



FuturHist

# Digital step-by-step toolkit (draft)



# Project Overview



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## Date of submission:

21/09/2026

## Project title

FuturHist – An integrated typology-based approach to guide the future development of European historic buildings towards a clean energy transition

**Grant Agreement** 101138562 (Horizon Europe)  
**Grant Agreement** 10105114 and 10110887 (UKRI)  
**Work package** WP4  
**Deliverable number** D4.3  
**Dissemination level** SEN (sensitive)  
**Version** 1.2

| Version | Date       | Lead Beneficiary (Revision comments log) |
|---------|------------|------------------------------------------|
| 1.0     | 01/09/2026 | First draft                              |
| 1.2     | 21/09/2026 | Submitted version after internal review  |



**Co-funded by  
the European Union**



**UK Research  
and Innovation**

Co-funded by the European Union and the UK Research and Innovation. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

# Executive Summary

This document serves as a guide for the first, not yet fully functional, test version of the FuturHist decision support toolkit.

Its main goal is to instruct the user on how to use the current version of the toolkit, together with explaining how it aligns with the overall methodology and what the technical principles allowing that are.

Finally, an overview of feedback received so far is made, together with an outlook to features, changes, and improvements to be made in the future.

# Acknowledgement

The work described in this document has received funding from Horizon Europe Funding Programme under Grant Agreement N° 101138562 and from UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (grant numbers 10105114 and 10110887).

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# Abbreviations and definitions

|                                  |                                                                                                                                                                                                                                                                                                                       |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Archetype</b>                 | Theoretically defined buildings based on the typical or average census values.                                                                                                                                                                                                                                        |
| <b>Be18</b>                      | Be18 is a calculation program that is used to document that a building complies with the Danish Building Regulations' energy provisions and to calculate energy needs and energy consumption in new construction.                                                                                                     |
| <b>Building typology</b>         | A set of buildings with common properties (e.g. age of construction, geometry, thermo-physical properties, and energy performance) (IEE Project TABULA, 2012).                                                                                                                                                        |
| <b>D</b>                         | Deliverable                                                                                                                                                                                                                                                                                                           |
| <b>DHW</b>                       | Domestic hot water, i.e. heating water for domestic or commercial purposes other than space heating and process requirements.                                                                                                                                                                                         |
| <b>Energy calculator</b>         | The core analytical function within the FuturHist Toolkit, responsible for estimating comparative energy performance. It generates paired scenarios: ex-ante (baseline) and ex-post (after proposed solutions).                                                                                                       |
| <b>Environmental values</b>      | The dimension of Educational Guides focusing on balancing energy performance improvement with resource efficiency, aiming to avoid excessive use of resources on energy-saving solutions. Key concerns addressed include operational and embodied carbon, natural resource use, circularity, and biodiversity impact. |
| <b>Heating Degree Days (HDD)</b> | A measure of how much (in degrees), and for how long (in days), outside air temperature was lower than a specific base temperature. They are used for calculations relating to the energy consumption required to heat buildings.                                                                                     |
| <b>Heritage significance</b>     | Combination of all the heritage values assigned to a building and its setting                                                                                                                                                                                                                                         |
| <b>HVAC</b>                      | Heating, ventilation, and air conditioning                                                                                                                                                                                                                                                                            |
| <b>IAQ</b>                       | Indoor air quality                                                                                                                                                                                                                                                                                                    |
| <b>IEQ</b>                       | Indoor environment quality                                                                                                                                                                                                                                                                                            |

|                                             |                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>KPI</b>                                  | Key performance indicator                                                                                                                                                                                                                                                                                                                                                  |
| <b>LCA</b>                                  | Life cycle assessment for an intervention; a systematic method for evaluation the environmental impacts of a product, service or process. Calculated for a period of 50 years.                                                                                                                                                                                             |
| <b>LCC</b>                                  | Life cycle costing for an intervention; a method to calculate the economic impacts of a building or a product. Calculated for a period of 50 years.                                                                                                                                                                                                                        |
| <b>Material impact</b>                      | The extent to which the physical interventions introduced during a retrofit alter the historic building's existing fabric or its setting — and how this affects the heritage significance of the building and its settings.                                                                                                                                                |
| <b>Non-renewable primary energy demand</b>  | Amount of non-renewable primary energy needed to meet the energy demand associated with a typical use of the building, which includes energy used for heating, cooling, ventilation and domestic hot water (DHW).                                                                                                                                                          |
| <b>Non-renewable primary energy savings</b> | Difference in non-renewable primary energy demand before and after retrofit                                                                                                                                                                                                                                                                                                |
| <b>Operational GHG emissions</b>            | Greenhouse gas emissions associated with the energy consumption of the technical building systems during the use and operation of the building                                                                                                                                                                                                                             |
| <b>PBE</b>                                  | pyBuildingEnergy. An open-source Python library for building energy performance simulation developed by EURAC in the European projects Infinite (EU Horizon 2020, grant agreement No. 958397) and Moderate (Horizon Europe, grant agreement No. 101069834).                                                                                                                |
| <b>Reversibility</b>                        | The potential of retrofit measures (materials, components, or alterations) to be removed, dismantled, or reversed without causing physical damage to the historic building's structure, finishes, or setting. Note: inappropriate retrofit interventions that would undermine the heritage significance of the building, even if they are reversible, should be discarded. |
| <b>SRI</b>                                  | Smart readiness indicator. A common European scheme introduced under the Energy Performance of Buildings Directive (EPBD) to evaluate the technological readiness of buildings to interact with                                                                                                                                                                            |

their occupants and connected energy grids, and to operate efficiently (European Parliament and Council, 2024)

**Spatial impact**

Spatial impact evaluates how the retrofit intervention alters the building's interior layout, volume, or external footprint, affecting its historic function, spatial experience, and relationship with its surroundings — and how this affects the heritage significance of the building and its settings.

**T**

Task

**U-value**

Thermal transmittance value, i.e., the rate of transfer of heat through a structure. [W/m<sup>2</sup>K]

**Visual impact**

The extent of visual alterations to the building and its setting, both internally and externally, such as changes in color, style, or the addition of new visual elements that affect its character — and how this affects the heritage significance of the building and its settings.

**WP**

Work package

# 1. Introduction

## 1.1. Overview of FuturHist

The FuturHist project is dedicated to addressing the challenge of energy retrofitting historic buildings while ensuring their long-term preservation and sustainability. Historic and traditional buildings constitute a significant portion of the European building stock and represent a key area of focus in the transition towards a low-carbon built environment. However, retrofitting these buildings is inherently complex due to their diverse construction techniques, material compositions, and heritage significance. Unlike modern structures, historic buildings require tailored solutions that balance energy efficiency improvements with the preservation of their heritage attributes.

To bridge this gap, FuturHist adopts a typology-based approach that allows for the identification and characterization of recurring building features in different regions. By defining common characteristics at the typology level, the project develops intervention strategies that can be standardized and replicated with minor adaptations, facilitating broader application across Europe. This approach enables a shift from a case-by-case assessment towards a more structured and scalable process, ensuring higher renovation rates and deeper interventions.

The project builds upon established methodologies such as the European Standard EN 16883:2017, which provides guidelines for improving the energy performance of historic buildings. FuturHist advances these efforts by integrating performance indicators, decision support systems, and innovative technical solutions, ultimately streamlining the planning process for energy retrofits. The project also emphasizes the need for holistic assessment methods, ensuring that technical interventions are compatible with the built heritage while optimizing energy efficiency, indoor environmental quality, and cost-effectiveness.

Through the development of assessment categories and indicators, FuturHist provides a structured framework for evaluating retrofit measures and monitoring their impact. The project's outcomes will support practitioners (architects, engineers, owners etc.), policymakers (planners, heritage authorities etc.), and researchers in making informed decisions about energy retrofits in historic buildings, contributing to the broader goal of scaling up the sustainable transformation of existing buildings across Europe.

## 1.2. Objectives

This report is a test user's guide to the draft version (V 0.1) of the FuturHist online decision support toolkit. The report is intended for accompanying the draft toolkit.

The primary objective of this deliverable (draft toolkit + report) is to test if the tools (re)developed in Task 4.2 and tested in Task 4.3, is working when synthesizing the tools into a digital step-by-step toolkit (the “toolkit”) with the methodology described in 4.1. The access to the toolkit will be explained in [Chapter 2.2](#).

The focus is primarily on the core functions of the toolkit:

- Functioning online step-by-step platform, where a user can click through the steps described in D4.1.
- Filtration of solutions based on user’s choice of typology and answers to questions in baseline assessment.
- Integration of energy models described in D4.2.
- Calculation of LCA, LCC and SRI for the limited selection of solutions.

The toolkit accompanying this report is a draft version of the FuturHist decision support toolkit, which means that functions described in D4.1 exceeding the core functions described above are not yet developed. Additionally, user interface and page layouts are also to be developed and refined. Hence, in this version the user will experience artefacts linking to the backend of the tool, like machine names of different variables and properties, weights for sorting questions and prioritizing calculations, etc. For more information on the planned development after this deliverable, please see [Chapter 4](#).

## 1.3. Structure of this document

The format follows the step-by-step toolkit, structured following the methodology defined in Deliverable 4.1 and using the tools as described in Deliverable 4.2.

Each step is covered with a screenshot from the current interface, instructing the user on how to use it and explaining core technical principles from the backend of the toolkit.

What follows is the overview of the feedback received from two review/testing sessions: internal session at ERIK architects and review from FuturHist partners.

Finishing chapter covers the planned changes, improvements and additional features.

## 2. FuturHist Integrated Decision Support Toolkit

### 2.1. Background

As per methodology defined in D4.1, Futurhist toolkit is a multidimensional decision-support system, structured as a step-by-step toolkit (the “toolkit”).

The aim is to support the users in decision-making in the very early stages of a project, using simplified assessment tools and guiding. The decision-making methodology manages different aspects in a retrofit, and, together with the toolkit, supports the multidimensional aim of the project.

In most retrofit cases, several solutions will be needed to achieve extensive energy savings and improved comfort; the methodology therefore combines the effect of several solutions developed in WP2 and WP3. This combination is often calculated in complex and time-consuming simulations and thus is often neglected in practice. Instead, the Toolkit is designed to build on predefined information in the Typologies and gathers information from the user about a specific building.

The step-by-step toolkit uses the KPIs and targets as identified in WP1 and includes all the passive and active solutions defined or developed in WP2 and WP3. To ensure the applicability of the result, the toolkit includes aspects like LCA, smart readiness, construction materials, and heritage significance.

A more detailed description of the methodology and all dimensions can be found in FuturHist D4.1 *Multidimensional decision-making methodology to identify an optimised solution for deep renovation of historic buildings*. In the report’s annex 7.1, the method system diagram can be found. In the figure below, the diagram is linked to the steps in the draft toolkit and this report:

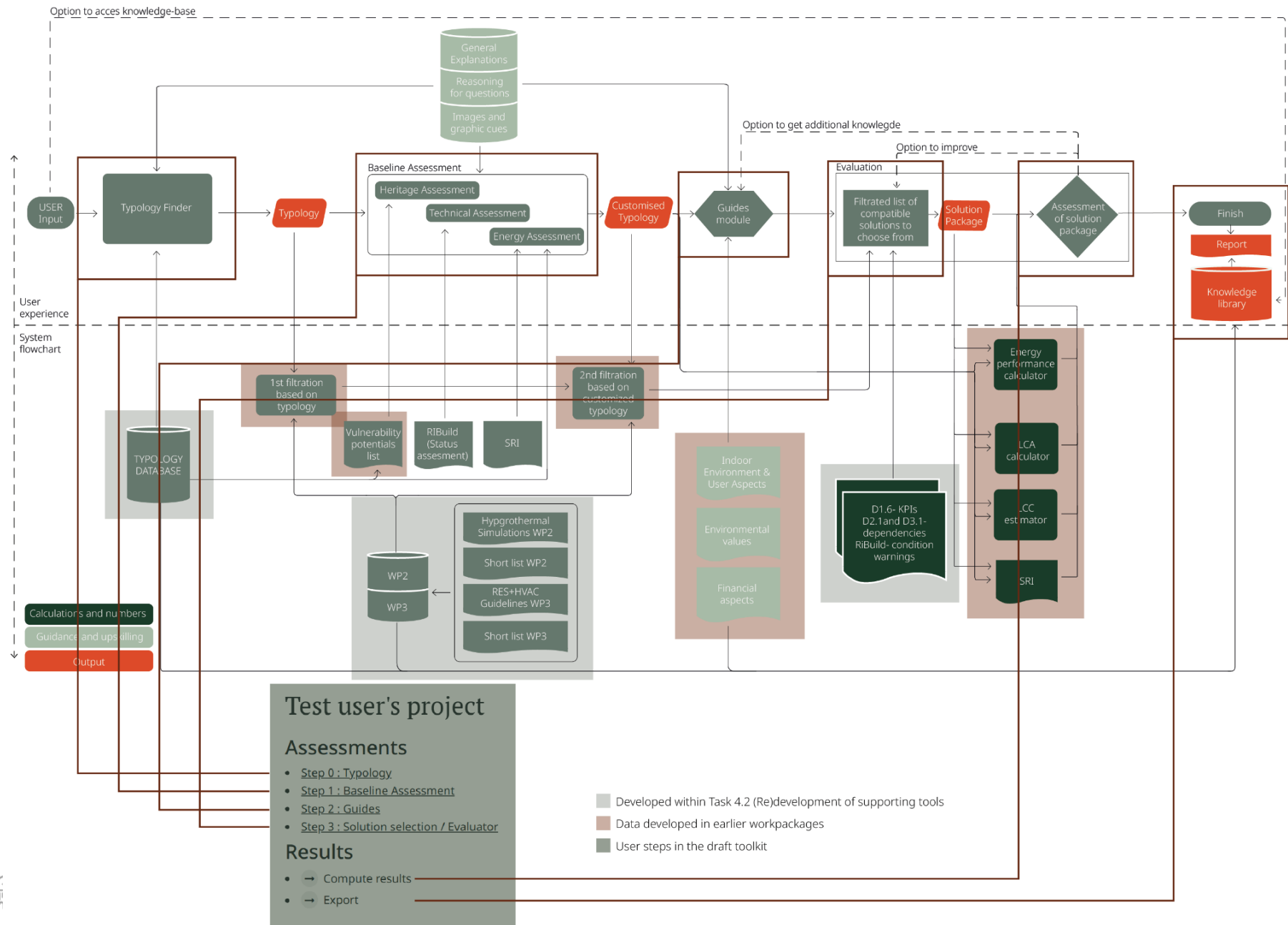


Figure 1. Steps in draft toolkit compared to Method system diagram

## 2.2. User guide to the step-by-step toolkit

In this chapter, each step in the toolkit is described.

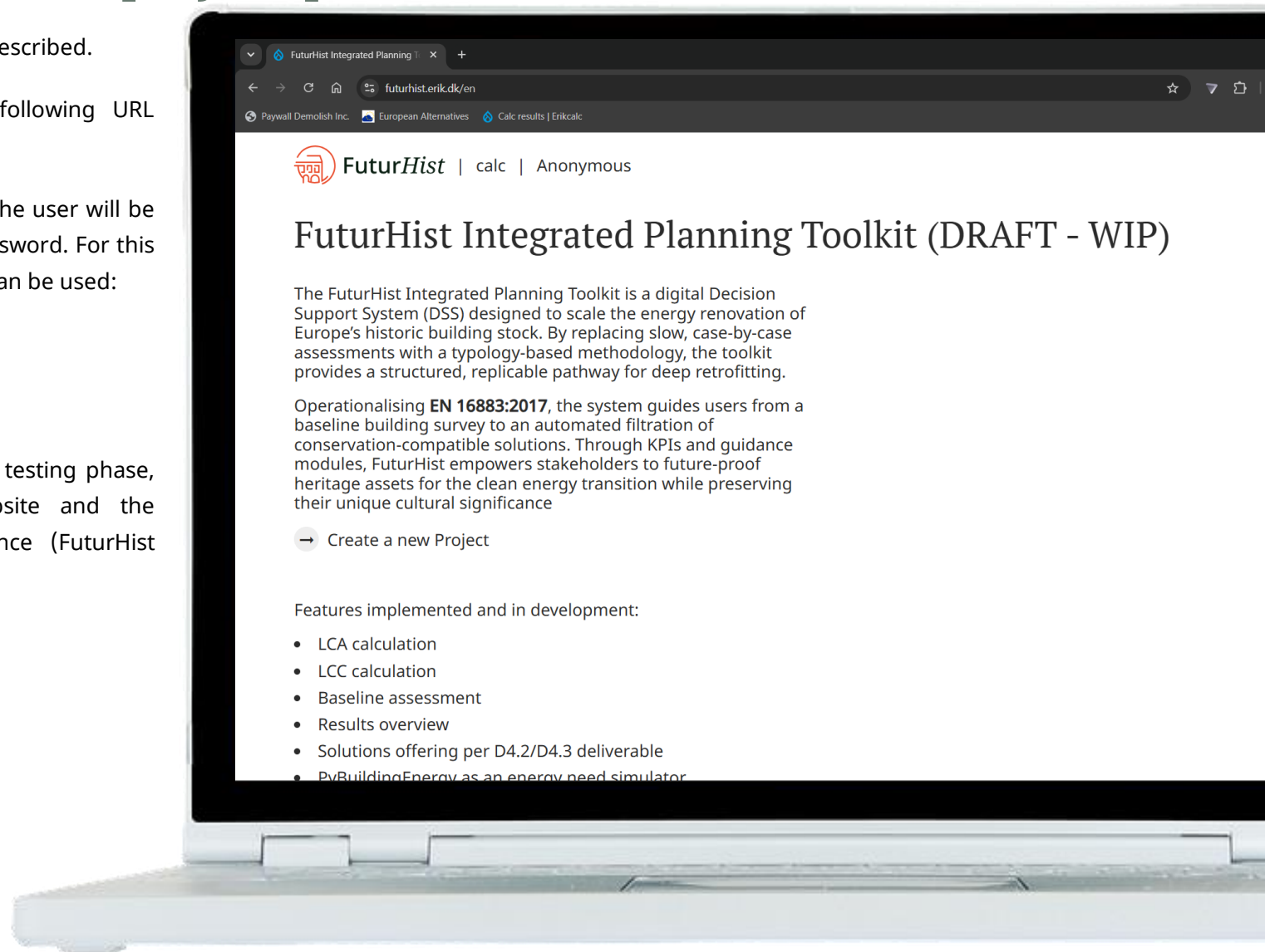
The toolkit can be accessed on the following URL  
<https://futurhist.erik.dk/en>

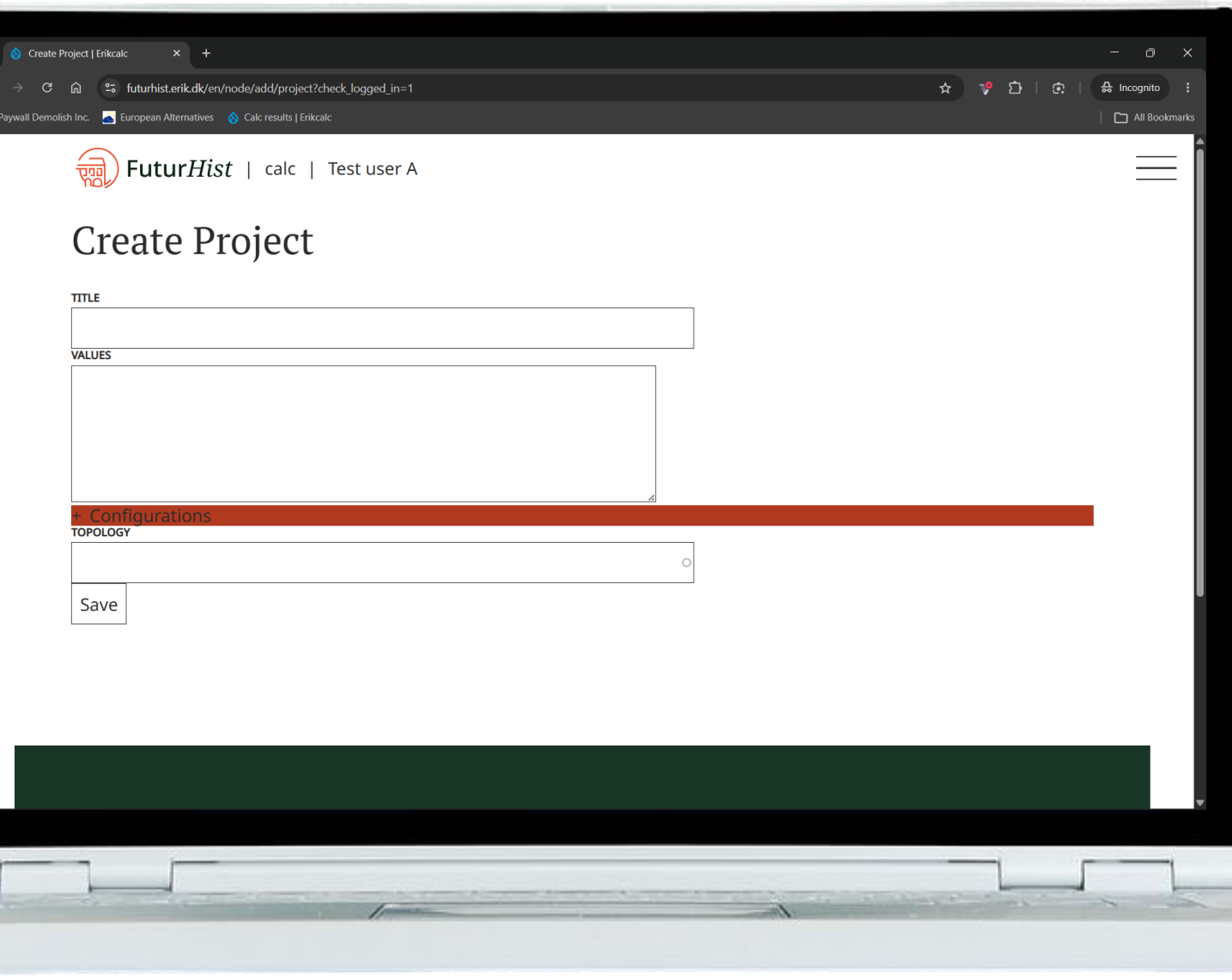
Upon clicking on **Create a new Project**, the user will be prompted to insert a username and a password. For this testing version, the following credentials can be used:

Username: Test user A

Password: FuturHist

As the toolkit is only entering the closed testing phase, please refrain from sharing the website and the credentials outside of intended audience (FuturHist partners, EU reviewers).





The screenshot shows a web browser window with the address bar displaying `futurhist.erik.dk/en/node/add/project?check_logged_in=1`. The page header includes the FuturHist logo, the text "calc | Test user A", and a hamburger menu icon. The main heading is "Create Project". Below this, there are three input sections: "TITLE" with a single-line text box, "VALUES" with a multi-line text area, and "TOPOLOGY" with a dropdown menu. A red horizontal bar with the text "+ Configurations" is positioned above the "TOPOLOGY" section. At the bottom left of the form is a "Save" button. The laptop's keyboard is visible at the bottom of the frame.

After you have entered the credentials, you will be presented with the **Create Project** page. For the current test version, project title is the only project information that needs to be completed in this step. The input is confirmed by clicking **Save**.

Any user can create multiple projects, that will be saved individually if the user wishes to explore different scenarios for one or several buildings. It is recommended to add an easily recognizable name to your projects, for the sake of future revisits and changes.

Once the project is created, the toolkit will guide you through the individual assessment steps. It is possible to move back and forth between all steps to alternate answers. You start by clicking on **Step 0: Typology**.

## 2.2.1. Step 0 – Typology

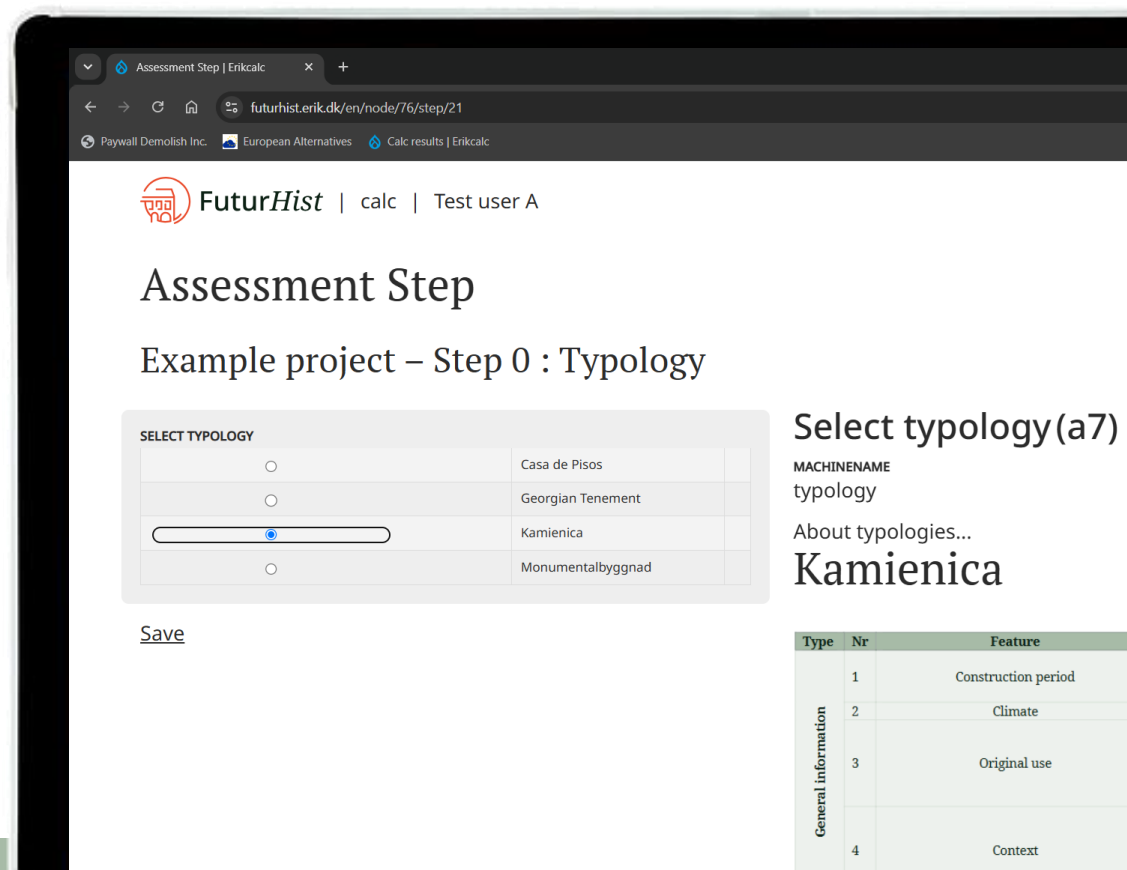
In this step, the user selects the typology that best corresponds to the building they are assessing.

The current version contains four typologies. Selecting a typology provides additional information in the panel on the right-hand side. This may include information about how the typology is constructed, typical wall characteristics, period of construction and its relationship to the surrounding urban environment. For some typologies, the information is based on actual demonstration buildings; for others, typical values from literature are used.

It is possible to use the toolkit even if the building is not one of the FuturHist typologies to browse knowledge, advice, solutions and rough estimations in the KPIs, but the user must choose the one resembling their building the most. As the toolkit is tailored to the typologies, the closer the relevant building is to a typology, the better the heritage assessment and energy calculation, LCA and LCC result are.

In previous deliverables, standard values have been defined for each typology, that regards relevant thermal, technical and heritage features as well as the energy models developed for each typology. The toolkit uses exactly that information that is necessary for the executing functions and loads it into the users' cache memory. For example, the typology-specific energy model is used as a reference model for conducting energy performance calculations.

However, as individual buildings inevitably vary, the reference model can be adjusted to reflect the specific characteristics of a given building through a structured series of user questions in the following Baseline Assessment (step 2), before which we must confirm the choice of the typology by once again clicking **Save**.



## 2.2.2. Step 1 – Baseline Assessment

The baseline assessment establishes the existing condition of the building. It contains questions about general building information as well as technical and heritage characteristics that are subsequently used to filter away inappropriate solutions.

The user answers the questions one by one and enters information available for the building in question. When clicking a question, additional information or guidance appears in the panel on the right. To avoid asking questions that are not relevant to the case building, certain questions are conditioned by previous answers (i.e. typology choice, heating source, etc.). Due to current limitations of the user interface, answers can only be single choice, or number inputs. This will be changed in future updates to accommodate a wider range of answers to fitting questions.

Assessment Step | Erikcalc

futurhist.erik.dk/en/node/76/step/8

Incognito

FuturHist | calc | Test user A

|                       |                |
|-----------------------|----------------|
| <input type="radio"/> | Spain          |
| <input type="radio"/> | Sweden         |
| <input type="radio"/> | United Kingdom |

**CITY**

|                       |          |
|-----------------------|----------|
| <input type="radio"/> | Krakow   |
| <input type="radio"/> | Warsaw   |
| <input type="radio"/> | Szczecin |

**BUILDING USE**

|                       |                              |
|-----------------------|------------------------------|
| <input type="radio"/> | Residential (Apartment)      |
| <input type="radio"/> | Residential (Detached House) |
| <input type="radio"/> | Office                       |
| <input type="radio"/> | School                       |
| <input type="radio"/> | Kindergarten                 |
| <input type="radio"/> | Department Store             |

**NET FLOOR AREA**

0

**NUMBER OF FLOORS**

0

**City(a77)**

MACHINENAME  
city

Write the name of the city/town, where the building is located.  
(Population > 1000)

WEIGHT  
2

### Specific building data

Starting questions of the baseline assessment are concerned with calibrating the reference, typology-specific, energy model to reflect the specific characteristics of the building under consideration, including its location, function, geometry, scale, construction, and energy-related conditions.

In cases where no additional information can be provided, the default values ensure that the computational process remains operational. The underlying principle is that increased data specificity enhances the accuracy of the results, while the framework remains robust enough to support analysis under conditions of limited input.

## Heritage significance and technical compatibility

A set of questions is deployed to collect information needed for filtering based on heritage significance and technical compatibility. Questions regarding heritage significance are typology-specific and are conditioned as previously described. Following the methodology described in D4.2, these answers are then used to filter solutions. The technical compatibility is developed by EURAC as part of the decision trees and the heritage assessment is developed by UU and ERIK, both are explained further in D4.1 and 4.2.

The questions relevant for both technical and heritage filtration are sorted under the building components: basement & foundation, roof, façade, interior and windows. More questions might be developed for future versions of the toolkit, as more solutions will potentially be implemented.

Upon completion of the Baseline Assessment and clicking **Save**, all the answers and provided inputs are stored for subsequent solution filtering, energy simulation and KPI calculation.

Assessment Step | Erikcalc

futurhist.erik.dk/en/node/76/step/8

Paywall Demolish Inc. European Alternatives Calc results | Erikcalc

**FuturHist** | calc | Test user A

|                                  |              |
|----------------------------------|--------------|
| <input type="radio"/>            | I don't know |
| <input checked="" type="radio"/> | 0-4 cm       |
| <input type="radio"/>            | 5-10 cm      |
| <input type="radio"/>            | 11-20 cm     |
| <input type="radio"/>            | >21 cm       |

**Internal finish (a69)**

MACHINENAME  
kamienica\_internal\_finish

Are the walls in the interior covered with

WEIGHT  
400

AVAILABLE SPACE FOR INTERIOR INSULATION

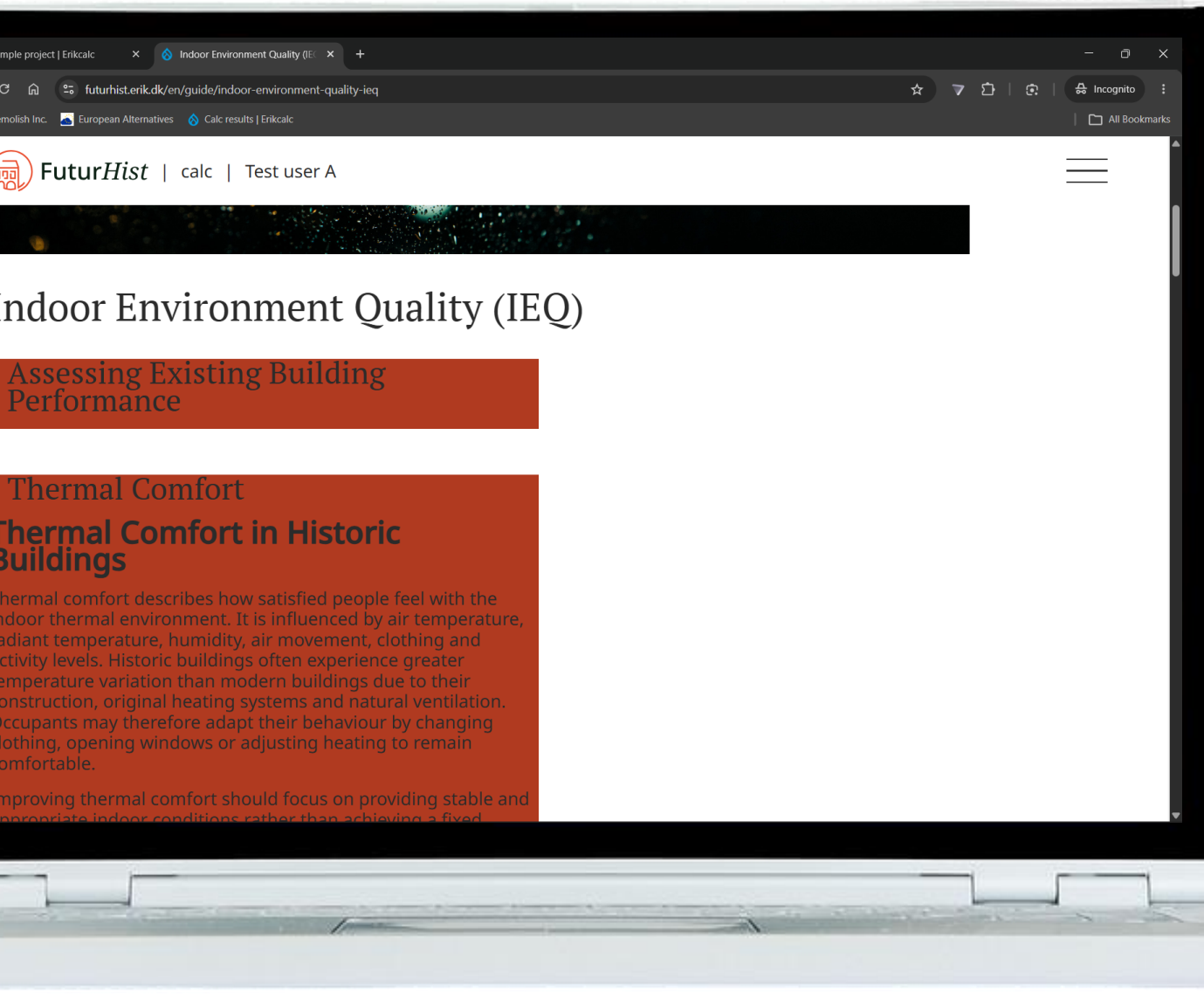
|                                  |              |
|----------------------------------|--------------|
| <input type="radio"/>            | I don't know |
| <input checked="" type="radio"/> | 0-4 cm       |
| <input type="radio"/>            | 5-10 cm      |
| <input type="radio"/>            | 11-20 cm     |
| <input type="radio"/>            | >21 cm       |

**INTERNAL FINISH**

|                                  |                                     |
|----------------------------------|-------------------------------------|
| <input type="radio"/>            | Paintings in the staircase          |
| <input type="radio"/>            | Wall paintings along the ceiling    |
| <input checked="" type="radio"/> | Visible wooden beams in the ceiling |
| <input type="radio"/>            | Paintings on the ceiling            |
| <input type="radio"/>            | Terracotta tiles on the floor       |
| <input type="radio"/>            | None                                |

TECHNICAL REQUIREMENTS FOR EXTERIOR INSULATION

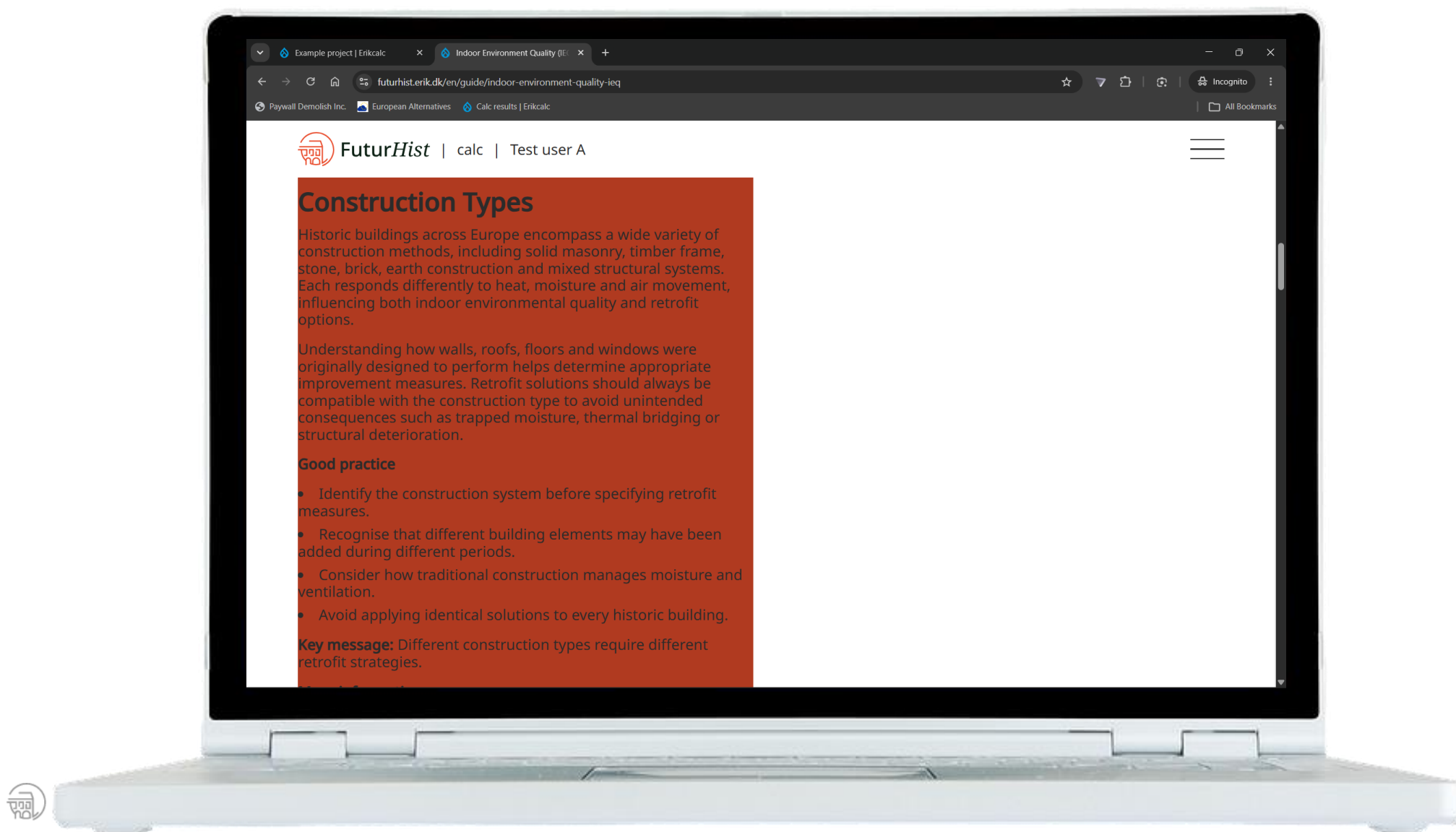
## 2.2.3. Step 2 – Guides



The toolkit contains **Guides** intended to provide additional explanations and support. In this step, the user can read the FuturHist guide “*Indoor Environment quality*”. As it is the only KPI that is not quantified by the toolkit due to its reliance on measurements, this guide is written in full length as part of the FuturHist D4.2. In the future, more guides will be developed, to cover financial and environmental aspects of the retrofit process. Additions for improving visual aspects of this guide are to be implemented.

As the toolkit is in development, so is the integration of Guides. Hence, different options are tried to explore technical capabilities of the platform and different user experiences. Currently, even though there are two buttons leading to Guides from the Steps Overview, only the **Explore the Futurhist Guide Library** does so. After clicking, Guides page will open in a new browser tab, from where the user can click on the **Indoor Environment Quality (IEQ)** to open it.

The chapters are expandable, allowing the user to choose the topics of the biggest interest, and one can simply go back to the previous tab to return to the Steps Overview.



### 2.2.4. Step 3 – Solution selection / Evaluator

Upon entering the **Solution Selector**, the toolkit filters each solution against the predefined conditions regarding previously collected answers and inputs, to determine their fitness for the case building.

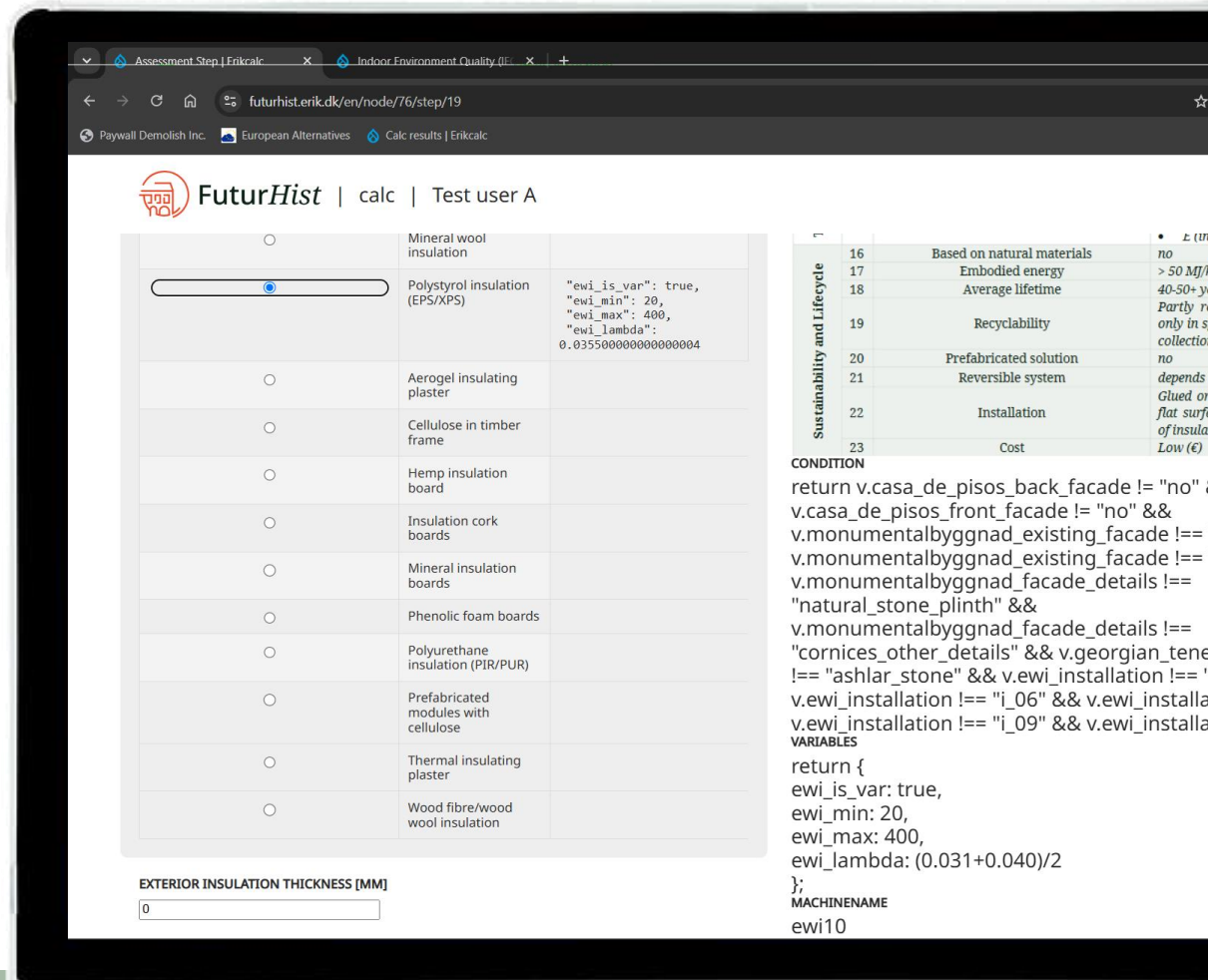
When choosing the solution for a certain category, this early testing version of the toolkit provides an insight into the backend, showcasing coded conditions (filter) that had to be achieved for the solution to appear in the Solution Selector. As previously stated, heritage significant conditions are typology-specific, which can be recognized in this condition overview as they have typology name at the beginning of the expression. Others are technical compatibility conditions.

The user can always alter earlier choices and answers if the list of solutions seems inappropriate. In the final version of the toolkit the user will also have access to the full list of FuturHist solutions when downloading the report.

Some solutions contain adjustable parameters. For example, an insulation measure may ask you to specify an insulation thickness in millimeters. It is up to the user to choose the desired thickness. In cases where invalid thickness is set, the toolkit automatically bounds it to closes minimum or maximum value.

Once the solutions are chosen and the required input is provided, pressing **Save** will guide the user back to the Steps Overview.

This phase of the project required testing of KPI calculation on a limited number of solutions, on the following page there is an overview of all the solutions that have the complete data for calculation.



## SOLUTIONS WITH COMPLETE DATA FOR TESTING KPI CALCULATION IN THE CURRENT PHASE

### Interior Wall Insulation (IWI)

Autoclaved cellular concrete (AAC)  
Calcium silicate boards  
Hemp fibre  
Mineral wool

### Exterior Wall Insulation (EWI)

Cavity wall insulation with insulation granulate  
Foam glass  
Mineral wool insulation  
Polystyrol insulation (EPS/XPS)

### Basement/Foundation Insulation (BFI)

Blown-in cellulose  
External insulation on foundation: EPS/XPS  
Foam glass on the floor

### Roof Insulation (RI)

Construction wood + mineral wool/glass wool/rock wool  
Mineral wool/glass wool/rock wool (loose/blown-in)

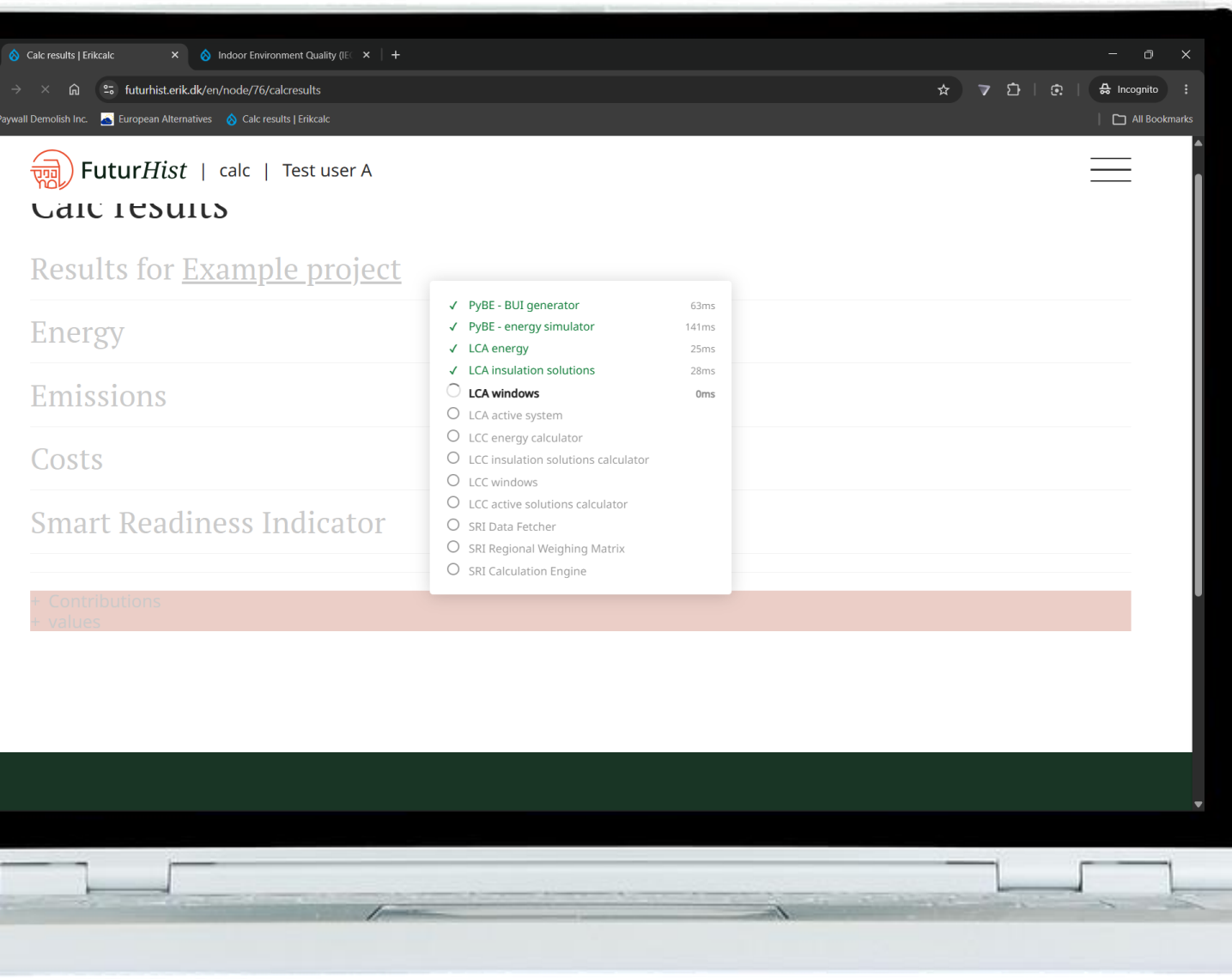
### Window Solutions

Repair window  
Add sealing to a single glazed window  
Add sealing to a coupled window  
Add sealing to the inner layer of a box type window  
Replace the single glazing with low-e glazing  
Replace the single glazing with double insulating glazing  
Replace the single glazing with thin double insulating glazing  
Replace the single glazing with thin triple glazing  
Substitute the existing single window with a replica wooden window with thin double glazing  
Substitute the existing single window with a replica wooden window with double glazing  
Substitute the existing single window with a replica wooden window with triple glazing  
Substitute the existing single window with a replica wooden window with thin triple glazing

### Active Systems (AS)

Central heat generation system with boiler for biomass and ceiling heating  
Central heat generation system with external heat pump and floor heating  
Central heat generation system with gas boiler and wall heating  
Central heat generation system with heat pump and floor heating

## 2.2.5. Step 4 – Results presentation



Pressing **Compute Results** gathers all the collected information and selected solutions, builds the baseline and improved energy models, executes the simulations and calculates the KPIs.

KPIs are calculated in different ways. For some, a subset of the input parameters is linked to external datasets that are automatically retrieved and integrated into the calculation process. For instance, geographical location is used to access relevant climatic data for energy performance modelling; European price indices are applied to estimate anticipated capital and operational expenditures; and energy supply data are incorporated to evaluate the potential for CO<sub>2</sub> emission reductions. For others, these values are built (hardcoded) into solution/calculation definitions in the toolkit.

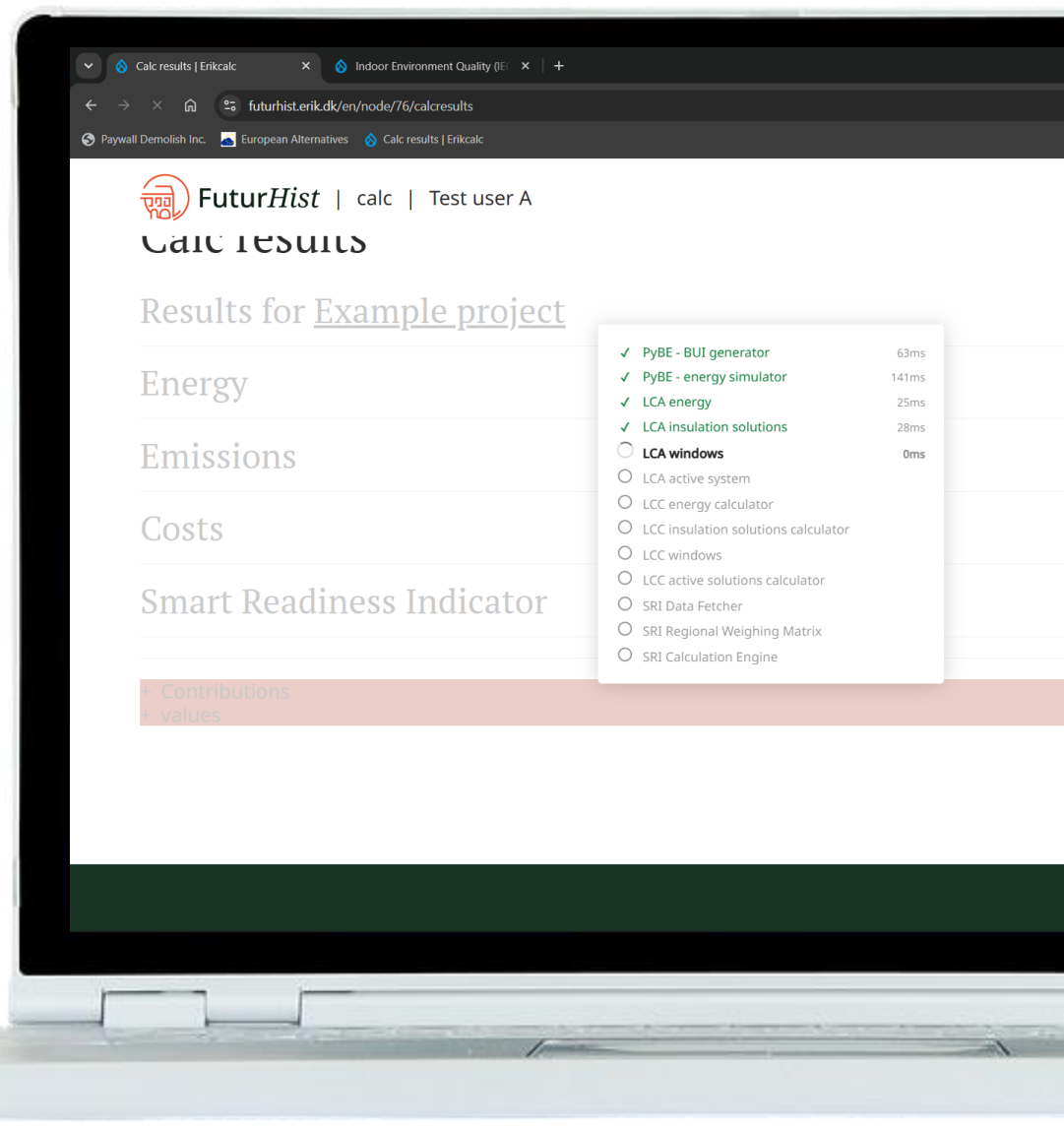
These are explained in more detail in Deliverable 4.2.

The results compare the baseline building with an improved scenario. Depending on the selected measures, the toolkit can calculate indicators including operational carbon emissions, embodied/material-related carbon emissions, LCA results and LCC results. If no relevant improvement measures have been selected, the improved scenario may simply remain identical to the baseline.

When the calculation process is initiated, the input values are transmitted via an API and converted into a data file compatible with the pyBuildingEnergy calculation engine. The returned output contains a range of data points which, in the final version, will be visualized for the user. In the current draft version, only the calculated energy consumption is presented, including values for the baseline condition (pre-intervention) and the post-intervention scenario (including selected measures), as well as the associated savings potential expressed in terms of CO<sub>2</sub> reduction and percentage.

Energy performance data derived from energy calculation are subsequently transferred to the Life Cycle Assessment (LCA) and Life Cycle Cost (LCC) modules, where they are incorporated as inputs. In this context, operational energy consumption (based on the regional energy mix in case of geographically sensitive energy sources) is evaluated alongside the quantified material impacts or costs. Results are presented for both active and passive solutions. In the final version, these outputs will be translated into user-friendly visual representations, including graphs, indicators, and summary metrics.

Finally, the extent to which the selected intervention measures contribute to the building's compliance with predefined Smart Readiness Indicators is quantified and presented as a percentage.



The results should currently be treated as test outputs rather than final verified calculations. Even though the KPI calculations have been validated for a limited set of solutions, one should keep in mind that the toolkit is still in early phases and that results can be faulty.

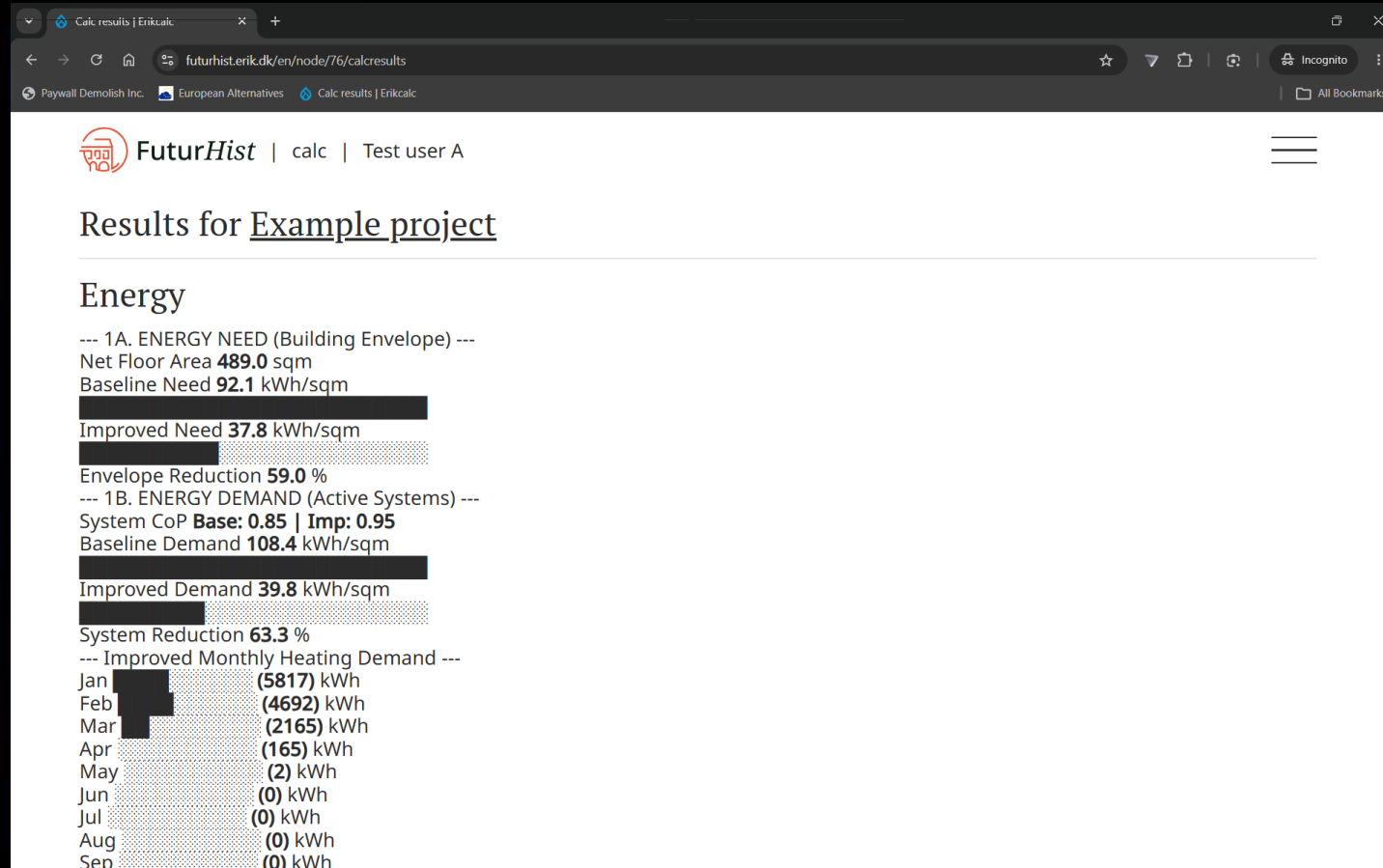
This is the last step in the current version of the toolkit. Almost identical version was used in the first feedback sessions, which is going to be discussed in the following chapter.

Readers of this report are welcome to leave additional feedback on following email addresses:

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## 3. Feedback on the current version of the toolkit

In this chapter feedback gained from review from FuturHist partners and from a review workshop within ERIK, can be found. Testing and feedback collected in this phase are a part of the Task 4.5 - Testing the step-by-step toolkit in demo cases, which runs parallel with the tools and toolkit development. Specifically, the following are results of Test 1, while Tests 1 and 2 will be carried out in the upcoming phases.

### 3.1. Review from UIBK

As part of the internal FuturHist review process, Marianna Muchorowska (UIBK) tested the draft toolkit. Her review is summarized for the purpose of this report in the following points of critique:

#### STEP 0: TYPOLOGY

- UIBK notes that further explanations and illustrations could improve this step

#### STEP 1: BASELINE ASSESSMENT

- Simple errors were found in through this step such as a few typos, a question written for Georgian Tenement found in the wrong typology, some units are missing, and lastly it is noted, that the list of building uses to choose from seems to have an error, as both *Kindergarden* and *School* might result in the same input to calculation, and at the same time Residential (terraced house) should be added.
- There are questions in the baseline assessment that needs more choices for the user, for example the current cities to choose from are only Polish, and furthermore a multiple-choice function is desired for some questions.
- Additional information and explanation for many of the questions is desired, it is noted that the baseline assessment is perceived to be a little chaotic, and could be improved with several smaller steps. Also, it is UIBK's opinion, that a few questions could be improved simply if the order is reversed.

#### STEP 2: GUIDES

- It is noted that the guides seem to be missing in the current version for UIBK test

#### STEP 3: SOLUTION SELECTION:

- When the user is getting an overview of possible solutions, better descriptions of solutions are desired, and UIBK expresses that the order of solutions could be different.
- It is noted that the limitations in insulation solution's thickness according to the data from WP2 might have errors, and it is recommended to add warnings instead of forcing down the possible thickness.

## STEP 4: RESULTS PRESENTATION

- Better graphics could improve the user's understanding

## GENERAL THOUGHTS

Graphics, explanations and lack of illustrations are a common point of critique. Here follows quote examples from the review about initiatives that could improve understanding through the toolkit:

### Step 0: Typology:

*"Here I would definitely add figures - we have nice graphs of each typology (see below). This could be also picture of a real building. Just to show the user what Casa de Pisos is. Maybe some short explanation based on D1.2?"*

### Step 4: Results presentation

*"The results view could be definitely improved with some graphics, right now the user can't see the improvement nicely"*

This quote is followed by concrete ideas as to how to illustrate the results in the toolkit.

All the ideas from the review will be taken into the next phases of developing the toolkit.

The comments about errors have been attempted to be fixed in the draft version.

Lastly, UIBK shared thoughts on an overall different approach to the order and phrasing of the user questions, different approaches will be re-evaluated before the final version of the toolkit.

## 3.2. Internal testing at ERIK architects

A workshop has been held at ERIK Architects to get feedback on the toolkit from colleagues that are not part of FuturHist but could be potentials user of a digital decision support toolkit. The participants in the workshop were chosen for having different roles in the studio, hence different approaches and wishes for a possible new set of tools in their everyday work. Some of the

participants have wide experience with using digital tools, and one participant has experience with user design.

## GENERAL THOUGHTS

The overall response to the toolkit was positive, and several participants described the concept as promising and potentially relevant for a lot of users. At the same time, the discussion highlighted a number of issues that should be addressed before the toolkit can provide a clear and convincing user experience:

## USER EXPERIENCE AND WORKFLOW

- The landing page is missing information and explanation for the user; *"Why is it a good idea for me to use this toolkit?"*
- The overall workflow must not feel too long and potentially overwhelming for the user, focus should be on guiding the user through shorter manageable steps.
- Some questions require interpretation before they can be answered, which makes the process feel more demanding than necessary.
- A progress indicator could show users where they are in the process and how much remains.
- The next version should include better explanations for each question
- Some users may desire a lot of additional information, others may not, especially if they use the toolkit frequently. Some technical details and background information could be shared with pop-ups.
- There was a discussion about whether some of the information could be automated from existing digital building databases for the baseline assessment to reduce questions for the user. Danish BBR data and energy performance information was mentioned as possible sources, but it was at the same time acknowledged, that similar databases from other countries were hard to find.

## FILTERING AND CHOICE OF SOLUTIONS

- There was discussion about whether users should only see recommended solutions or be able to see the full range. Showing too many unsuitable solutions could create unnecessary complexity, but some may want to understand which solutions were filtered out and why.

## RESULTS

- Participants had difficulty understanding what the results were being compared against.

- We need clearer illustrations of what is included in the baseline, what has changed with the retrofit measure scenario, and what assumptions are being made automatically.

## REPORT

- The final report should clearly reconnect to the purpose of the assessment.
- The report should clearly establish what has been achieved through the selected measures
- It would be good if the report could include more than one scenario, so the user is able to compare different possible measures.

## OVERALL POTENTIAL

- Despite the issues identified, the overall concept was seen as promising.
- Participants saw value in a tool that could compare different renovation strategies while taking technical, environmental, economic and heritage considerations into account. A participant underlined that a proper tool for heritage evaluation is currently missing, and the FuturHist approach seems very useful.
- The main priority is therefore not to change the fundamental idea, but to make the workflow, assumptions and results simpler, clearer and more transparent for the user.

## 4. Conclusion, next steps, planned features, changes and improvements

The first tests and the collected feedback were carried out successfully. It gave direction for further development of the toolkit, in both functional and graphical sense.

After the deliverable 4.3, the consortium under WP4 continues to develop and improve the toolkit towards the final toolkit, that will launch in M42. In this chapter is a list of some of the important improvements, the team in WP4 expects to focus on the next phase of the toolkit development. This list is not exhaustive and will be influenced by the topics of concern raised during upcoming tests, reviews and collected feedback.

### GRAPHIC AND LAYOUT

The current draft version has a layout that is intentionally oversimple, with no colors or other identifiers, as this will be developed as part of D4.4. Furthermore, it is the current ambition to further divide the step-by-step experience into several pages for each step to ensure a better focus on the current task for the user.

### TYPOLOGIES AND SOLUTIONS

The draft toolkit is developed and tested for four typologies: Casa de piso, Kamienica, Monumentalbyggnad and Georgian Tenement. These first four represent a typology from each case country, and the remaining five typologies will also be part of the final toolkit.

As described in the Grant Agreement, the draft version of the toolkit must work for 10 solutions. The draft toolkit has filtration based on technical compatibility working for all solutions, while the filtration based on the heritage assessment is developed and tested for all passive solutions, 4 window solutions and 4 active solutions.

The calculation of the KPIs only works for a limited set of solutions currently, as mandated by the Grant Agreement. Consequentially, the user may experience a mismatch between suggested solutions and calculations, as it's likely to choose a solution that has not yet been included in the energy- LCA and LCC calculators.

Data collection for the remaining solutions will be part of the next steps in the development of the toolkit. Furthermore, alternation of exclusions and warnings for some solutions may be expected in the final toolkit.

## INFORMATION AND GUIDANCE

As described in D4.1, general knowledge sharing is a key part of the methodology to share a wide range of knowledge gathered throughout the FuturHist project and make all content and tools of the toolkit understandable to the user. The implementation of this is yet to come and is expected to consist of informational cues to the user, aimed to enlighten why certain questions are asked, as well as warnings to give notice to the user when there is need, when implementation of a certain solution is depending on a condition outside of filtration scope of FuturHist Heritage and Technical compatibility assessments, for example.

## USER EXPERIENCE

It is the ambition to develop a progress bar that allows the user to get an understanding of the progress during the use of the toolkit.

Furthermore, the landing page should be updated with further descriptions as to what the user can expect as well as disclaimers of the limits of the digital decision support.

As previously mentioned, one of the priorities will be allowing for multiple answers to certain questions in the Baseline Assessment.

## USER'S INFORMATION:

When a user engages with the toolkit, e.g. asked a question or presented to a solution's KPI, the user should have the opportunity to open a box or window with further information. Depending on the context, this information can be:

- Illustrative image or drawing
- Justification of questioning
- Example or guidance of how to answer
- Link to further information

## GUIDES

In the draft toolkit, the user can read the *Indoor Environment Quality (IEQ)*-guide as an optional step between the baseline assessment and the evaluator. The current ambition is to add further guides here, e.g. a guide on sustainability and financial aspects of retrofit. Other guides developed within the FuturHist consortium can be added.

## WARNINGS

As the user will be presented with some solutions that can possibly be problematic, or only should be applied under certain conditions, it is the ambition to add warnings to each of these. Some of these warnings will be specific for the typology, others are triggered by a certain user answer,

and some warnings will be specific for a solution or solution category regardless of typologies and answers.

## CHARTS AND DIAGRAMS VISUALIZING THE RESULTS

Currently, there is a simple visualization of results to simply showcase KPI results. Instead of that, richer, more detailed charts will take place, displaying energy need and demand simulation results, as well as LCC and LCA calculations, with more in depth and interesting facts like repayment curve, emissions through the study period, etc.

## REPORT DOWNLOAD

After completing the toolkit, the user will be able to download a report with the results. In the current version, the user gains information about possible solutions and resulting KPIs when finishing the toolkit. It is the ambition that a much broader amount of information is found and available for download with the final version of the toolkit, both broader information about the typology, its features, assumptions and complete heritage assessment, a link to the full solution database, links to a broader set of guides and so on.

## FURTHER VALIDATION AND FINE TUNING OF THE KPI CALCULATIONS

These earliest tests and developments, covered in this milestone, ensured that the aimed calculations can be done with sufficient accuracy. As the expanding of the solution databases has already begun, it has been proved that some adjustments will be necessary in order to continue delivering meaningful results to the user.

One example is window improvements, which often require a lot of manual and expensive manual labor, but in return they do not provide as big of thermal improvement. This could be a compromise of restoring historic buildings, but more efforts will be invested to ensure these calculations are accurate.

## INTEGRATION OF MORE ACCURATE SIMULATIONS OF ACTIVE SYSTEMS

Currently, the toolkit uses a simplified method to calculate energy demand, using Coefficient of Performance for each active system from energy need calculated by dedicated energy simulator (pyBuildingEnergy).

The energy simulator has an option to simulate active systems in the approximated building, and in the following phases, this option will be explored in more detail.

Furthermore, separating energy systems into respective domains (heating, cooling, ventilation) is needed to properly assess buildings with more complex technical systems, as well as to deepen the SRI calculation which also covers more than one domain.



## Tailored intervention solutions for future-proofing historic buildings

At FuturHist, we research and test energy-efficient retrofit interventions tailored to historic building typologies. We implement these solutions in real-life demonstration cases in Poland, Spain, Sweden and the UK. We focus on innovative solutions such as bio-based materials, internal insulation systems, window retrofits, HVAC, and RES integration.

DURATION OF THE PROJECT: JANUARY 2024 – DECEMBER 2027

COORDINATOR

**eurac**  
research



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Consejería de Fomento,  
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