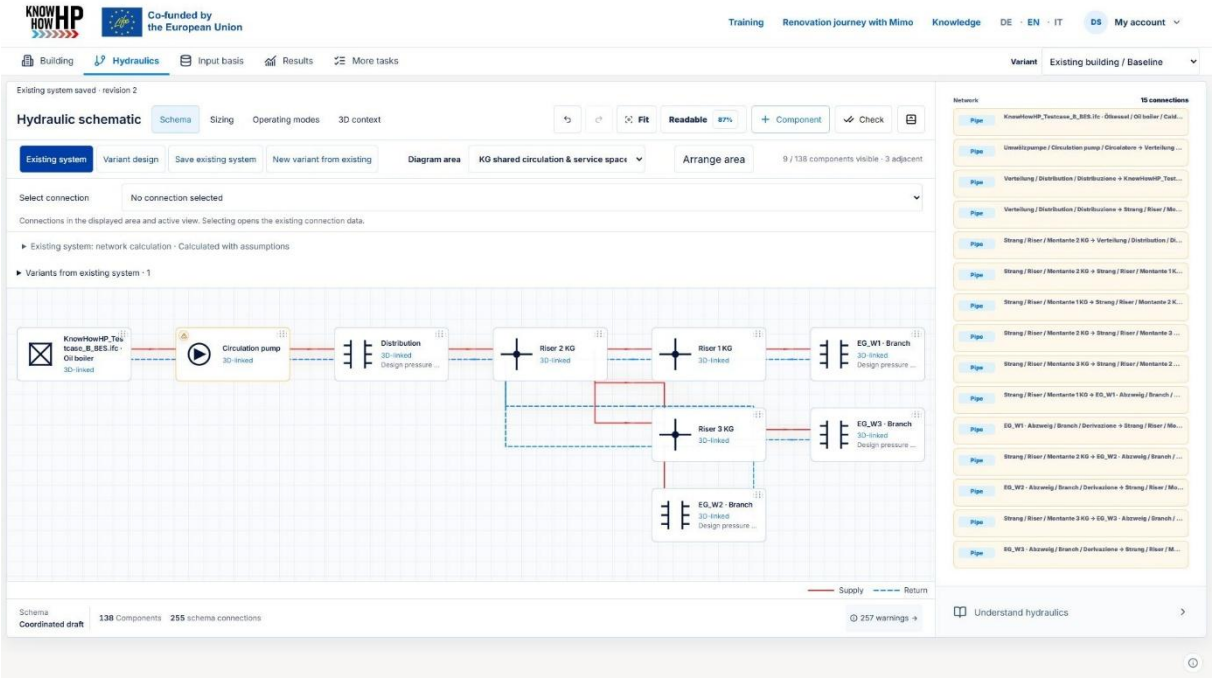

Figure 13 Existing system in the basement area of the Bregenz reference project. The boiler, pump, distribution and risers are connected through supply and return paths. The interface identifies this as an assumed system model, not a surveyed installation.

Hydraulic systems and equipment relationships in detail

The following excerpts enlarge the relevant parts of the preceding desktop view. Each excerpt retains the original values, labels and status information.

Oil boiler, circulation pump and distribution

Figure 14 Oil boiler, circulation pump and distribution. Enlarged interface excerpt.

The three risers and their ground-floor branches

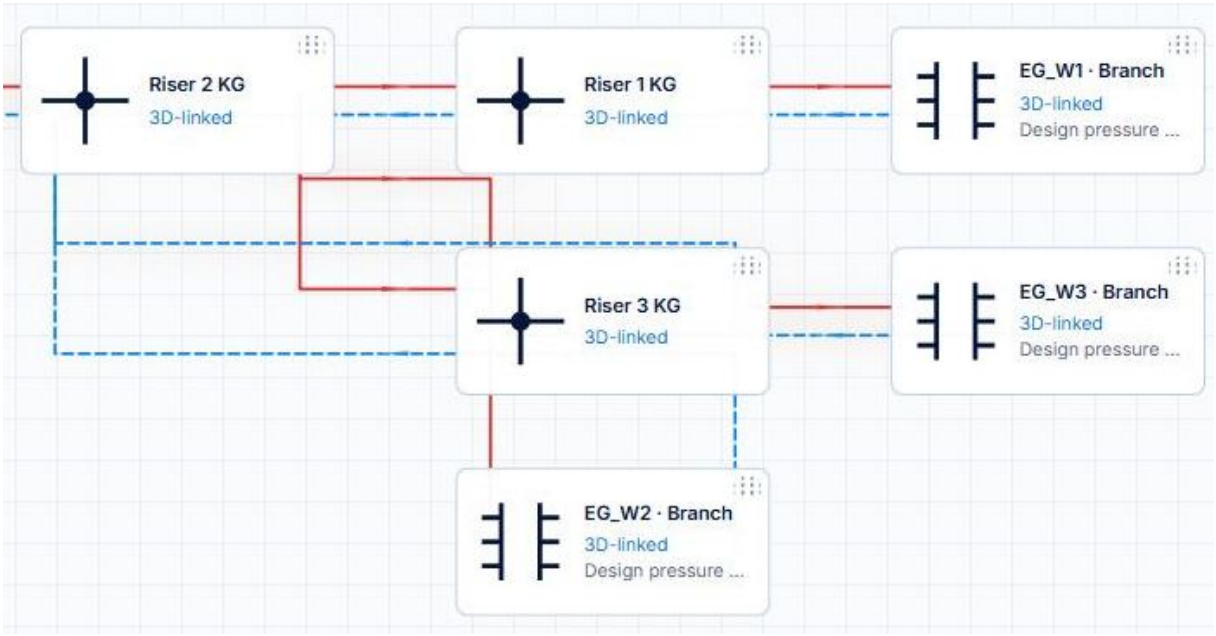

Figure 15 The three risers and their ground-floor branches. Enlarged interface excerpt.

Equipment selection placement and related checks

The platform's equipment workflow connects a heat-pump selection to the project rather than treating it as an isolated catalogue choice. The documented implementation retains the selected product identity and its source information. Sizing, installation assumptions and placement are related parts of the workflow, each with its own information needs.

Product parameters should come from the relevant evidence. Capacity and efficiency depend on operating conditions; dimensions and connection requirements affect placement and installation. A schematic teaching asset can communicate the function of a heat pump without supplying all these product-specific values. Learners should recognise when they are working with a concept and when they are evaluating a defined product.

Spatial placement connects equipment to the building context. The participant considers the available location, routes, access and relationships to affected rooms or neighbouring uses. The same context supports discussion of acoustics, electrical connection and serviceability. A component drawn beside the building is a starting point for these checks, not proof that the installation is acceptable.

Acoustic teaching comparisons require an explicit source and receiver basis. The implementation distinguishes numerical screening from site-specific qualification. This helps learners understand why an attractive location may still require more evidence. A useful exercise asks the participant to compare two placements, identify the assumptions that change and explain which specialist review would be needed before selecting the final arrangement.

Table 7 Connections between equipment choices and project evidence.

Choice	Connected evidence
Heat-pump product	Performance conditions, documented parameters and selected product identity.
Number and arrangement of units	Required capacity, operating concept and practical installation constraints.
Location	Geometry, routes, service access and affected surroundings.
Acoustic comparison	Source characteristics, operating assumptions and receiver conditions.
Installation decision	Reviewed technical interfaces and explicit remaining checks.

Calculations and the meaning of results

Calculations help learners connect a design choice to a physical or economic consequence. The platform presents several result domains, including design heat load, dynamic heating behaviour, heating demand, investment and lifecycle indicators. The professional calculation methodology and toolbox are part of WP4; their use in this training environment supports explanation, comparison and critical interpretation.

These outputs must be read according to their definitions. Design heat load describes a design condition. A peak found in a dynamic simulation depends on the time series and operating assumptions used in that run. Annual heating demand is an energy quantity. Heat delivered, electricity consumption and comfort response describe different parts of system performance. They should not be exchanged merely because all relate to heating.

The training value lies in asking why a result changes. A lower transmission loss can reduce room demand. An inadequate emitter or unfavourable control assumption can still limit heat delivery. A good equipment efficiency value does not establish low annual electricity use for the whole building. Learners should therefore follow the chain from building need through distribution and generation to the selected indicator.

The result state is also part of the information. No result, a calculation in progress, a result for an earlier input state and a current result with unresolved checks are different situations. Available diagnostics can help investigate a result without making it valid for a design decision. This documentation does not claim that every calculation route or reference case has completed technical validation.

Table 8 Result domains and the questions they support.

Domain	Typical training question	Interpretation requirement
Design load	What capacity is required at the chosen design condition?	State the design conditions and spatial scope.
Dynamic behaviour	When is demand or comfort critical?	Use the actual time basis and operating assumptions.
Emitter suitability	Which rooms constrain supply temperature?	Match emitter output and room load at the same conditions.
Investment and lifecycle	What changes the economic or environmental comparison?	Use consistent quantities, boundaries and time horizons.
Acoustics	Which placement or operating assumption is critical?	Distinguish teaching screening from a site-specific assessment.

Reading a room heat balance

The Heating load view turns a building total into a room-by-room explanation. The illustrated training case shows a physical room balance of about 34.3 kW across 57 rooms. The room list is ordered by load, which helps participants identify the parts of the building that deserve closer attention before discussing heat-pump capacity or emitter changes.

The selected room shows separate contributions from transmission, thermal bridges, ventilation, infiltration and the heat-up allowance. In the captured view, the selected second-floor room totals about 1.48 kW. Its largest displayed contribution is transmission. Each contribution can be inspected, and the Inputs and provenance section connects the result back to its calculation basis. These are calculated training values, not site measurements.

The teaching activity is to explain why this room differs from another room and which input or measure would affect each contribution. Participants can then return to the envelope or room inputs to check their reasoning. The interface identifies the calculation as a training profile and requests review before design use. The annual-result status in the top bar concerns the separate saved annual run; it must not be read as the status of every displayed room-balance value.

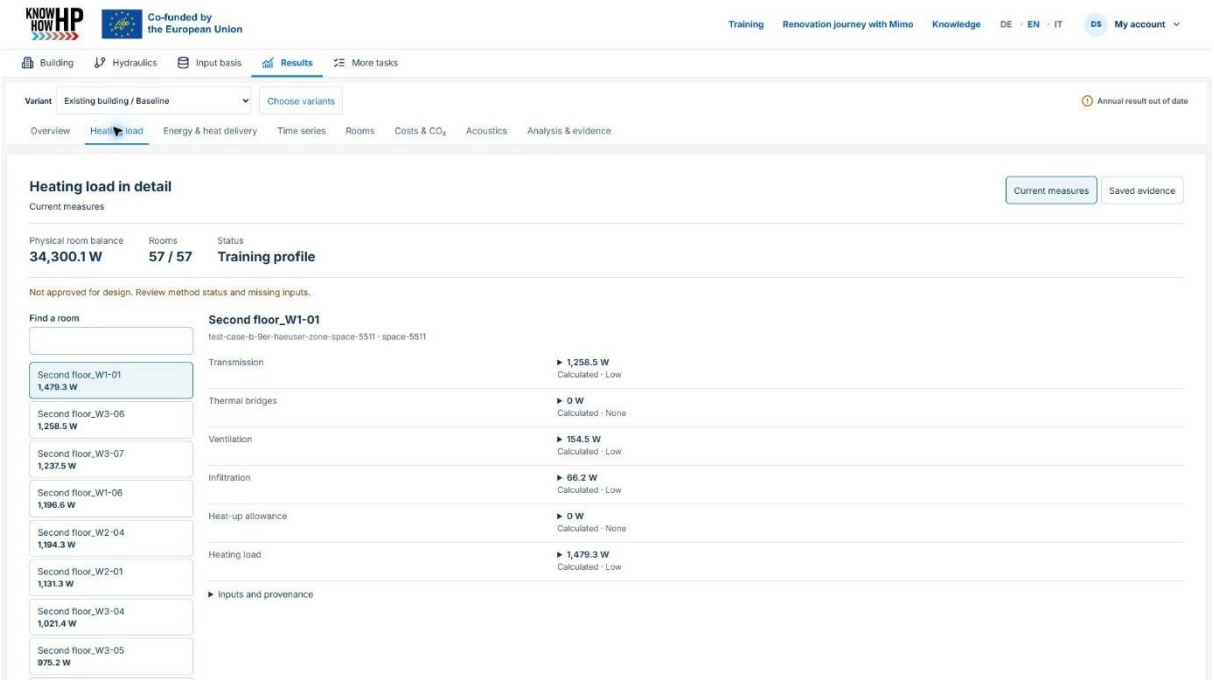

Figure 16 Room heat-balance results with individual loss contributions and access to inputs and provenance. The screen explicitly identifies the training profile.

Reading a room heat balance in detail

The following excerpts enlarge the relevant parts of the preceding desktop view. Each excerpt retains the original values, labels and status information.

Building total and calculation status

Figure 17 Building total and calculation status. Enlarged interface excerpt.

Contributions to the selected room heat load

Figure 18 Contributions to the selected room heat load. Enlarged interface excerpt.

Exploring time dependent behaviour

The Time series view connects annual results to operating conditions over time. The displayed example is a retained annual run with 8,760 hourly values. The chart compares outdoor conditions, simulated operative room temperature and heating-system temperatures. Controls allow the participant to select a date range, inspect the entire run or focus on the worst week.

The room-temperature trace represents a floor-area-weighted mean. It does not show that every room has the same temperature. Participants should therefore use the chart to identify a period of interest and then examine room-level information where available. The adjacent period summary provides selected values for the saved worst week. Additional views expose loads and heat delivery, weather, hourly values and other aspects of the same calculation.

The screenshot deliberately retains the historical-diagnosis notice: this saved run no longer represents the current model inputs. It illustrates how results can be explored and discussed, while preventing the earlier calculation from being mistaken for a current refurbishment recommendation. In training, learners can explain seasonal relationships and recognise why a changed design needs a new calculation. The curves are simulated rather than measured.

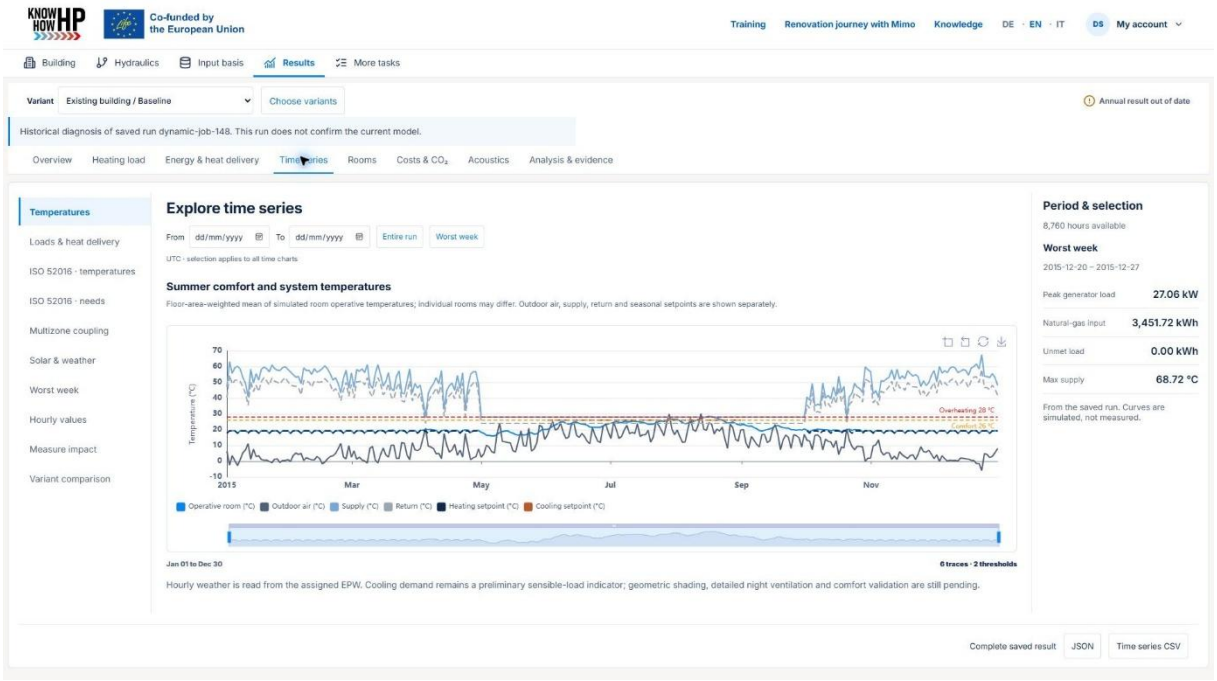

Figure 19 Time-series exploration of a retained annual run. The historical-diagnosis notice remains visible because the current project inputs differ from the saved calculation.

Exploring time dependent behaviour in detail

The following excerpts enlarge the relevant parts of the preceding desktop view. Each excerpt retains the original values, labels and status information.

The saved run remains identified as historical

Figure 20 The saved run remains identified as historical. Enlarged interface excerpt.

Reading the selected period summary

Figure 21 Reading the selected period summary. Enlarged interface excerpt.

Variants and transparent comparison

A variant records a particular refurbishment proposal. It combines the selected measures and their parameters with the project context needed to evaluate them. The baseline describes the existing building. Keeping baseline and variants separate enables learners to explain what changed and prevents proposed work from being confused with surveyed conditions.

A useful comparison starts with a common basis. Alternatives should use the same building scope and clearly identified assumptions for weather, use, prices and study period unless the difference itself is the object of the exercise. If a learner changes the building data after calculating a variant, the earlier result must be interpreted against its original input state.

The platform's implementation links calculation records to their inputs and retains validity and currentness information. The teaching consequence is simple: a saved result is evidence of what was calculated, not automatic evidence that it remains applicable. A changed input can require recalculation; an unresolved check can prevent a seemingly attractive result from supporting a decision.

Comparison should lead to a reasoned recommendation. The participant identifies the technical consequences, cost and environmental trade-offs, remaining uncertainty and practical dependencies. A preferred package may need a further survey or a coordinated sequence of works. Recording that reasoning is more useful than declaring a winner from one indicator alone. The diagram below shows the repeated loop between proposal, calculation and review.

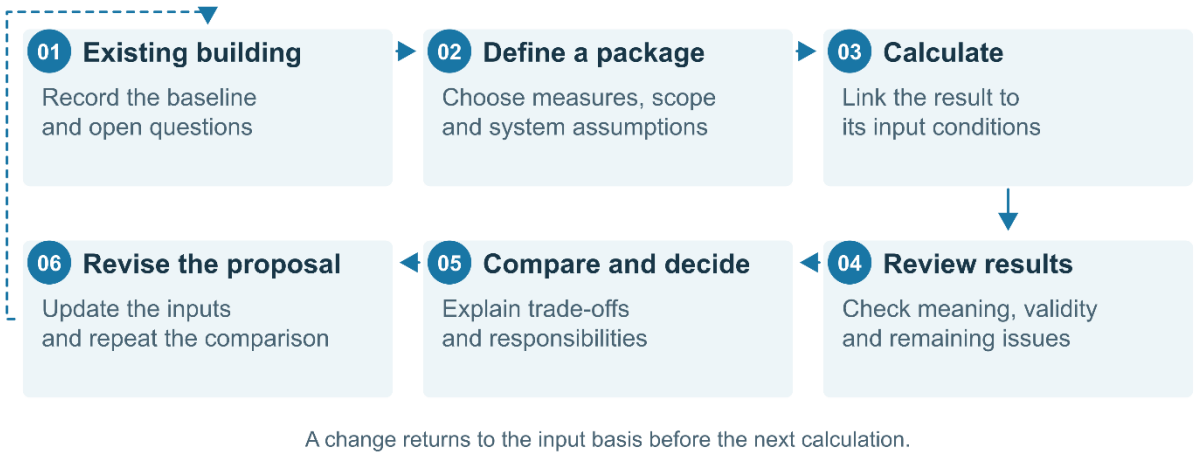

Figure 22 Variant workflow from the existing-building baseline to a reasoned decision. Revisions return to the inputs and measures before a new comparison is made.

The Wiki and shared technical language

The Wiki is the platform's structured technical learning library. It is organised into subject collections and searchable articles. The current public interface contains 132 guides in ten collections and supports German, English and Italian. Topics range from the building envelope and heat emitters to hydraulic systems, domestic hot water, acoustics, economics, commissioning and the people involved in refurbishment.

Articles provide a stable place to read an explanation independently of a conversation. They can include illustrations, practical decision points and links to related subjects. A learner who encounters an unfamiliar issue in a building exercise can consult the relevant article and return to the project. A trainer can use the same material to prepare a session or support a discussion after an exercise.

Consistent terminology links the Wiki, assistant and practical activities. In this documentation, heat emitter is the general term and radiator is used for that particular emitter type. Design heat load, heating demand and delivered heat retain separate meanings. Integral refurbishment includes coordination across technical subjects, responsibilities and project stages. A glossary supports these distinctions and helps maintain the same concepts across languages.

The knowledge collection is intended to remain useful throughout the project. Ongoing updates to Wiki content are foreseen during the project period. Articles and illustrations can therefore develop as project knowledge is consolidated. A dated description and traceable content basis are preferable to treating the library as an unchanging annex.

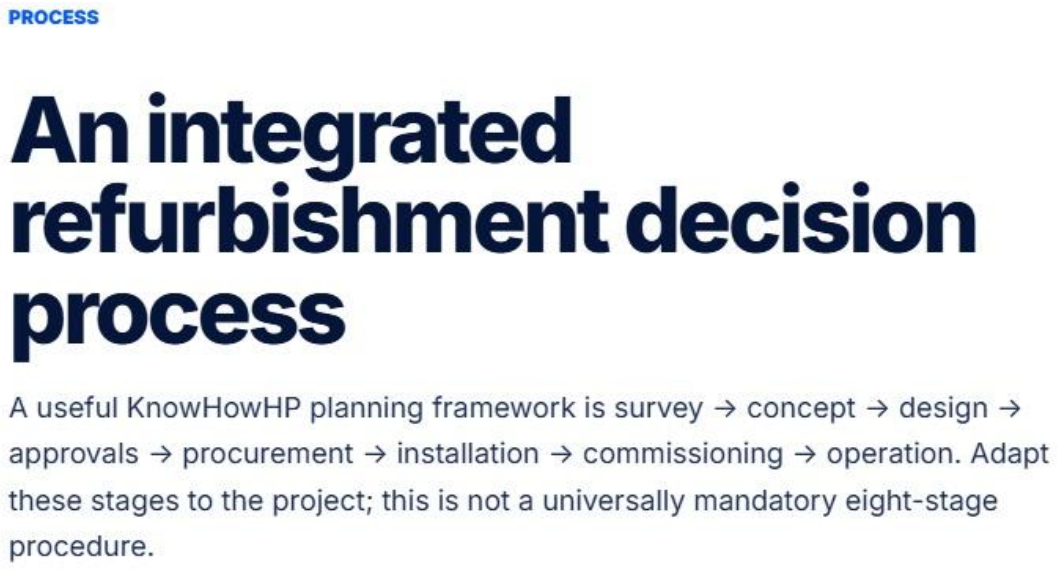

Figure 23 An English Wiki article introduces the integral refurbishment decision process and its stages. Enlarged excerpt from the desktop interface.

Mimo and conversational support

Mimo is the recognisable companion across the homepage, knowledge area and renovation journey. The character gives continuity to the experience and helps direct attention to the current subject. In the renovation journey, Mimo explains the building and the decisions in each scene. In the chat, participants can ask a question in their own words and continue with related questions.

The conversational assistant combines published Wiki material with general technical knowledge where needed. Wiki references should appear when they support the answer. This makes the conversation useful for questions that are broader than the current article collection while preserving a route back to the project's documented knowledge. A conversational answer remains an explanation; it does not certify the suitability of a particular installation.

The chat interface offers text entry, a dictation control and read-aloud controls. An optional Images and diagrams checkbox allows participants to request visual supporting material. The visual material should explain the answer and remain distinguishable from project drawings or verified equipment documentation. The screenshot shows these controls; it does not demonstrate every browser or audio-device configuration.

Mimo's presentation changes with the activity. The renovation scenes use gestures and task-related appearances, including a work outfit in the commissioning scene. The homepage provides an option to pause movement. These features support engagement and orientation. They should remain subordinate to a readable explanation and accessible controls, particularly when a trainer is presenting the platform to a group.

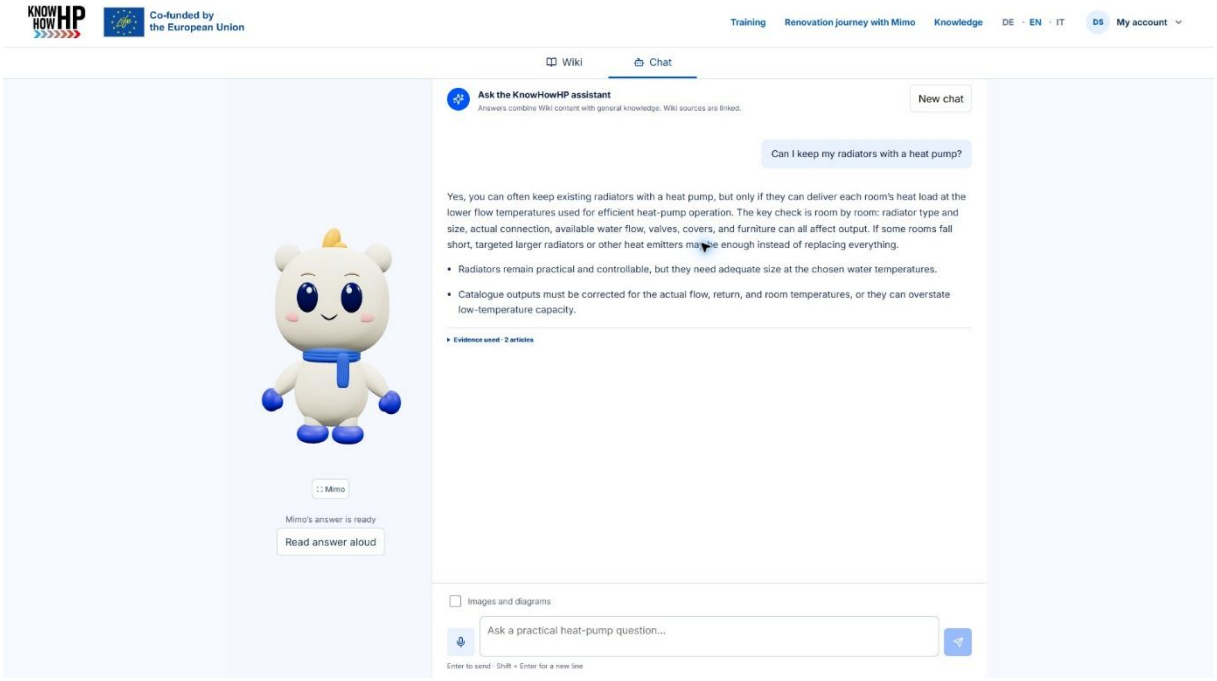

Figure 24 Conversational knowledge support with Mimo, follow-up question entry, voice controls and the optional Images and diagrams checkbox.

Mimo and conversational support in detail

The following excerpts enlarge the relevant parts of the preceding desktop view. Each excerpt retains the original values, labels and status information.

Reading the answer and its linked evidence

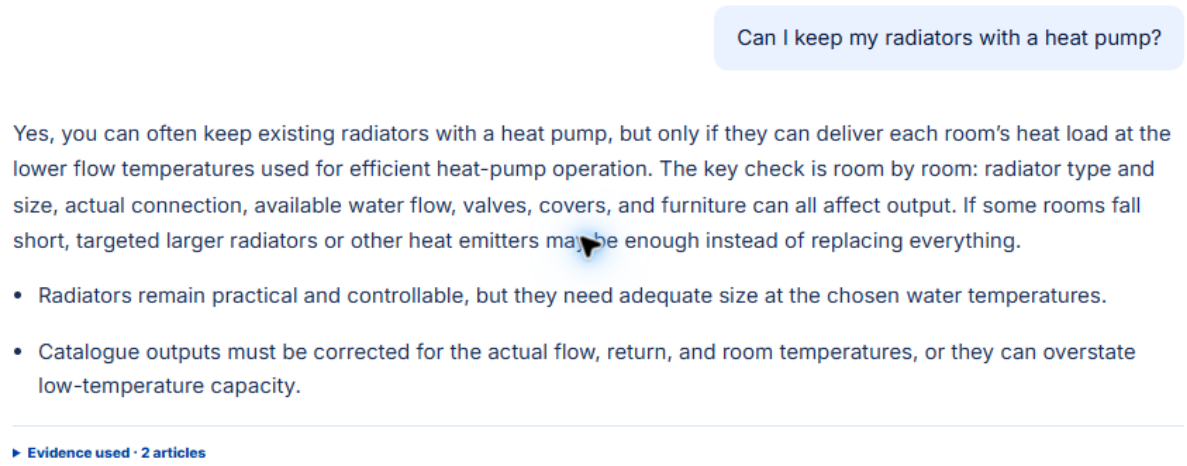

Figure 25 Reading the answer and its linked evidence. Enlarged interface excerpt.

Asking a follow-up and enabling images

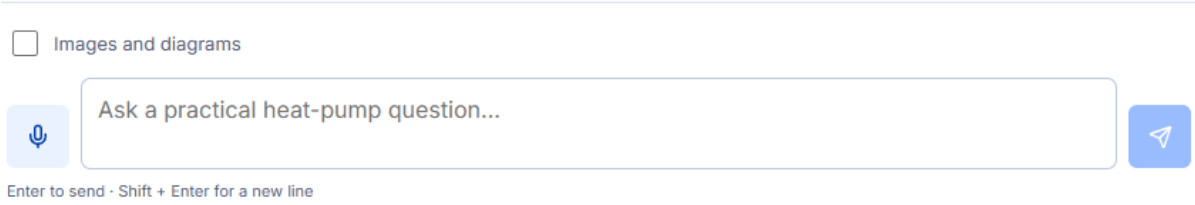

Figure 26 Asking a follow-up and enabling images. Enlarged interface excerpt.

Access and continuity of work

The platform distinguishes public information from personal work. The Wiki and renovation journey provide an accessible introduction. Account access supports personal learning records and project continuity. Participants should know whether they are browsing a reference case, working in their own copy or submitting work for review. These contexts carry different expectations for persistence and responsibility.

The renovation journey provides a learning record that distinguishes viewed scenes from assessed topics. In the authenticated view, the interface reports synchronisation with the account and offers an explicit import of separate guest progress from the device. Participants can therefore continue with a personal record while retaining control over whether earlier guest observations are imported. Viewing a scene alone does not confirm competence.

Guest access retains a separate record on the device. This distinction matters when participants move between a classroom computer and their own device. Before continuing, they can check whether they are using their account record or a local guest record and decide whether to import earlier guest progress. The learning record distinguishes topics answered correctly from topics not yet assessed.

Training records should be interpreted in proportion to the evidence they contain. Watching an explanation records engagement. Answering a recognition question records a specific response. Applying knowledge to a building and transferring it to a changed case require more substantial work. Keeping these different forms of evidence separate supports a fair discussion of progress and avoids turning activity counts into claims of professional competence.

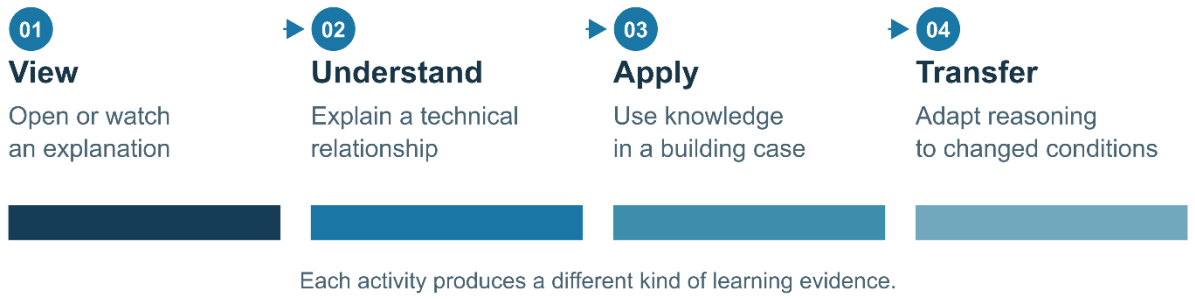

Figure 27 Different forms of learning evidence. Viewing, answering, applying and transferring are related activities, but they do not establish the same outcome.

3.3.2. The integral refurbishment process

One building through the whole process

The integral approach treats refurbishment as a connected sequence of decisions about a building, its heat supply and the people who use and deliver it. Replacing a heat generator is one possible intervention within that sequence. The building envelope, heat emitters, domestic hot water, controls, electricity connection, space, costs and responsibilities can all influence the feasible solution.

The platform's renovation journey makes these relationships visible through a schematic occupied apartment building with nine homes. The current presentation contains 18 scenes grouped into eight sections. It follows the transition from the initial motivation through understanding the building, developing packages, connecting the system, comparing and financing options, design and procurement, work in occupied homes, and verification and operation.

This teaching sequence complements the project's general planning framework: survey, concept, design, approvals, procurement, installation, commissioning and operation. The two arrangements have different purposes. The presentation groups topics for learning; the planning framework organises work and decision responsibilities. Neither should be treated as a universally mandatory sequence independent of the actual project.

Iteration is essential. A survey finding may change a package. A procurement substitution may require a new technical check. Operating evidence may reveal a control issue that returns to commissioning. The aim is to retain the connection between the decision, its evidence and the next responsible person when such changes occur.

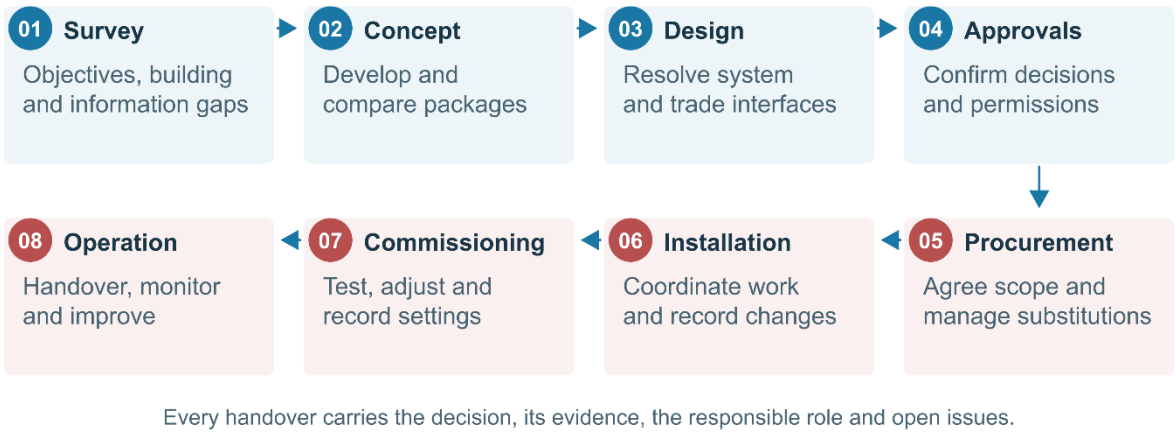

Figure 28 Integral refurbishment as a connected process with review and feedback. The sequence is adapted to the project and includes the people and evidence needed to proceed.

Establishing the brief and understanding the building

The process begins with the reason for refurbishment. A failed generator, planned façade maintenance and a long-term decarbonisation objective create different time pressures and opportunities. Participants define the objective before selecting equipment. They also identify the owners, occupants, property management, designers, installers and future operator whose information or decisions will be needed.

The building survey combines available drawings and model information with observation and operating evidence. Learners consider the envelope, areas, use and room temperatures together with the existing installation. Consumption records can provide context but are not automatically a room-by-room design heat load. Existing drawings need to be checked against the installation actually present.

The output is a shared baseline and a list of relevant gaps. For each gap, the learner explains why it matters, who can resolve it and what decision depends on it. For example, uncertain emitter performance can prevent a credible supply-temperature concept. Unclear ownership of common parts can prevent a technically feasible placement from proceeding.

The first handover should therefore communicate more than a model file. It should make the objectives, known conditions, assumptions, constraints and unresolved questions understandable to the next person. The platform's spatial views and learning scenes support this conversation by keeping technical observations connected to the building and its users.

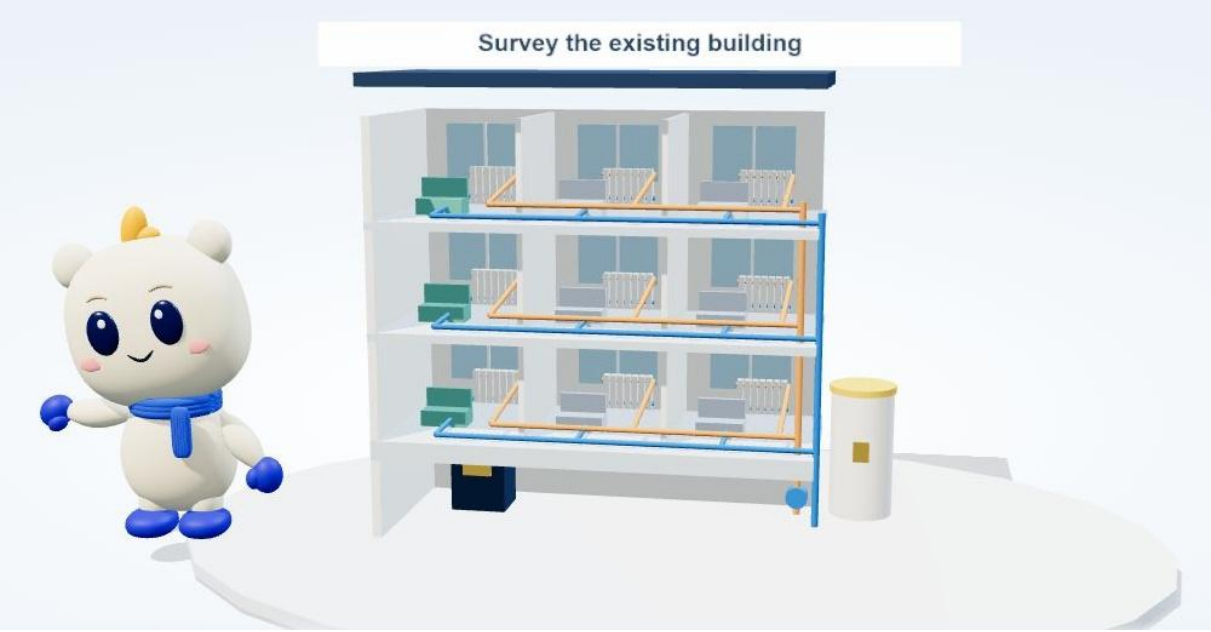

Figure 29 Survey scene in the renovation journey. The building cutaway helps connect envelope, apartments and heat distribution to the questions in the explanation. Enlarged excerpt from the desktop interface.

Developing packages and connecting the system

Concept development compares complete refurbishment approaches. A package may combine envelope improvements, selected emitter changes and a heat-pump system. Another may retain more of the existing building and address critical rooms or distribution constraints. Participants examine which dependencies make each package coherent and which assumptions still need evidence.

The selected heat source and equipment location introduce further questions. Availability, space, electrical connection, service access and acoustic conditions must be considered together. The renovation journey uses an air-to-water example to explain these relationships. That example is a teaching choice, not a general recommendation for every apartment building.

Hydraulics connects the generator to useful heat in the rooms. The heat pump, pumps, distribution and emitters need compatible operating conditions. Domestic hot water adds service, storage and control requirements. A buffer or separation arrangement should have an identified function in the proposed system; the mere presence of a component in a diagram does not explain why it is needed.

The resulting concept should be clear enough for another role to challenge. A planner can explain the proposed temperatures and circuit arrangement. An installer can identify access, routing and maintenance implications. Occupants can contribute information about use and disruption. The platform supports the common technical context for these exchanges, while the exercise requires the participant to state the reasoning.

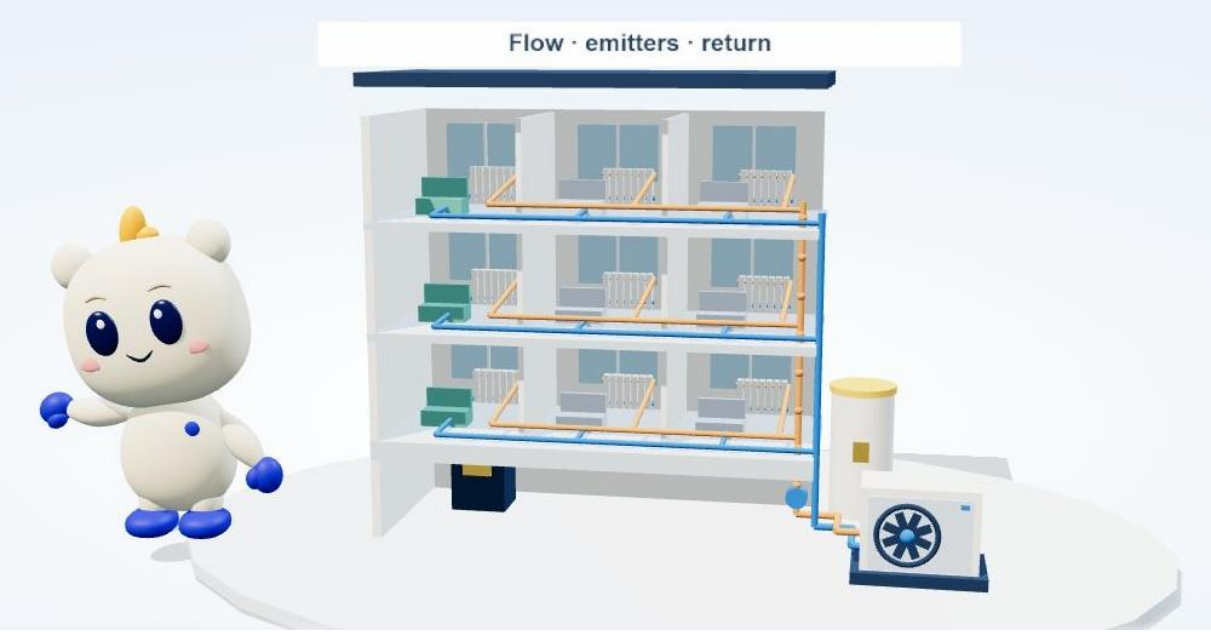

Figure 30 System scene connecting heat source, plant, distribution and rooms. The illustration is a schematic teaching example, not an installation drawing. Enlarged excerpt from the desktop interface.

Comparison and decision preparation

A refurbishment decision combines technical suitability with costs, environmental consequences, practical constraints and the objectives in the brief. The platform allows these aspects to be considered within the same building case. A comparison should make assumptions visible so that apparent advantages can be questioned and understood.

The participant first checks that the alternatives are comparable. Quantities, system boundaries, study period and operating assumptions need a common basis. An incomplete package must not appear cheaper simply because necessary work has been omitted. A change in supply temperature should be accompanied by the relevant emitter and distribution checks. Where uncertainty could alter the ranking, the comparison should show the consequence rather than conceal it.

The next step is a decision record. It identifies the preferred option, the reasons for selecting it, alternatives considered and unresolved issues. It also identifies who has authority to decide. A designer's recommendation, a property manager's coordination activity and an owner's approval are different actions. Learning to keep these actions separate is part of the integral process.

The following matrix provides a concise structure for the learner's comparison. It is an educational record, not a substitute for the project's contractual or statutory documentation. The same headings can be used in a facilitated discussion or an individual online exercise.

Table 9 Content of a reasoned refurbishment comparison.

Aspect	What the participant documents
Technical suitability	Load basis, temperatures, emitter consequences, system concept and critical checks.
Practical implementation	Placement, access, occupied-building constraints and sequence of works.
Economic basis	Included quantities, investment scope, operating assumptions and study period.
Environmental basis	Included lifecycle stages and the source of energy and material assumptions.
Decision and uncertainty	Preferred package, reasons, evidence still needed and responsible decision-maker.

Design approvals and procurement

The concept becomes a design when the required detail and interfaces are resolved. Learners identify the information that an installer, supplier or other specialist needs to implement the selected package. This includes the relevant design conditions, spatial arrangement, hydraulic concept, control intent and requirements for testing and documentation.

Approvals and permissions depend on the actual location, ownership structure and system. The training task is to recognise these dependencies and assign responsibility for checking them. The platform's teaching process does not create a permit, an owner resolution or a professional approval. Those remain separate project actions supported by the appropriate evidence.

Procurement translates the reviewed design into an understandable scope. Offers can only be compared fairly when they address equivalent technical and service requirements. The learner therefore checks whether plant, distribution changes, electrical work, controls, commissioning, documentation and support are included where relevant. A lower equipment price alone does not establish a better complete offer.

Substitutions create a useful exercise in coordination. If a proposed product or arrangement differs from the reviewed concept, the participant identifies which checks must be repeated. Capacity, operating temperatures, acoustic properties, dimensions, service access and control compatibility may be affected. The revised decision should remain linked to its evidence before the change is accepted for implementation.

Table 10 Information passed from design into procurement.

Information package	Purpose of the handover
Building and design basis	Keep the selected system tied to the reviewed building conditions.
System and interface description	Make scope boundaries and responsibilities understandable.
Product and performance requirements	Allow equivalent offers and controlled substitutions.
Installation conditions	Include routes, space, access, sequencing and resident coordination.
Verification and handover requirements	Specify the records and demonstrations expected at completion.

Installation and commissioning in occupied homes

An occupied building adds constraints that cannot be understood from a calculation alone. Work may require access to apartments, temporary interruptions to heating or hot water, protection of occupied spaces and coordination between trades. The training case asks participants to connect these practical conditions to the technical sequence of the refurbishment.

An installation deviation should be recorded and assessed against the design intent. A changed route, omitted balancing device or substituted component can affect performance and maintenance. The relevant role needs to know what changed, why it changed and which consequences were reviewed. Concealed work and interfaces deserve attention before they become difficult to inspect.

Commissioning verifies the system in operation. The learning journey includes flow distribution, settings, heating-curve and hot-water checks, and repeated testing after corrections. The educational emphasis is on evidence: a running heat pump does not by itself demonstrate that the whole building receives the intended service. Unfavourable rooms and representative operating modes need attention.

Mimo's commissioning scene connects the technical explanation to the same apartment building used earlier. This continuity helps participants see why decisions made during survey and design return as practical checks. In an instructor-led course, the trainer can pause the scene and ask learners to identify the measurements and records they would require before accepting the work.

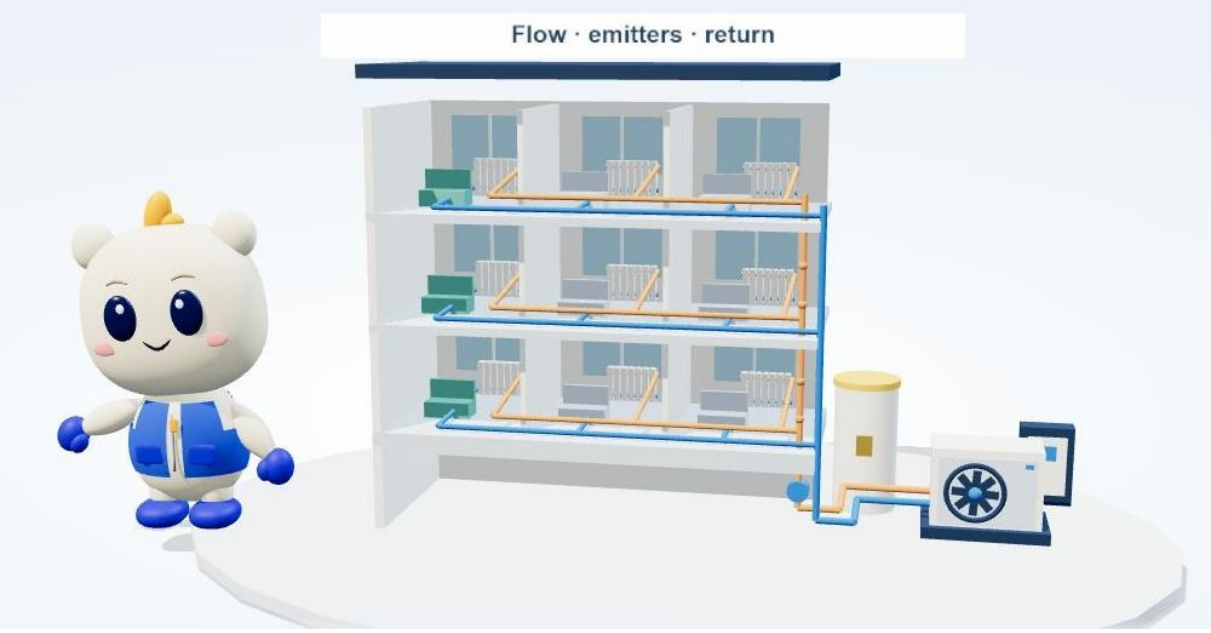

Figure 31 Commissioning scene with Mimo in a work outfit. The explanation connects hydraulic balancing and room response to the overall system. Enlarged excerpt from the desktop interface.

Handover and learning from operation

Handover transfers the ability to operate and maintain the system. It includes more than delivering files. The operator needs understandable settings, instructions, maintenance responsibilities and routes for dealing with faults. Outstanding defects or unresolved checks should remain visible with an owner and an agreed action.

The commissioning record provides the starting point for operation. It should identify the tested conditions, measured values, settings and corrections. Learners can then compare later observations with that baseline. If a room remains cold or the heat pump cycles frequently, they can investigate the system context rather than immediately change a global setting.

Monitoring is most useful when it answers a defined question. The participant identifies which measurements distinguish between possible causes and how the energy boundary is defined. Heat output, electricity use, temperatures, operating modes and user observations can support diagnosis when their timing and meaning are clear. A single performance figure without this context is difficult to interpret.

The integral process therefore continues into operation. Lessons from use can lead to revised settings, maintenance actions or a later refurbishment stage. Recording these lessons closes the link between intended and actual performance and gives future learners a concrete basis for understanding why commissioning and handover matter.

Table 11 Handover evidence and its use during operation.

Record	Question it helps answer
System description and current drawings	What was installed and how is it intended to operate?
Commissioning values and settings	Which conditions were tested and what was adjusted?
Operator instruction	Who can operate the system and recognise a problem?
Open items and maintenance duties	Who is responsible for the remaining work and recurring tasks?
Monitoring basis	Which data will show whether the intended service is achieved?

3.3.3. Training based on prior knowledge

Finding a useful starting point

Participants enter a course with different experience. Some are familiar with installation work but have less experience comparing refurbishment packages. Others understand energy calculations but need a better view of site constraints and operational handover. The platform supports a starting point that reflects these differences.

The public renovation journey offers an orientation dialogue with eight situations. Participants can choose an answer or indicate that they are not sure. Explanations connect the response to the underlying refurbishment decision. The observed interface explicitly presents this as initial orientation, not an assessment of professional competence. All topics remain available.

The authenticated training implementation adds role, experience, learning goals and selected topics to the learner's context. Knowledge checks and targeted practice are linked to learning criteria. The resulting learning path can therefore focus attention on a prerequisite, an observed gap or the next application task. It should remain understandable why a particular activity is suggested.

The course design uses the starting profile to select the depth and emphasis of the building exercise. A learner who needs foundations can first explore the relevant scene and Wiki article. A more experienced participant can work directly on a package and explain the decision. Both remain connected to the same integral process, which makes later discussion between professional roles possible.

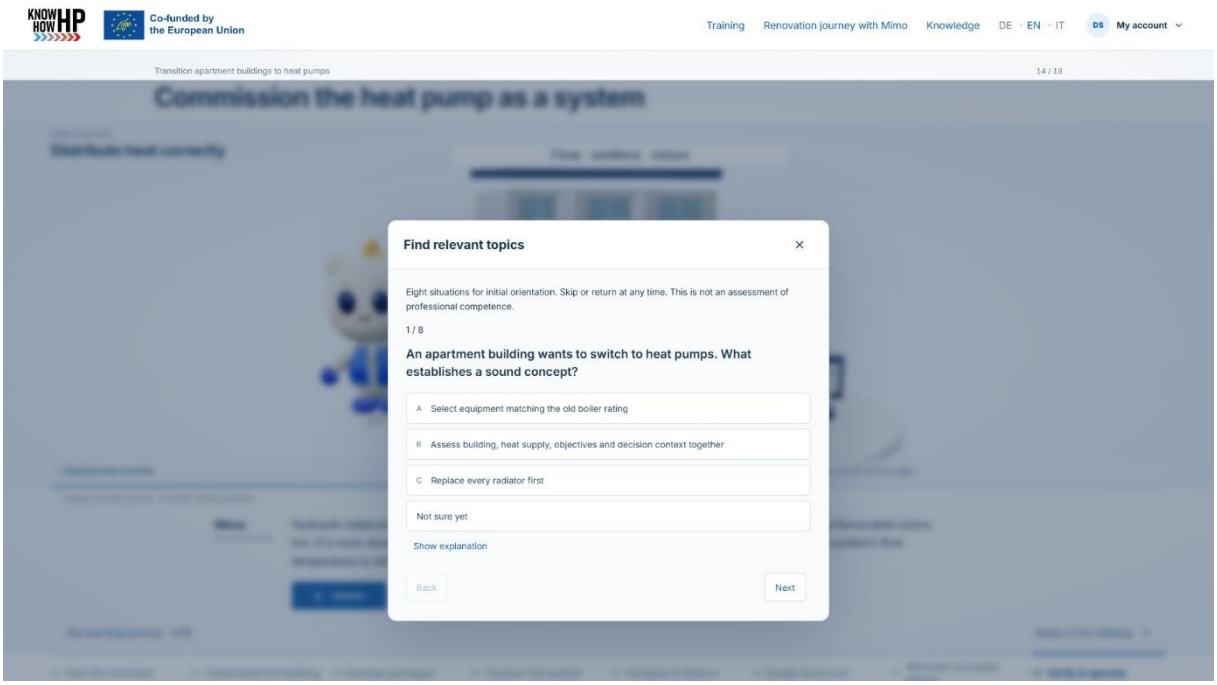

Figure 32 Initial orientation in the public renovation journey. The example asks learners to connect the building, heat supply, objectives and decision context and provides an explanation.

Finding a useful starting point in detail

The following excerpts enlarge the relevant parts of the preceding desktop view. Each excerpt retains the original values, labels and status information.

Answering an initial orientation question

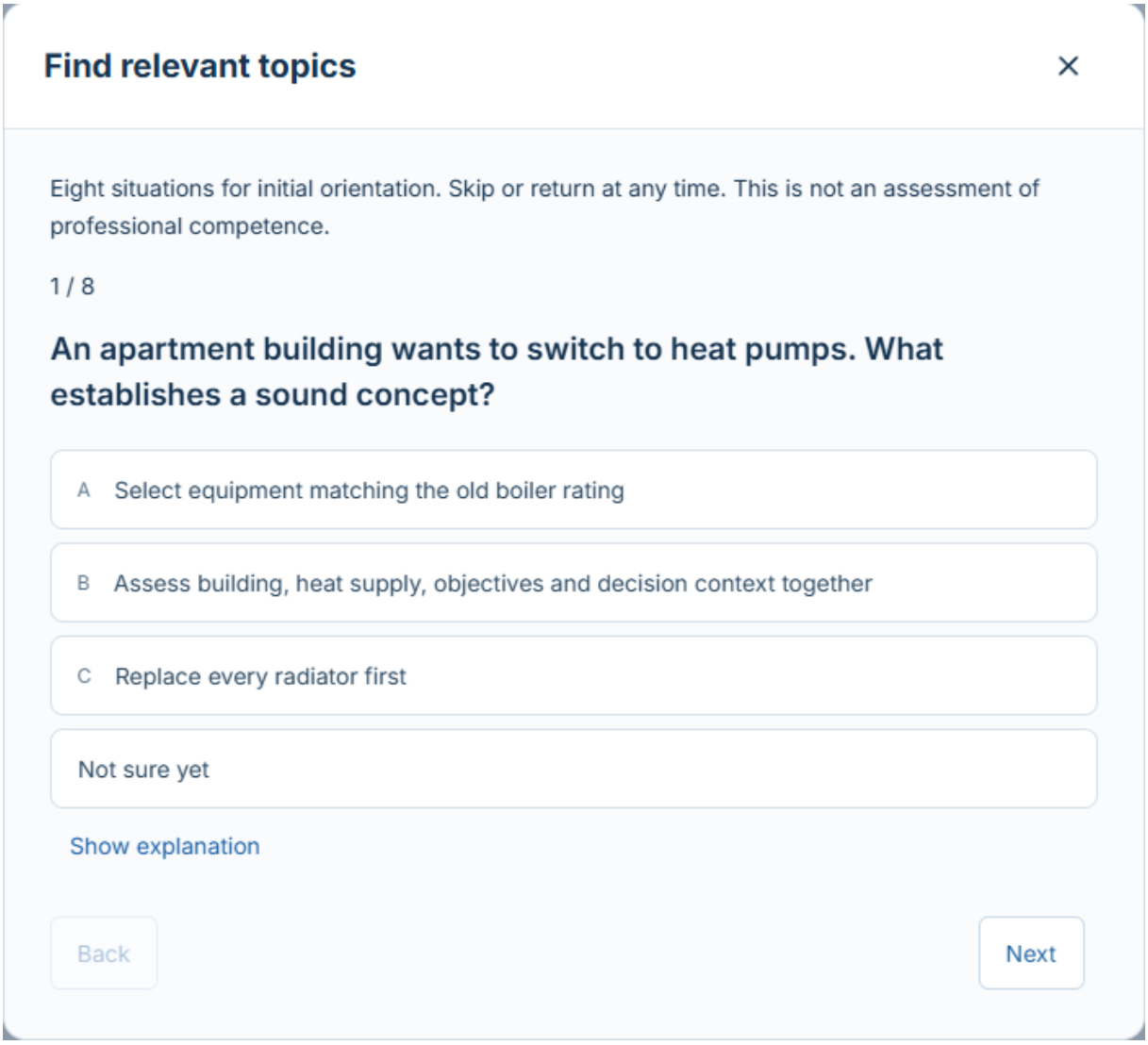

Figure 33 Answering an initial orientation question. Enlarged interface excerpt.

From explanation to practical application

The learning sequence builds on the project training materials. The platform turns their technical explanations and examples into connected learning activities. Participants first explore a concept, such as the relationship between heat load, emitter output and supply temperature. They then check their understanding and apply the concept to a building case, using the relevant project information to explain a choice.

The building case provides continuity across these activities. A participant can consult a Wiki article, inspect the relevant room, compare measures and return to the process question. The work should produce an observable result: a justified survey request, a package comparison, a hydraulic explanation or a handover record. These outputs give a trainer something concrete to discuss.

Transfer requires changed conditions. Repeating the same question after seeing an explanation may consolidate knowledge, but a different building condition tests whether the learner can use it elsewhere. A transfer exercise might change the critical room, the available plant location, the sequence of envelope work or the responsibility for an interface. The participant must explain which parts of the earlier reasoning still apply.

The platform implementation supports learning records and work-sample review, including feedback and revision. This is a formative structure. The documentation describes the learning approach and available mechanisms; it does not report measured learning gains or participant competence outcomes. The value of the exercise lies in the evidence the participant produces and the quality of the subsequent review.

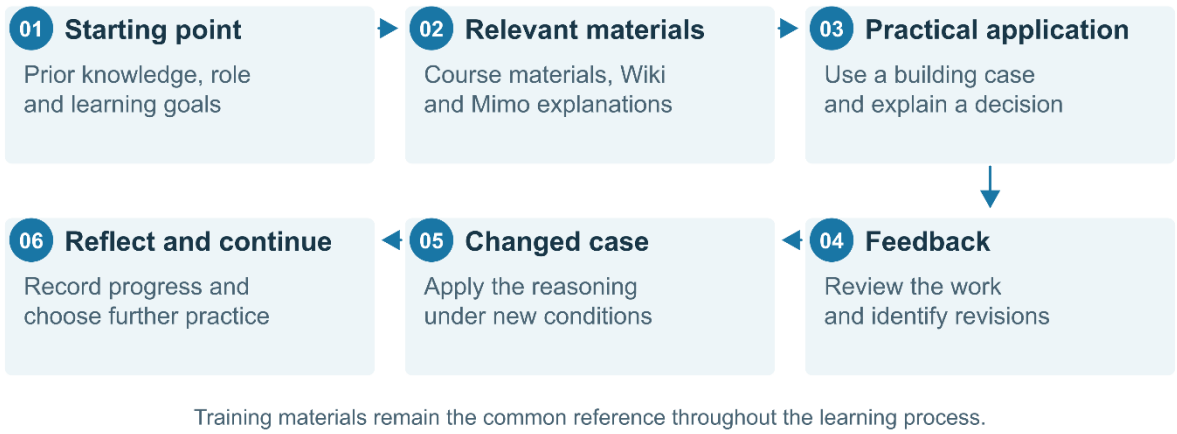

Figure 34 Learning from prior knowledge through the project training materials, practical application and feedback. The same materials provide a reference when the learner revisits a decision or works on a changed case.

Personal training and autonomous online learning

The same platform can support two delivery settings. In a personal training session, the trainer introduces the case, selects the activities and leads the discussion. Participants use the building workspace, calculations and knowledge material as shared working resources. The trainer takes over the guidance that digital assistants would otherwise provide; the course does not need parallel assistant instructions competing with the trainer.

In autonomous online learning, the participant works through the activities independently. Mimo, the renovation journey, the Wiki and conversational help provide orientation and explanations. The learner can revisit a topic and continue at a suitable pace. An explicit learning record helps show what has been viewed, answered or submitted and what remains unresolved.

The delivery setting changes the source of guidance, not the technical learning objective. Both settings should require the participant to explain the evidence, dependencies and consequences of a refurbishment decision. In a classroom, that explanation may be discussed with a group and recorded as part of an exercise. Online, it may be submitted as a structured work sample for later review.

A mixed course can use online orientation before a session, a shared building exercise during the session and reflection afterwards. This is a course-design option. The presence of platform functions alone does not demonstrate that a particular course has been delivered. Course organisation, facilitation and review remain responsibilities of the training provider.

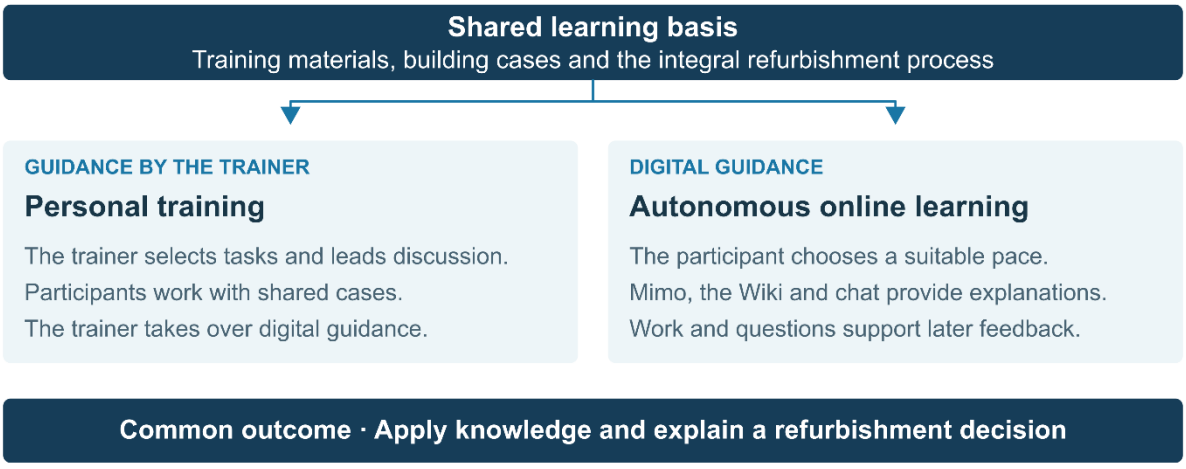

Figure 35 Two delivery settings using the same building cases and learning objectives. The trainer leads personal sessions; digital guidance supports autonomous online work.

Learning records and meaningful feedback

A learning record should explain what a participant has actually demonstrated. The renovation journey distinguishes topics answered correctly from those not yet assessed. It supports account synchronisation and a separate local guest record. The authenticated training data model provides a broader record of attempts, learning criteria, assignments and submissions. These records should be connected deliberately rather than treated as interchangeable.

The implementation distinguishes understanding, application and transfer. A work sample can be reviewed against criteria with a rationale for each rating. Feedback can request revision, and a later attempt remains separate from the submitted snapshot. When the evidence basis changes, an earlier review remains part of the history rather than silently becoming an assessment of the new work.

For trainers, this supports a practical feedback conversation. Instead of saying that a learner has completed a topic, the trainer can identify what was understood, which part required guidance and which decision still lacks evidence. Group information can help choose what to discuss next, while personal work remains associated with the appropriate learning context and access rights.

For the course concepts, progress should therefore be expressed through observable outputs. A sound explanation of a radiator constraint, a consistent variant comparison or a clear commissioning handover is more informative than time spent on the platform. The platform supplies the environment and records; the training concept defines the activity and the standard of evidence expected.

Table 12 Examples of evidence appropriate to different learning activities.

Activity	Evidence	Useful feedback
Read or watch	Topic visited or explanation viewed	Invite the learner to explain the relationship.
Answer a question	Response and associated explanation	Clarify the specific misconception or uncertainty.
Apply to a case	Work sample with sources and reasoning	Identify missing evidence and review the decision.
Transfer to changed conditions	Revised reasoning for a different case	Check which assumptions and dependencies were reconsidered.

3.3.4. Application in the installer course

Practical responsibilities and learning outcomes

For D5.1, the platform builds on the installer training materials developed in WP3 and connects them to the whole refurbishment process. Participants apply that content when recognising site conditions, interpreting the design intent and preparing commissioning and handover records. The platform and its exercises continue to develop as the installer training materials are expanded and refined. Installers contribute before the concept is fixed, so their practical knowledge can improve the proposed solution.

The shared building model supports discussions about access, pipe routes, space, serviceability and work in occupied apartments. The hydraulic view helps learners explain connections and operating modes. The measure catalogue makes proposed changes visible, while the Wiki and Mimo provide explanations when a technical relationship needs clarification.

The intended outcomes are concrete. Participants should be able to identify information missing from a survey, explain the effect of an installation change, recognise an incomplete technical handover and specify what they would verify during commissioning. They should also be able to communicate an issue to the responsible planner without losing the room, component or source context.

The course should use the participant's prior knowledge to select emphasis. An experienced installer may need little introduction to component functions but benefit from comparing packages and tracing decisions into operation. A participant with less experience may first use the schematic journey to understand the complete system before working through a limited installation task. Both work on a meaningful building problem.

Table 13 Installer learning activities and expected outputs.

Activity	Expected participant output
Review the existing installation	A short survey record distinguishing observation from assumption.
Check practical feasibility	An annotated list of access, routing and service constraints.
Discuss a design change	A clear request identifying the affected interface and required review.
Prepare commissioning	A test and measurement plan tied to the intended system behaviour.
Prepare handover	An operator-oriented record of settings, instructions and open items.

Worked course scenario for installers

The following scenario is an authored teaching example using the platform's apartment-building context. It is not a report of an actual participant or a completed field installation. The building is to move to a heat-pump system while remaining occupied. Most heat emitters are intended to remain, but one apartment reports inadequate comfort and the proposed pipe route crosses a space with limited access.

The learner first inspects the building and the relevant room. The task is to state what can be established from the model and what requires a site check. The learner then reviews the emitter information and the system concept. An acceptable response identifies the performance data and operating conditions needed before concluding that the radiator is unsuitable. It also records the access issue as an implementation dependency.

The second activity introduces a proposed installation change. The learner explains how the changed route or component could affect pressure loss, control behaviour, access or maintenance and identifies who must review the change. The platform is used to maintain a common spatial and hydraulic context; the exercise output is a reasoned change request rather than an unreviewed adjustment to the design.

The final activity prepares commissioning and handover. The learner identifies representative checks of flow, temperature and room response, then explains how the results and settings will be recorded for the operator. A trainer can challenge the reasoning in discussion. In autonomous work, the participant records the evidence and unresolved questions for feedback. A changed follow-up case can introduce a different critical room or access constraint to test transfer.

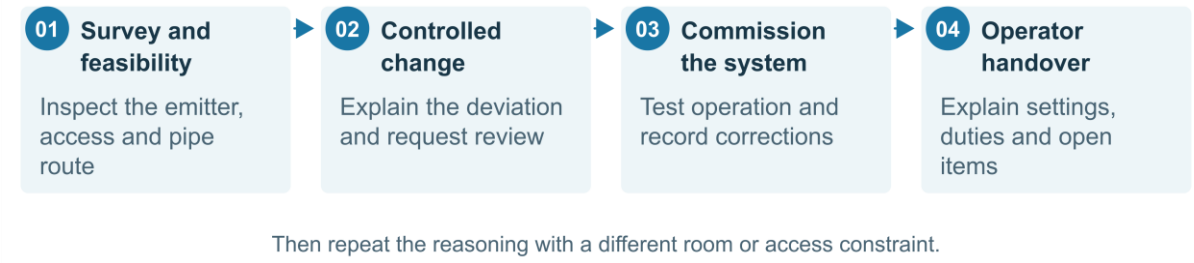

Figure 36 Installer teaching example linking survey, practical feasibility, controlled changes, commissioning and operator handover. No numerical result or completed installation is implied.

4. OUTLOOK

The course concept described in this deliverable is the basis for the trainings for installers that start in autumn 2026. The first courses are already scheduled: Klim (23/11/2026), THRo (26–27/11/2026) and eza! (01–02/12/2026). Further trainings by EIV, Klim and THRo are planned for 2026 and 2027, with dates still to be fixed. The cancellation of two courses in 2026 due to a lack of registrations shows that reaching installers remains the main challenge. Course length and promotion therefore need ongoing attention, as does the added value compared with manufacturer trainings.

The training providers THRo, eza! and Klim will adapt the concept to their own needs and to the national regulations and standards in Germany, Austria and Italy. In Germany, meeting the requirements of VDI 4645 remains essential, because the qualification as a “heat pump systems specialist” gives participants an additional incentive.

The training material from WP3 will be finalised in parallel, especially the slides and the web-based heat load tool. Material and course design will be evaluated and adapted based on the train-the-trainer workshops and the first courses. The KnowHowHP training platform and its Wiki will be updated continuously during the project period as the project’s training material is expanded and refined.

All participants are asked for feedback using the standardised form in German, English and Italian. The results will be evaluated systematically and used to improve the content, structure and teaching methods of later trainings.