FuturHist

Selection of tools: a review of guidelines and tools for energy retrofits in historic buildings

Project Overview

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Summary

Since the launching of the EPBD in 2010 there have been increasing efforts to develop guidelines and tools that can support the decision process to implement energy retrofit solutions in historic buildings. This deliverable gives an overview of relevant guidelines and tools that are available and asses their relevance in relation to a soon to be developed *FuturHist* toolkit.

To be able to identify potentially relevant guidelines and tools previous research was consulted, different search engines were used and *FuturHist* partners were asked to contribute. In addition, previous produced material from interviews and results from a questionnaire both targeted to *FuturHist* stakeholder groups was contributing to this deliverable. A workshop within the *FuturHist* consortium was organised to be able to get extra input. This leads to the identification of a wide range of different tools and guidelines that were analysed (see annex 1) and of which the most relevant are assessed in this deliverable. Within the inventory a distinction is made between single-dimension and multi-dimension tools, as well as guidelines and digital tools.

A wide range of single dimension tools are identified within the spectrum of the conservation, financial, energy and life-cycle compatibility of the implementation of retrofits. When it comes to multi-dimensional tools only a limited amount of potentially relevant web-based tools is identified. The availability of relevant guidelines, however, is large, as almost every European country have developed and published guidelines within this specific field.

The inventory and analysis show that there are several tools and guidelines available that can help to support the decision-making process. The potential of these tools in the context of a *FuturHist* toolkit is, however, only limited and the lack of longevity causes serious problems. On the contrary, there are many relevant guidelines. At the same time, they are often context specific, being a product of a specific heritage authority or other organisation which complicates their universal use.

The results of this work will inform the toolkit developed within FuturHist. In addition to that, the tools identified here will be shared and documented via the BUILD UP website, the European portal for energy efficiency and renewable energy in buildings, in order to make this knowledge more easily accessible.

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Disclaimer

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Abbreviations and definitions

Below is a selection of terms and concepts in relation to guidelines and tools, collected and defined to establish a common understanding of what partners and stakeholders mean by using these terms.

Calculation tool

A tool for calculating the numerous effects and/or impact of different conditions or actions. It can be life cycle assessment calculations, greenhouse gas calculations, or indoor air quality calculations. Such a tool needs to be based on coherent data from different databases.

Conservation-compatible retrofit solutions

Energy retrofit solutions that do not undermine the heritage value of the building and are in line with the conservation targets. Since in practice it is almost unavoidable that retrofit solutions will impact the heritage value, finding conservation-compatible solutions often entails to limit the impact on the historic character as much as possible.

Decision Support System

Usually abbreviated as DSS, this is a system under control of one or more decision makers that assists in the activity of decision making by providing an organized set of tools intended to impose a structure on portions of the decision-making situation and improve the ultimate effectiveness of the decision outcome (Marakas, 2003).

Energy retrofit

A general concept for all types of renovations where reduced energy consumption is the main goal for the renovation. It is used for the entire renovation process, from planning to evaluation, and is closely related to sustainable renovation (Thuvander et al., 2012).

Guidelines

Guides the user by giving information on how and in what order something should be done. In the *FuturHist* context a guideline tool is a step-by-step guide covering different parts of the planning process and implementation of energy efficiency measures in historic buildings.

Historic building

Within EN 16883:2017 defined as “a building of cultural significance.” A more elaborated definition is stated by the Institute of historic building conservation that states: “Is generally considered to be a building or structure that has some kind of 'historic value', i.e. people in the present are connected to it via past events in some way. This value warrants it being afforded consideration in planning decisions that have to be made concerning it. A building may hold special historic interest because of its importance with respect to a particular historical event or period, or be associated with nationally important people. Alternatively, there might be special historic interest in the building itself, i.e. its construction methods, design, architectural significance, and so on (IHBC 2021).”

Repository tool

A tool that works as an information repository. In the context of *FuturHist* this is defined as a tool that presents a set of retrofit solutions where pros and cons, references and useful links are provided. These tools are mainly aimed at investigating possible retrofit solutions and are not necessarily focused at supporting experts in the decision-making process (Buda et al. 2022).

Stake holder groups

Manager/ owner

Includes managers of public buildings, users of public buildings, real estate owners, demo case owners, demo case users and researchers.

Practitioner

Architects, engineers, contractors, craftsman, heritage experts, energy experts and retrofit experts.

Public authority

Includes local heritage authority, regional/national heritage authority, planning officers and policy makers

User

Includes private building owner, private building user.

Tool

The term tool is used in many different contexts and forms when it comes to the field of energy efficiency in historic buildings. In the context of this report, the definition of a tool is a set of information that has the scope “to facilitate a transparent discussion and a better understanding of different valuing and assessment processes, providing a framework that unifies different stakeholders’ perspectives in strategic decision-making" cf. (Buda et al., 2022). Tools can consist of a web-based interface, software, guidelines and other hybrid forms. In the context of this report in the *FuturHist* project we make a distinction between different kinds of tools; single-dimension tools, multi-dimensional tools, digital decision-making tools, digital decision-making tools,

Single-dimension tool

A tool that is mainly focused on one dimension of the energy retrofit process, for example heritage values, energy efficiency or economy, in historic buildings.

Multi-dimensional tools

A tool that is focused on multiple dimensions of the energy retrofit process in historic buildings.

Digital decision-making tool

A tool that aims at helping decision makers to take the right action based on a multi criteria process (Carli et al. 2018) using a digital interface. In the *FuturHist* context a digital decision-making tool aims at guiding the decision maker to an optimal energy retrofit solution in a historic building through the use of a digital system. This can be both a single dimension as well as a multi-dimension tool.

Toolkit

Skills and knowledge that are useful for a particular purpose or activity, considered together (Cambridge dictionary). In the context of FuturHist a toolkit contains knowledge and guidance to support the decision-making process of implementing energy retrofits in historic buildings.

1. Introduction

This report summarises the results from Task 1.4: "Analysis of existing guidelines and tools" of the project FuturHist. It aims to identify and sort out the most appropriate tools and guidelines, or selected parts of these, that can contribute to the development and improvement of the planning process of energy retrofits for historic buildings.

1.1.Background

Since the launching of the European Energy Performance of Buildings directive (EPBD) in 2010, there has been a need for supporting tools and guidelines on how to deal with energy issues in buildings with heritage values. This need has led to the development of tools and guidance to support property owners and developers in upgrading the energy performance of their building stock. Numerous projects funded by different European development and research programs have been carried out with the aim of developing coherent tools and guidelines for improving the energy efficiency of historic buildings while respecting their heritage value. Also, a web-based portal, BUILD UP, with the aim to function as the primary source for issues concerning energy efficiency and renewable energy in the building and construction sector was launched in 2009 to support the implementation of the EPBD in the member states. Today, the requirements to reduce the climate footprint of buildings have increased further. Recently, a revised EPBD for Europe's building stock has been adopted and will be implemented in each European member state and affiliated countries. Authorities, organisations, companies and research networks have been involved in developing and producing knowledge and guidance, both nation-specific and internationally. The purpose of *FuturHist* deliverable 1.4 is to build upon the insights and development provided by previous projects, in order to contribute with input to the development of a *FuturHist* toolkit.

1.2.Objectives

Within the *FuturHist* project two objectives for task 1.4 were identified, being:

- Identify and select existing tools and guidelines that could be elaborated and simplified in order to contribute to the development of a *FuturHist* toolkit.
- Analyse the identified tools and guidelines to select the most important parts of each tool that can contribute to the development of the *FuturHist* toolkit.

FuturHist task 1.4 takes the standard EN 16883:2017 as point of reference for evaluating existing tools and guidelines and to find and identify the most appropriate ones, or selected parts of these. The aim of the work in this part of the *FuturHist* project is to feed in information that will contribute to the work that will be done in WP4 where both the development of a multidimensional decision support toolkit as well as development and redevelopment om existing support tools will be conducted. The research presented in Buda et al. (2022) serves in this respect as a starting point together with collected data from the project network.

Delimitation

Tools and guidelines that are described and analysed in this report can potentially support the planning and decision support process to implement energy retrofits in historic buildings. This means that only tools and guidelines that do meet these requirements are listed in Annex 4. Tools that are currently unavailable have in some cases been inventoried and included in the list as well, but since a more in-depth analysis of these tools was impossible, they are not described in detail in this report.

1.3.European standards

The implementation of energy retrofit measurements in historic buildings are, besides national legislation, regulated through non-binding European standards. In many cases these standards are adopted by European member states as national standards. Three European standards are of major interest in the context of the development of a *FuturHist* toolkit: EN 16883:2017, EN 16096:2012 and EN 15898:2019.

EN 16883: 2017

In 2017 the first European standard for energy efficiency in historic buildings was published: EN 16883 *Conservation of cultural heritage. Guidelines for improving the energy performance of historic buildings*. The standard was established to facilitate the sustainable management of historic buildings through the implementation of energy retrofit measures in line with an adequate historic conservation of the buildings. Having a predominantly informing character, the standard gives suggestions for energy retrofit procedures that can be interpreted and implemented in the context of different individual cases. The standard provides a working procedure to select different solutions that can be implemented to improve the energy efficiency in the given historic building and offers guidance to practitioners and building owners. The standard recognises several steps within the decision-making process. These steps are numbered according to the article of the standard they match (fig1).

6. Initiating the planning process: Identifying the scope of the project in line with the stakeholders' expectations as well as identifying the project team.

7. Collection of relevant information: Creating a building survey that describes 1) heritage significance and conservation opportunities and constraints, 2) past and present use, 3) structural systems, 4) energy performance assessment and 5) indoor environmental assessment.

8. Identification of objectives: Identification of the problems to be solved. The objectives that should be specified are culture, economy, environment and society.

9. Deciding if a building retrofit is needed: Decision is made if an energy retrofit is needed, based on the foregoing steps while taking into consideration both technical and heritage aspects.

10.3-10.4. Identification of the retrofit solutions: Defines possible solutions to the problem.

10.5-10.7. Assessment and selection of solutions: Identified solutions are evaluated with a risk-benefit analysis.

11.2 Implementation of solutions: The best option is selected and implemented. After a decision is made there is a need to monitor and follow up this decision, which is covered by the following step:

11.4. Post-occupancy: Follow up on the selected and implemented solution after a certain amount of time.

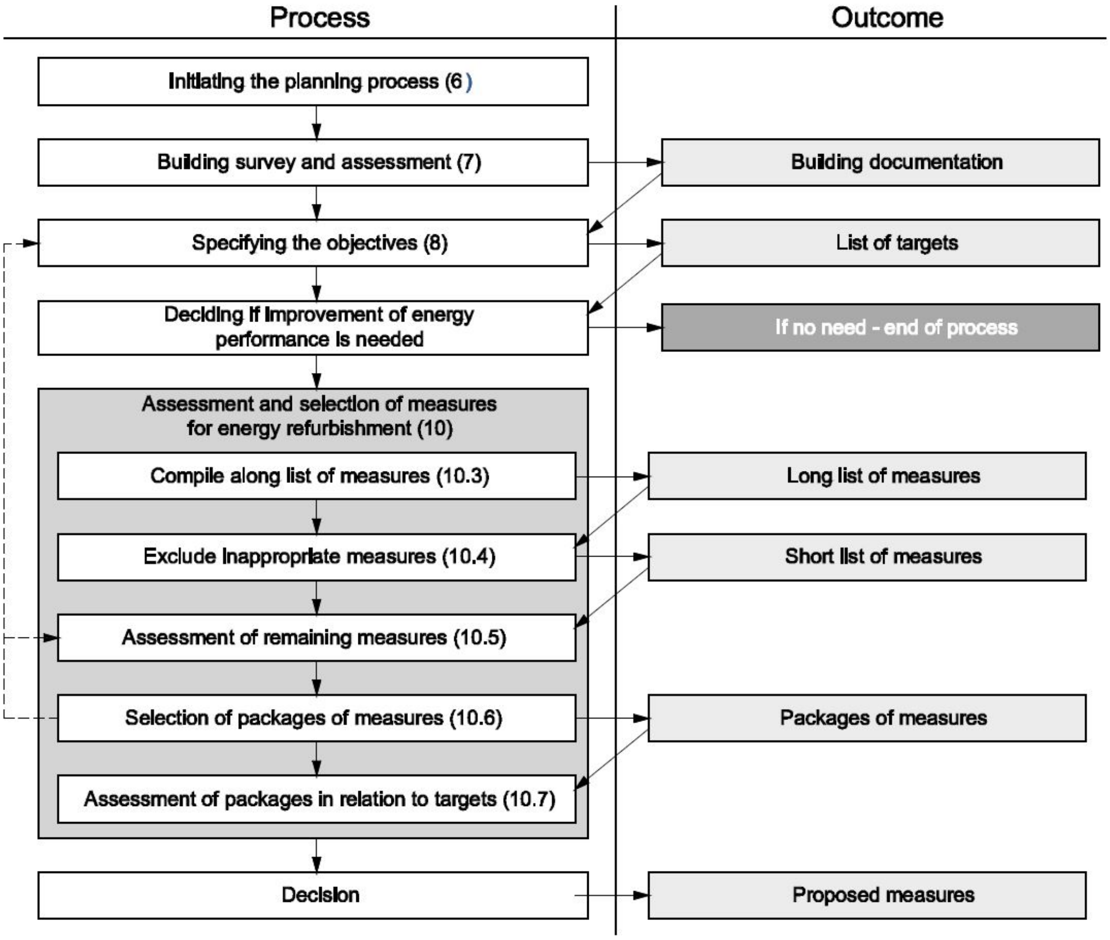

Fig.1 Schematic overview over the steps in the decision-making process as defined by EN 16883 (European Committee for Standardization, 2017)

The standard was the starting point for the development of a handbook to make the rather concise text of the standard more accessible to the standard's target groups. The main objective with this handbook was to exemplify how the use of the standard could look like in practice when it comes to integration in existing practices and what the benefit of following the standard could be. Also, examples of energy retrofits and energy measures is added to this handbook. (Leijonhufvud et al 2021)

While analysing the different guidelines and tools, the steps from the above presented standard will serve as points of reference. Since a *FuturHist* toolkit is aiming to be able to assist in every step of the process, determining which steps are covered by which tools and guidelines is important and will be central to the research.

Currently a working group of CEN is revising the standard. Members of the *FuturHist* consortium are part of the working group and will be able to contribute with new scientific results.

EN 16096:2012

Another important standard is EN 16096:2012 *Conservation of cultural property – Condition survey and report of built cultural heritage*. This standard supports the value and condition assessment of built heritage. It set standards for compiling a survey that includes elements such as object information and description, condition description, and risk assessment that in turn are supposed to result in recommendations and a condition report. The assessment of the value and condition of a building is prerequisite to make energy retrofits, making this standard of high importance in retrofit processes and something that tools should relate to.

EN 15898: 2019

Being first implemented in 2011 and updated in 2019 EN 15898 *Conservation of cultural heritage – Main general terms and definitions* aims to provide a set of terms and definitions connected to concepts that are used in the field of cultural heritage conservation. Consequently, this standard provides a common ground in the context of the implementation of energy retrofits in historic buildings.

1.4. Previous research

As background to the review of existing guidelines and tools it is important to take into consideration the body of previous research that has been done on this topic, both when it comes to previously executed reviews as well as literature on specific methods, guidelines, and/or tools. Stanica et al. (2021) point out that new approaches to assessing potential solutions to increase the energy efficiency of historic buildings are needed. This requires flexible and adaptable tools to support in the decision-making process. They therefore recommend moving the focus from single buildings to a whole district since it will enhance the way in which we can assess local energy potentials and innovative measurements. On top of this they propose an integrative approach that involves a large variety of energy conservation and renewable energy measures that are evaluated at multiple levels and scales.

During recent years, multiple attempts have been made to make a review over the available tools for enabling conservation-compatible retrofit solution in historic buildings. Ferreira et al. (2013) analyse 40 different methods for refurbishment decision support tools. They conclude that an evolution from single objective to multi-objective methods have occurred during the past years. Furthermore, they highlight the need to implement LCA in decision-making models, to develop fast and effective methods, to increasingly include social aspects, to focus on regional specificity and to use a stochastic perspective rather than a deterministic one so that poor decisions will not be responsible for a wide range of losses. Pohekar and Ramachandran (2004) reviewed more than 90 papers to analyse the use and application of different methods for multi-criteria decision making for energy retrofits. They conclude that multiple methods often are used in parallel to validate results. In addition, they identify a development towards more interactive decision-support systems. In the context of the IEA-SHC Task59, (Buda et al., 2022) investigate the possibility of combining EN 16883:2017 (CEN, 2017) with computer-based tools to support stakeholders in the decision-making process for energy retrofits in historic buildings. Therefore, (Buda at al., 2022) analyses a set of tools to study how they work, what input they require and what their advantages and disadvantages are. The inventory that has been made in the context of this deliverable (see chapter 3) takes its starting point from this article and uses some of the analysis as a source.

In addition, there has been a focus within previous research on specific practices and methods for decision-making in the context of energy retrofits. Also linked to Task59, Herrera et al. (2020) discuss dissemination of best practice and guidelines as critical approaches for addressing a lack of support during the design process and accessibility to proven design solutions. By assessing existing databases, they find that there is a lack of best-practice examples in the context of historic buildings and state that there is a need for more tailored information in relation to these case studies. Eriksson et al. (2021) present a new heritage impact assessment methodology to balance cultural significance and the installation of retrofit measurements, developed in the context of the EFFESUS research project. Di Guiseppe et al. (2020) present the application of a probabilistic approach to life cycle costing in internal insulation of historic buildings in the context of the project RIBuild. The study states that this method can estimate the range and likelihood of global costs, while also including energy alternatives and future economic scenarios. In Sagarna et al. (2024) an attempt to develop a replicable prototype to maintain heritage values in historic buildings that need to undergo energy improvement interventions on facades was made. This is done in the context of the Oriental expansion of San Sebastian, Spain. By using the Design Science Research Methodology (DSRM) a protype was developed to determine regulations for facade interventions. The final prototype enables a “faster, more rigorous, and efficient understanding, characterization, classification, study, and definition of intervention criteria, measuring the vulnerability of buildings to these interventions quantitatively.” Egusquiza et al. (2018) describe a method that supports decision making for Energy Conservation Measurements (ECMs) in historic districts during the early stages of the planning process. This method focuses the improvement of the energy performance of buildings as a positive impact while balancing this with potential negative impacts. By using CityGML-based urban models this method can be used for planning large-scale energy retrofitting. Kim et al. (2010) propose an alternative decision support system that aims to prioritise restoration needs in the executable budget. They create this model using stochastic analytic hierarchy process (S-AHP) and knowledge-based experience curve (EC). Jaggs and Palme (2000) developed the EPIQR methodology to assistant apartment building owners that want to refurbish their building stock. This is a computer-based system that will allow the user to identify the most cost-effective and appropriate action. The field is continuously evolving, with ongoing research and development efforts aimed at managing buildings and building stocks to meet the increasing climate requirements. One such initiative currently under development is the CERPlan methodology, which has been introduced at an early stage (Castagna et al., 2024). This methodology will be integrated in a web tool that will help property owners and municipalities to make more tailormade decisions about renovation strategies for buildings and building stocks.

2. Methodology

Central to this task is the identification of tools and guidelines that are inventoried and analysed. The analysis of the selected tools and guidelines were supported by the *FuturHist* partner network. In addition, a workshop was organised within the project partner network and an interview study and questionnaire were conducted among different stakeholders to get further input in what kind of tools and guidelines are needed.

2.1. Interviews, questionnaire and workshop

2.1.1. Interviews

In the context of WP1, a series of interviews were conducted, with different stakeholders in different countries with the purpose of getting an insight into user needs for a *FuturHist* toolkit. A distinction was made between different kind of stakeholder groups (the same definitions as was used in the interview study) :

- **Public authority**: Includes local heritage authority, regional/national heritage authority, planning officers and policy makers
- **Manager/ owner**: Includes managers of public buildings, users of public buildings, real estate owners, demo case owners, demo case users and researchers.
- **User**: Includes private building owner, private building user.
- **Practitioner**: Architects, engineers, contractors, craftsman, heritage experts, energy experts and retrofit experts.

For each of these stake holder groups different interview schemes were developed as part of the work done in *FuturHist* Task 1.3. In the context of this report, one question within these interviews was directly relevant: 'Are there guidelines/standards for the overall planning process of energy retrofit in historic buildings? How are they used?'

2.1.2. Questionnaire

Secondly, a questionnaire was conducted in *FuturHist* Task 1.1 that aimed at defining barriers and challenges that different stakeholder groups faced when aiming at making historic buildings more energy efficient. The answers to the questions have been used as input also for this report together with the interviews. The results from both the interviews and the questionnaire were used as input to identify relevant guidelines and tools for the inventory within this deliverable (cf. paragraph 'Inventory of existing tools').

2.1.3. Workshop

Thirdly, a workshop was held within the *FuturHist* project partner network in Sevilla in June 2024. This workshop was a follow-up from a preparatory workshop held at the first partner network meeting in Bolzano in January, 2024. The participants in the partner network represent a wide variety of different professionals, but the majority were architects or researchers (or both). The workshop was structured into two main parts.

The first part of the workshop was inspired by the OPERA co-creative meeting or workshop process (**O**wn ideas, **P**air suggestions, **E**xplanation, **R**anking, **A**lignment/Arranging). More information about the method can be found in the URBACT Toolbox (https://urbact.eu/toolbox-home). In this specific context the workshop consisted of three steps:

Individual Reflection: Participants individually identified and listed the five most crucial issues or components essential for the development of the *FuturHist* toolkit.

Group Discussion and Consensus Building: In small groups, participants discussed and negotiated to agree on the three most important issues from their individual lists to present to the larger group.

Ranking of Priorities: The groups wrote their selected issues on a whiteboard. The larger group then ranked the two most critical aspects among these.

The second part of the workshop focused on in-depth discussions around in beforehand set key topics, which included:

Scope: Should the toolkit cover the entire process or just specific parts?

User Focus: Should the toolkit be designed for professionals or laypeople? Should it be designed for frequent or occasional use?

Durability: What is the expected lifetime of the toolkit? Considerations included funding, maintenance, and the need for updates.

Approach: How much calculation capacity and "intelligence" should be integrated into the toolkit?

The results from the workshop were documented and analysed in order to contribute to the outcome of the work in this task. A summary of the output from the workshop is presented under results in this report.

2.2. Inventory of existing tools

An extensive inventory was made of existing tools that can support the decision-making process of energy renovations in historic buildings. Those that were deemed useful were analysed and described. Within the inventory we made a distinction between two categories of tools: single-dimension tools and multi-dimension tools. **Single-dimension tools** are focused on a specific dimension of the implementation of energy retrofits in historic buildings. Here a distinction was made between the following dimensions: heritage significance, energy performance, life cycle assessment and financial assessment. **Multi-dimensional tools** are tools that include multiple dimensions (such as the dimensions mentioned in the context of single-dimension tool) and often aim to provide an integrated tool for the implementation of energy retrofits in historic buildings.

A search for guidelines and tools was made by looking into relevant literature regarding the topic, using scientific databases, and by asking the *FuturHist* consortium for input and suggestions. The web-based portal BUILD UP has also been used as it offers a list of tools that support decision making, such as simulation tools, benchmarking tools, planning tools, etc. The tools gathered include LCA software and BIM software as well as the New European Bauhaus toolbox. Today the list consists of approximately over 100 different tools. These tools are labelled under 14 different themes like building renovation, policy and regulatory frameworks and indoor environmental quality. No specific theme is covering historic buildings and how to handle heritage values in decision making processes.

Data/input from the interviews and questionnaires was also used to find relevant guidelines and tools. Information about this is presented together with the results on page 21 in this report. In the case of the interviews the answers to the question 'Are there guidelines/standards for the overall planning process of energy retrofit in historic buildings? How are they used?' and the question 'Are there any guidelines/tools that you would like to be developed?' was used as input. When it comes to the questionnaire the answers on the questions 'What kind of support/guidance is missing? and 'Are you aware of a best practice database for energy retrofit of historic buildings? If so, please share any link or sources.' were used as input. The answers covered both national guidelines, links to national authorities and scientific papers. Among the tools and databases, the HIBERATLAS was the most mentioned. Twenty-eight respondents to the questionnaire pointed at this work and the work done in IEA-SHC Task 59. The most common answer to the last question was though simply "No".

Tools were identified as being relevant for the inventory based on the following criteria:

- The tool provides information and insights that are relevant in the context of the implementation of energy retrofits in historic buildings. This can also include tools that are not specifically developed to be used in the context of energy retrofits in historic buildings but still can be relevant in this context.
- The tools are currently available for use.

- The tools contribute to support the planning process of energy retrofits in historic buildings.

Within this inventory certain parameters were used to describe the tool. The parameters were derived as result from the workshop conducted, and partly from the questionnaire and the interviews. The selected parameters for the inventory of the different tools where:

- **Function**: How does the tool work?

- **Focus**: On which types of buildings is it focused?

- **Steps in the decision making process**: Which steps (according to EN 16883:2017) does it cover?

- **Repository or DSS**: Is the system a repository system or a DSS system?

- **Target group**: On which group of people is the tool aimed?

- **Costs and availability**: How is the tool available and how much does it cost?

Based on this analysis and description, key advantages and disadvantages were formulated for every tool. The results were summarised in a table where important information is gathered, and the tools are described (see annex 1). A summary of the most relevant tools is presented in this report in chapter 3. The selection of the most relevant tools have been made by combining the above mentioned three criterias combined with the selected parameters.

3. Results and Discussion

This chapter consists of two main parts. First the results from the workshop, interviews and questionnaire. Secondly the results from the inventory of existing tools.

3.1. Interviews, questionnaire and workshop

3.1.1. Interviews and questionnaire

The main results from the interviews and the questionnaire are presented in *FuturHist* deliverables in WP1.1 and in WP1.3, dealing with barriers for making historic buildings more energy efficient and a survey of current policies and their implementation within the field of energy renovation and historic buildings. The results presented in this section refers to specific questions about the need and use of different guidelines and tools. The questionnaire had 148 answers and the number of interviews was 25.

Most of the professionals interviewed state that they use guidelines or the standards that has been developed like EN16883. In several cases they refer to national guidelines, often formulated by official national bodies like the ministry of culture or national heritage authorities. At the same time, these professionals notice that these documents are only sparsely used and that more guidance is needed, criticizing the lack of detail and depth of these guidelines. It is also often noted that a more site and context specific approach is needed. The interviewees highlighted that best practice, together with exemplifying case studies could be beneficial in this context. While some of the interviewees mention specific guidelines they use, almost none of them mentions a specific tool. One of the professionals mentions a tool but says that it's not possible to use the tool since it is too complicated for them. Another interviewee does stretch the lack of tools that can be deployed in specific contexts.

The answers in the questionnaire did not lead to any clear results about tools or databases that are known or used but it gave some indications. The question about the knowledge about databases resulted among most of the respondents in no answer or a no. But for those who answered a majority (28 answers) mentioned the Hiberatlas or the work done in the project IEA Task 59. Other answers that gave input to this report was the mentioning of the organisation Sustainable Traditional Building Alliance (3 answers) that is responsible for the development of the tool the Responsible retrofit guidance wheel. Also, the French resource center for renovation of historic buildings, CREBA, that has translated this tool to suite the French renovation context was mentioned by a couple of respondents. Some larger European projects that have resulted in tools or databases like Ribuild, Tabula and Episcope was also recognised together with the running project Inrenova which is led by Eurac. One of the respondents mentioned the EU web-based portal Build Up. Some nation specific databases or just websites were mentioned like Retrofit Canada (Canada), Spara och Bevara (Sweden) and Historic England as well as Historic Environment Scotland. A lack of homogenous answers implies that the respondents to the questionnaire approached the questions in different ways depending on their pre understanding of the topic.

3.1.2. Workshop

Below the results from the workshop are presented thematically. The thematic aspects are presented in the order they were ranked by the workshop participants by using the step-by-step methodology presented in the previous chapter. In general, functionality and user needs were the most recurrent aspects to consider for a FuturHist toolkit within the project partner network followed by flexibility and adaptability.

1. *Functionality and user need*

It is recommended that the *FuturHist* toolkit is

- easy to use, regardless of the user's expertise level.
- tailored to the needs of the different users. Differentiating between professional users (e.g., architects, engineers) and non-professionals (e.g., building owners) ensures the toolkit addresses the specific needs of each group.
- accessible and reliable. It is important to find a balance between simplicity and accuracy.
- a step-by-step guide that helps users navigate complex processes, making it easier for both professional and non-professional users to understand and apply the toolkit. Both building requirements and user requirements need to be considered.
- intuitive for the user, providing general directions, avoiding mandatory solutions.
- useful for quick assessment (traffic light) but also for more in-depth analysis. Thorough and in-depth information for making decisions on changes to historic buildings was highlighted.

Further, it is recommended that the *FuturHist* toolkit

- cover the entire process of a retrofit project offering a pathway and signposting to more detailed tools without reinventing existing solutions.
- provide recommendations that allow users to make informed decisions without replacing professional judgment.

2. *Flexibility, adaptability and durability*

Flexibility and the possibility to expand or adapt the *FuturHist* toolkit is important for its longevity and relevance. Preferably the toolkit is

- easy to update with new data, methods and technologies.
- supports informed decisions and aligns them with long-term goals.
- covers a range of building types and different scenarios.
- helps the users to be well-prepared before they start making decisions and take actions.

One of the concerns that were raised at the workshop was that a EU funded research project format is not the most favorable for the long-term sustainability of a tool, as funds are rarely allocated for long-term management.

A durable toolkit is preferred with an open-source framework allowing for continuous development by different innovators. This requires that the tool must be updated regularly, particularly in terms of technical data and new solutions, to maintain relevance and effectiveness.

3. *Assessment support - heritage values and calculations*

It is recommended that the toolkit

- guides the user to solutions that consider heritage and cultural values. How different decisions impact heritage values is essential when dealing with historic buildings and guidance on how assessment could be done is needed.
- integrates simple calculations with links to more complex resources if needed, balancing meaningful outputs and ease of use. Ideally the toolkit requires minimal data input and is not too complicated, ensuring that it is easy to update and use without requiring specialized software. Calculation support dealing with before and after scenarios was addressed mainly for professional users.

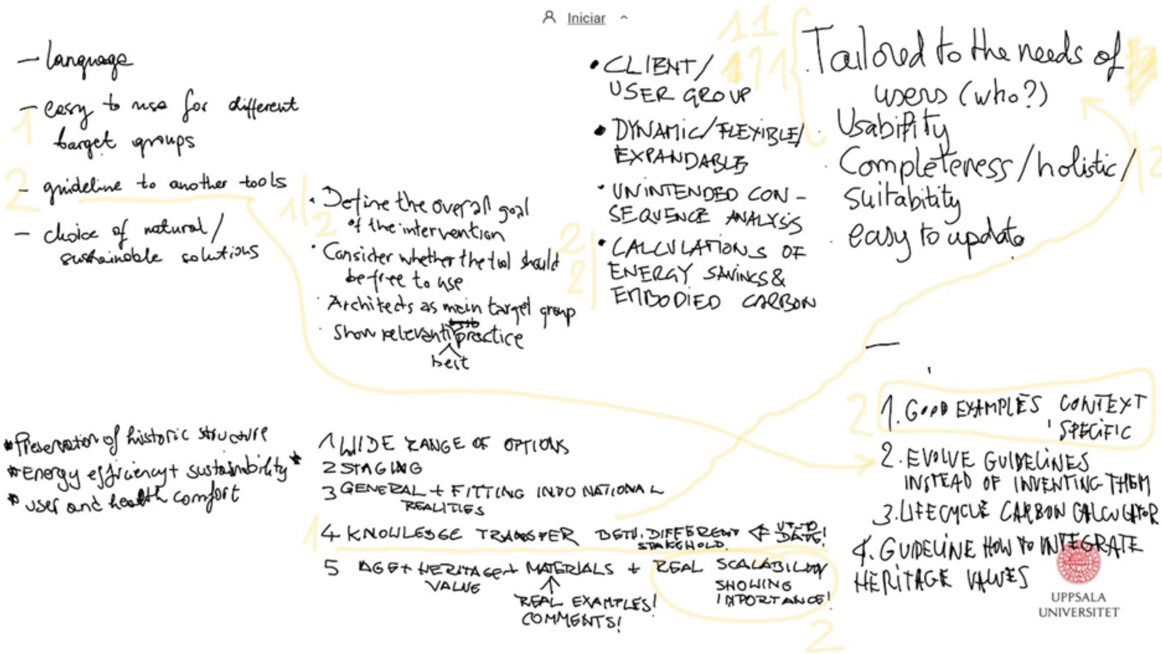

Fig.2 Whiteboard notes to illustrate the workshop results.

3.2 Inventory of existing tools

Within the inventory of existing tools, a distinction is made between single-dimension tools and multi-dimension tools, as presented in chapter 2. An inventory was made where all the tools and also guidelines that was identified as relevant for the development of a FuturHist toolkit. The long list from the inventory is presented in annex 1. From this long list a selection of tools and guidelines with specific interest for the FuturHist project is presented in this section.

3.2.1 Single dimension tools

Single dimension tools are divided in four different assessment categories, these are, heritage assessment, energy assessment, financial assessment and life cycle assessment (LCA).

Heritage assessment

This inventory presents an evaluation of various tools and methodologies developed for the assessment and conservation of cultural heritage. By examining their strengths, limitations, and alignment with the standard EN 16883:2017, the analysis aims to understand their potential for promoting sustainable and context-sensitive interventions in historic buildings. The following tools and methodologies with a focus on heritage values and heritage assessment have been chosen as of specific interest for the project; Monitoring and assessment Heritage Tool, The Burra charter method, The Conservation principles and guidance by Historic England, Urban heritage analysis - DIVE, Survey of Architectural Values in the Environment -SAVE, DuMo Monumental

Score, Value Assessment Tool (VAT), Arches Project and finally the P- Renewal.

Monitoring and Assessment Heritage Tool (MAHT)

The Monitoring and Assessment Heritage Tool (MAHT) was introduced in 2023 in Portugal as a strategic framework with a primary purpose to systematically and statistically assess the condition, risks, and management needs of heritage assets. MAHT is designed with a broad target audience in mind, including heritage site managers, conservation professionals, governmental and non-governmental organizations, and policymakers involved in cultural and natural heritage management; it helps identifying vulnerabilities, prioritizing interventions, and ensuring the long-term integrity of historical buildings and other heritage assets. Its systematic approach to heritage management allows for the identification of diverse risks and conditions, supported by data repositories and decision-support systems (DSS). This data-driven functionality aids in shaping informed policies and interventions (Ornelas et al., 2023).

This tool encourages practices that balance conservation with socio-economic development and facilitates stakeholder engagement, improving collective stewardship. It can be also customised to different types of heritage sites and contexts. The effectiveness is closely tied to the quality and availability of data about buildings and building stocks, which can vary significantly across regions. Heritage sites in areas with limited data or resources may face challenges in fully utilising the tool's capabilities. Similarly, larger or more complex heritage sites may encounter scalability issues, potentially requiring additional customisation or resource investment. Furthermore, it is not specifically designed to evaluate or improve energy efficiency in historic buildings.

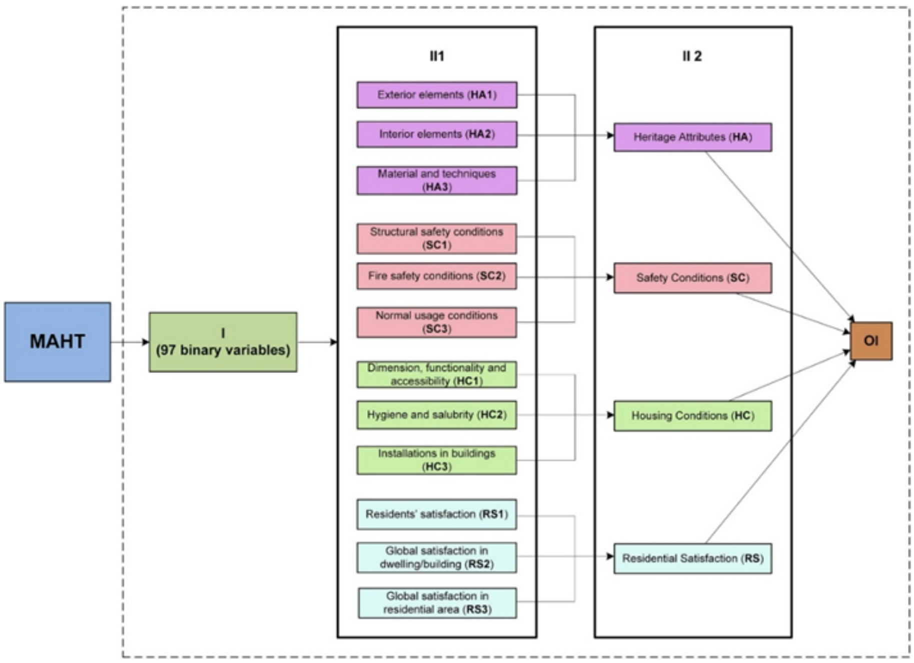

Fig.3 The MAHT statistical procedures (Ornelas et al., 2023).

The Burra Charter Method

The Burra Charter Method, established in 1979 by Australia ICOMOS, is a model designed to guide the assessment, conservation, and management of cultural heritage sites. The method is centred on preserving cultural significance, ensuring inclusive decision-making, and employing adaptive management strategies to address site-specific challenges (Marquis-Kyle and Walker, 2004).

The process involves the following steps:

1. Assessing significance to determine what aspects of a place should be preserved.
2. Planning and managing to ensure that interventions align with the identified values.
3. Engaging stakeholders to include community perspectives and respect traditional associations.

The Burra Charter Method emphasizes the integration of both tangible and intangible values in the conservation process. Its adaptability makes it suitable for a wide range of cultural contexts and challenges, ensuring that historical authenticity is maintained while accommodating practical and sustainable uses of heritage sites. The method also prioritises long-term care and minimal intervention, striving to balance preservation with the evolving needs of communities and users. Furthermore, the Burra Charter involves multiple stakeholders promoting a holistic approach to decision-making.

Fig.4 Steps in planning for and managing a place of cultural significance (Marquis-Kyle and Walker, 2004).

However, the method has its limitations: the comprehensive assessments and extensive consultations required can be both costly and time-consuming. Involving multiple stakeholders, while beneficial for inclusivity, can slow the decision-making process and occasionally lead to conflicts. Additionally, terms such as "cultural significance" may be open to subjective interpretation, potentially resulting in inconsistencies in application.

The Burra Charter Method’s limited reliance on technological tools could also pose challenges in efficiently addressing modern conservation needs, especially when dealing with large or complex projects. Furthermore, this method lacks specific tools or guidance for evaluating or enhancing the energy efficiency of historic buildings.

Conservation Principles, Policies, and Guidance

This is a guidance document published in 2008 by Historic England that establishes a set of principles and methods designed to ensure that heritage assets are conserved and managed in a sustainable way. The approach is centred on six key principles, including understanding the significance of an asset, maintaining its value, and ensuring decisions are transparent and sustainable. It aims to achieve a balance between the preservation of cultural heritage and the need to accommodate societal, economic, and environmental changes, reflecting a dynamic approach to heritage conservation (Historic England 2008).

The document is freely accessible, promoting broad adoption and encouraging collaboration among a diverse range of stakeholders. It emphasizes sustainable decision-making that respects the significance of heritage assets while underscoring the critical role of ongoing maintenance in preserving these assets over the long term.

Despite its strengths, the application of the Conservation Principles can be challenging. Expert interpretation is often required to effectively implement the guidance, which can increase costs, particularly for small-scale organizations or private property owners. Additionally, the principles outlined in the document may be somewhat ambiguous when applied to specific, complex cases, requiring careful and nuanced decision-making. The resource-intensive nature of implementing the guidance may pose challenges for smaller organizations or individuals with limited capacity.

Moreover, there is no specific reference to energy performance, and it does not provide tools for evaluating or improving the energy efficiency of heritage buildings. It can be used as a complementary resource by providing a robust foundation for understanding the cultural significance of heritage assets, which is essential for any intervention, including those focused on energy performance.

Urban Heritage Analysis - DIVE

The Urban Heritage Analysis -DIVE, developed in 2008 by the Norwegian Directorate for Cultural Heritage (*Riksantikvaren*), is a decision-support guide designed to integrate cultural heritage values into urban planning and development. DIVE that stands for Describe, Interpret, Valuate and Enable, promotes a collaborative approach particularly between urban planners, architects, heritage professionals, local governments, and community organizations. It begins by describing the historical and spatial characteristics of a site, then interpreting its cultural and social meanings. Next, it focuses on valuating the significance of the area based on its historical, aesthetic, and social dimensions. Finally, it concludes with enabling sustainable development strategies that integrate heritage values into urban planning and decision-making (Riksantikvaren, 2010).

Its flexibility and adaptability allow it to be applied across diverse urban contexts, making it a versatile tool for incorporating heritage considerations into planning processes. A core strength of DIVE lies in its ability to enhance awareness of the historical and cultural significance of urban areas, ensuring that these values are accounted for in development decisions.

It relies heavily on expert input for interpreting and valuing heritage assets, which can increase costs, particularly for smaller-scale projects or organizations. The lack of integrated digital tools or software-based methods may reduce efficiency compared to other web-based tools. Additionally, the subjectivity inherent in valuing heritage assets can sometimes lead to disagreements among stakeholders, complicating decision-making processes. Finally, DIVE lacks the tools or methodologies needed to assess or improve the energy efficiency of heritage buildings.

Stage (work phases)	**Objective**	**Relevant subtasks**
Prepare	Input	Organisation and work plan for the analysis
S1 Describe	Historical character of the area of analysis	Establish a knowledge base, collate, describe and process information about the origins, development and character of the area.
S2 Interpret	Historical meaning of the area	Explore the area's historical legibility, its significant and communicative contents, integrity, authenticity and overall condition.
S3 Valuate	Value and potential of the area	Assess the value, development potential, vulnerability, tolerance and capacity for change of the cultural and historical resources.
S4 Enable	Active intervention	Define the potential field of action for the cultural heritage, suggest strategies and principles, instruments and concrete measures for management and development.
Summarise	Output	Summary of the contents, results and recommendations of the analysis

Fig.5 Steps in the DIVE methodology (Riksantikvaren, 2010).

Survey of Architectural Values in the Environment -SAVE

This method, developed in the 1980s by the Danish Ministry of Environment and Energy, offers a systematic approach to evaluating and documenting the architectural and environmental value of buildings and urban areas, helping local governments and planning authorities prioritize preservation efforts within their communities. It categorizes structures based on their historical, cultural, and environmental significance, assigning scores to guide prioritization for preservation efforts (Tonnessen, 1997).

SAVE's structured approach ensures transparency in the evaluation process and assists in making informed decisions about resource allocation. This prioritization is especially important for areas with limited preservation resources, as it focuses efforts on the most valuable assets. Additionally, SAVE encourages public and community engagement in the heritage preservation process, fostering a shared sense of responsibility and value for cultural heritage, it is indeed particularly aimed at local governments, urban planners, conservation professionals, and heritage organizations. The SAVE method aligns with aspects of the standard by offering a systematic approach to evaluating the heritage value of architectural and urban assets, which is a critical first step in planning any conservation or intervention efforts. Its focus on prioritization and integration of heritage conservation in urban planning also supports the standard's broader goals of balancing preservation with modern needs.

SAVE is better suited for broad urban or environmental contexts rather than in-depth analysis of individual buildings. Furthermore, the subjective nature of scoring architectural and environmental values can lead to variations between evaluators, potentially affecting the consistency of the results. Although valuing heritage in nature always is subjective to some extent, this tool lacks a systematic and common reference frame, increasing the risk of highly personal interpretations. The method lacks tools or criteria for assessing or improving the energy efficiency of heritage buildings, instead, it focuses on the identification and evaluation of architectural and environmental values, making it more suitable for informing conservation strategies rather than implementing energy-related upgrades.

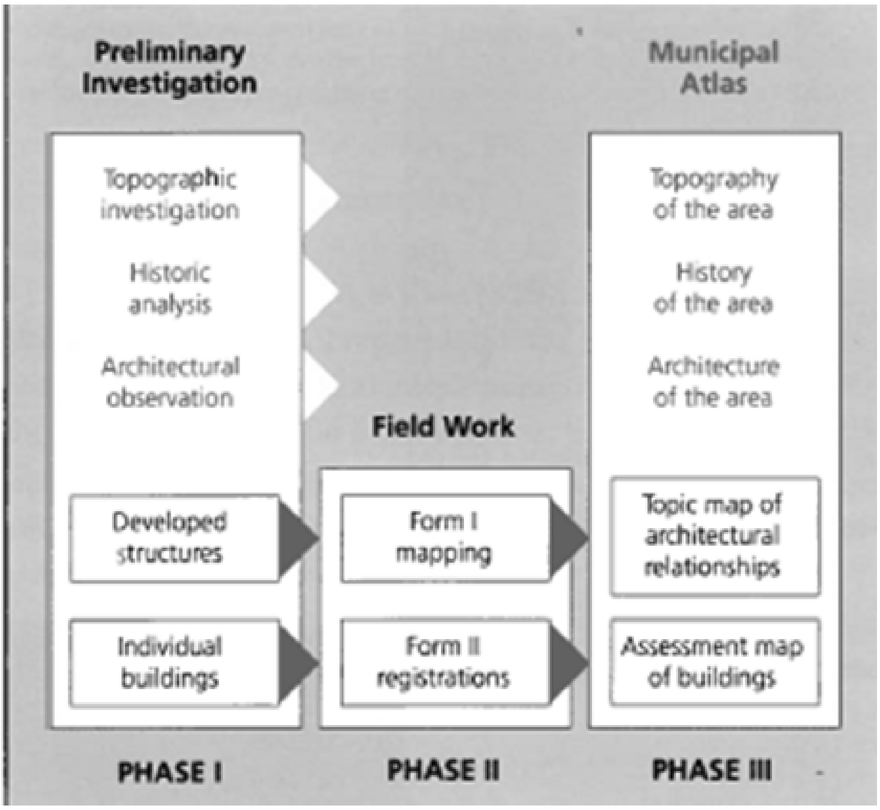

Fig.6 Outline of the phases in SAVE (Tonnessen, 1997).

DuMo Monumental Score

The DuMo Monumental Score, developed by NIBE in the Netherlands, is a tool used to assess the interplay between heritage value and sustainability in heritage buildings. It consists out of a combination of a sustainability score (Du) and a monumental score (Mo). The Monumental Score (which is the part of the tool we focus on in this context) is derived using a structured template. This template divides the heritage value of a building into four primary categories, each further broken down into subcategories. Evaluators assign scores to each subcategory based on predefined maximum values, and these scores are then aggregated to produce the overall Monumental Score. The DuMo Monumental Score focuses on listed buildings, emphasizing the preservation of historic fabric (NIBE, 2008).

It combines qualitative with quantitative analysis. While the tool is publicly available, its effective use requires the expertise of qualified evaluators, ensuring that assessments are both accurate and consistent. However, the system's concentration on listed buildings may limit its applicability to unlisted structures with heritage significance. The DuMo Monumental Score does not provide specific methodologies or tools for assessing energy performance improvements directly. Instead, its primary focus lies in quantifying heritage value as a prerequisite for further sustainability assessments.

Value Assessment Tool (VAT)

The Value Asessment Tool - VAT was developed in 2017 by MedINA in Greece and is designed to assess both natural heritage and cultural heritage values. Since the two often are intertwined VAT aims to assess them as one integrated whole. The tool is structured around two primary tables that guide the assessment process. The first table, called the 'Record and Justification of Values Table,' focuses on cataloging the diverse values of natural environments and their cultural assets. It provides a framework of predefined value categories, enabling users to justify the significance of each asset systematically. The second table, the Overall Record and Assessment of Assets and Values Table, compiles these values and highlights those deemed most significant. To facilitate prioritization, this table uses a straightforward numbering system, allowing users to rank assets based on their importance (Pantzou, 2017).

The main interesting aspect is that the tool integrates cultural heritage in its natural context. The tables are easy to use since they are paper templates. Nonetheless, it does not provide an in-depth assessment at the building level and is predominantly focused on the Mediterranean region, potentially limiting its applicability in other geographic or cultural contexts; also, the VAT does not address energy performance improvements directly, nor does it provide tools or methodologies for assessing the energy efficiency of heritage buildings. Its focus on broader cultural and natural contexts rather than specific building-level interventions limits its applicability to the energy-related goals of EN 16883:2017.

Arches Project

The Arches Project, initiated in 2013 by the Getty Conservation Institute (GCI) and the World

Monuments Fund (WMF) in the United States, is an advanced heritage inventory and management system. It combines geospatial and relational database technologies to document, manage, and analyse cultural heritage sites. Arches allows users to collect data, create digital inventories, and map heritage assets. Its flexible design makes it adaptable to various heritage contexts and compatible with international standards. While primarily focused on documentation, it can inform decision-making related to conservation and management, though it does not specifically address energy performance (GCI, 2013).

The open-source nature of the Arches Project is one of its key strengths. Being free to download and customizable, it allows organizations to adapt the system to their specific needs. It is built on international standards, ensuring its compatibility with a wide range of heritage documentation frameworks. The integration of geospatial technology enhances its capability to map and analyze heritage sites with precision. Additionally, the system is scalable and flexible, catering to projects of varying sizes and complexities. Its open-source model is supported by an active community that shares resources and knowledge, contributing to its development and implementation.

Despite its advantages, the Arches Project requires technical expertise for effective implementation and use. The initial setup can be resource-intensive, posing a challenge for smaller organizations or those with limited technical capacity. But, while it excels in documenting and analysing heritage assets, its scope does not extend to evaluating or improving energy efficiency in heritage buildings. As such, the Arches Project can be seen as a complementary tool to EN 16883:2017 rather than one that fully complies with its objectives.

P-Renewal tool

The P-Renewal tool, developed by UC Louvain in Belgium, is designed to make use of a structured methodology that examines eleven distinct interests in cultural heritage significance. Through the use of a template all these interests are given a qualitative description that then produces leads to a final assessment of the heritage value of the building. All eleven interests are separate yet complementary analytical perspectives on different building characteristics that are constituent to the buildings heritage value. These interests must be matched to four defined quality indicators, creating a detailed framework for evaluating the heritage significance of various building elements.

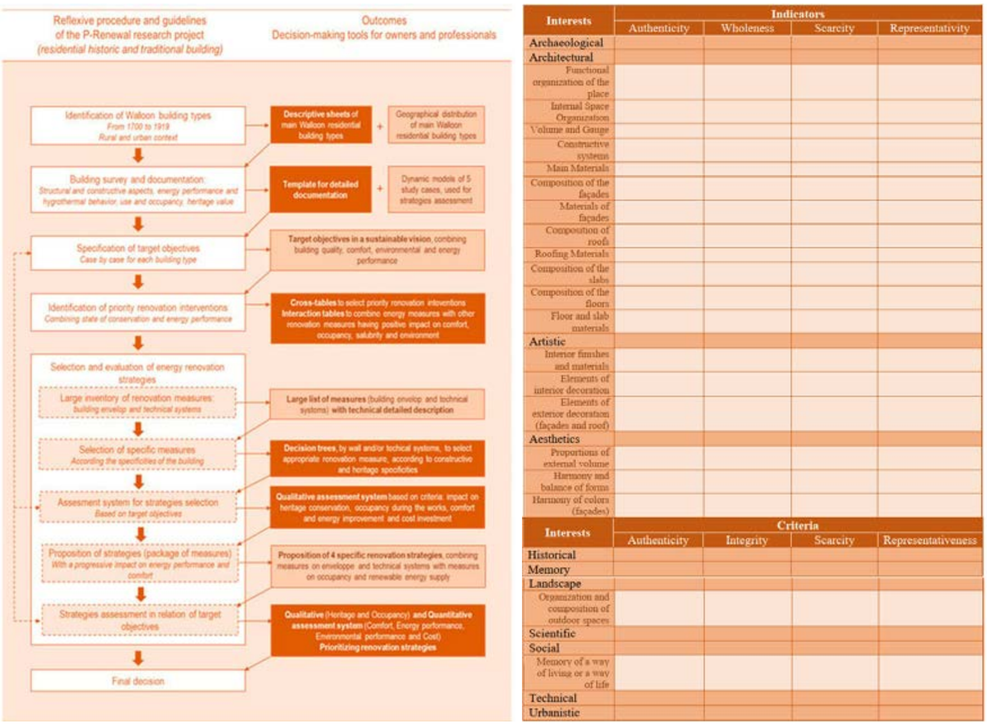

Fig.7 *(Left) Reflexive planning process and outcomes of the P-Renewal research tool. (Right) Template listing the different interests that are asses in the context of heritage significance (UC Louvain, 2023).*

The process is facilitated by a summary table that systematically matches the interests with the indicators, ensuring consistency in the evaluation (UC Louvain 2023; Trachte & Stiernon 2024). Together with the suggested reflexive planning process it covers both the aspect of assessing heritage values and the process of making decisions, see fig 7. This reflexive planning process has also similarities with the EN 16883:2017 Standard process.

The open-access availability and comprehensiveness of P-Renewal enhance its usability, making it accessible to a wide range of heritage professionals and researchers. The tool's focus on detailed, element-level analysis is consistent with the EN 16883:2017 Standard emphasis on preserving material integrity and understanding the specific values and characteristics of heritage buildings.

However, it does not incorporate immaterial values such as cultural narratives, historical significance, or social context. This absence reduces its ability to capture the full spectrum of heritage value. Additionally, the tool does not employ a rating or scoring system, which might make it less intuitive for prioritizing interventions or comparing different heritage assets.

Energy assessment

The following tools and methodologies with a focus on energy assessment is of certain interest for the *FuturHist* project; Minoro, Audodesk green building studio, The Healthy and Efficient Retrofitted Building Tool – HERB and finally UBAKUS. A short presentation of each of these follows in this section.

Minoro

Minoro is a tool developed by Grimshaw, a UK based company in partnership with the World Business Council for Sustainable Development. It is an online web-based tool that guides the user through implementing carbon reduction measures in the built environment. The tool is structured in different steps to identify key actions and responsibilities at different stages of the process. The tool touches upon different carbon measurements strategies, including energy retrofits, user and optimising operational systems. Minoro is particularly interesting for architects, engineers and planner that work with energy retrofits. It is available open access as webtool (Grimshaw, n.d.).

Advantages of the tool is that it gives a detailed overview of the steps to be taken in the carbon management process. It is easy to use with an accessible interface. Furthermore, it aims to broader approach to energy management where it is linked with other forms of sustainable development.

Although in the context mainly interesting for its energy assessment dimension, Minoro is focused on other sustainability dimensions as well. This makes that it sometimes misses depth when it comes to the information and support it provides regarding energy retrofits. Another limitation is the fact that it does not work with an input or output but only gives general advice. It can therefore be seen as a digital guideline rather than a tool.

Autodesk Green Building Studio

Autodesk Green Building Studio is a web-based building performance simulation software designed to assist architects, engineers, and designers in creating energy-efficient and sustainable buildings. It performs energy modeling and carbon analysis to optimize design decisions. It is specifically focused on energy performance and can be used by architects, engineers and sustainability consultants involved in green building design and connected certification processes. The tool is part of Autodesk's subscription model.

A major advantage of the tool is that it is integrated with Autodesk Revit and other BIM tools, enabling data flow. More so, it reduces the computational load on local machines by running simulations on Autodesk's servers. Other advantages are that it facilitates compliance with green building standards and certifications such as LEED and that it provides comprehensive energy, water, and carbon data for decision-making.

Limitations are that is requires and Autodesk subscription, which can be costly for small firms. Also, users need training or experience with Autodesk tools to be able to use it effectively and a stable internet connection is required to be able to make simulations and access data.

The Healthy and Efficient Retrofitted Building Tool - HERB

The Healthy and Efficient Retrofitted Buildings Tool (HERB) is developed by the organization C40 which is a global network of mayors of the world's leading cities that are united in action to confront the climate crisis. The HERB-tool supports the user in the process of using evidence to make compelling cases for building retrofits. The tool can be used universally and can be applied to a single building as well as a group of multiple buildings and larger urban areas. It covers health benefits, socio-economic benefits, and climate and pollution benefits. The tool consists of an excel sheet and comes with a supporting technical manual tool. By filling in the data regarding the retrofits project, the template calculates the benefits that the retrofit potentially can provide. The tool is focused on the energy performance of the general buildings stock, mostly on an area scale. It is therefore mainly suitable for cities and communities to be used in planning processes. The tool is available open access and can be downloaded through C40's web platform (C40, n.d.).

Advantages of HERB is that it is driven by a strong cooperation between different actors that plan to keep the tool updated in the future. Furthermore, it is easy to use, can also be used offline and does also involve social benefits among its parameters.

The fact that it is mainly focused on area and city scale can however be limiting, although it can be used for single buildings also. Other limitations are the strong reliance on consequent and constant updating of the involved multipliers and that is does only calculate benefits.

UBAKUS

The UBAKUS webtool is developed by a researcher and data developer Ralf Plag that saw a need for better support to calculate U-values when different layers of buildings materials are combined. As input the type of material and its thickness is required. A U-value for these materials is then generated as well as a life cycle (heat loss, primary energy and green house gas potential), moisture (moisture protection, mould protection and drying reserve) and heat analysis (heat storage capacity and thermal capacity of inner layers) in relation to the selected materials. The tool includes graphic depictions to clarify the results and to make it more user-friendly. It includes separate options for new buildings and refurbishments. It is mainly aimed at architects and for educational use. A free educational version is available but only during weekends and during evenings after 6pm. Different paid version are available where you can choose between different packages where the higher priced deals provide more functions and possibilities.

The tool is easy to use and contains a large inventory of different buildings materials, including many traditional materials making it suitable to use in historic buildings. The tool is available in several languages, among the German, English, French and Dutch. Not much expertise is needed to use the tool.

Access to more advanced version is possible through a paid subscription. You can subscribe to get more storage space in the tool, customizable PDF document, U-Value according to DIN EN ISO 6946, moisture protection according to DIN 4108-3, materials from DIN 4108-4 & DIN 10456, layer color freely selectable, 3D view in PDF document, manage calculations in folders, project folders included and finally custom thermal contact resistances.

Financial assessment

CraveZero

CraveZero was a Horizon research and development project that aimed to reduce costs and improve net zero buildings under the different stages of its lifecycle by focusing on both new and proven approaches. It was led by the Austrian organisation AEE - Institute for sustainable technologies The main aim was to get rid of extra costs due to inefficiencies in the process and different forms of technology while at the same time stimulating innovative business models. The cost-effectiveness of all stakeholders is taken into account in the developed tool with the same name as the project. CraveZero aims to do this by presenting an organised and transparent interdisciplinary process. It takes both environmental and economic aspects into consideration while searching for energy saving potential. This has led to the development of different forms of guidelines and process descriptions that can be used. On top of this, the CraveZero pinboard was developed to provide an interactive web-based structured framework that organises all the required information and different tools that can be used (AEE, 2020).

CraveZero's main advantage is that it covers different phases of the lifecycle. Furthermore, it includes both economic and environmental considerations in terms of energy saving and is easily accessible through a web platform.

The Pinboard is however only available in a BETA version and its use is therefore limiting. If a full commercial version will be released is still unclear. The tool does not have a focus on historic buildings either and requires a high level of expertise within energy retrofits and life cycle assessment.

Renewable Energy and Energy Efficiency Software. RETscreen

The Renewable energy and energy efficiency software - RETscreen is an energy management software platform used to analyse the economic viability and performance of renewable energy, energy efficiency, and cogeneration projects. The software was developed for a Canadian context by the governmental organisation Natural Resources Canada. The software helps users assess technical and financial feasibility, monitor ongoing performance, and plan for greenhouse gas (GHG) emission reductions. The tool focuses mainly on providing decision-makers with data and analysis to improve energy efficiency, reduce costs, and lower carbon footprints. It can be used by energy consultants, facility managers, policy makers project developers, government and non-governmental organisations and financial institutions evaluating clean energy investments. The tool is available through a subscription model (NrCan, 2016).

RETscreen supports a wide variety of energy efficiency and renewable energy projects. It also provides a wealth of built-in resources (climate data, technology costs, etc.), reducing the need for external tools. It is flexible and applicable across different project scales and sectors, easy to use with a well-organized interface and customizable reporting options. Further, it enables greenhouse gas emissions tracking, aligning with sustainability goals and it is cost-effective, especially compared to more specialized tools.

The limitation of the software is that it takes the bigger picture of a project into account and does not offer the same depth of analysis as specialized tools for specific energy systems. It comes with an annual subscription fee and is it requires training or familiarity to fully utilize advanced features.

LCCbyg

LCCbyg is a tool that calculates life cycle costs for either an entire building or individual building components. The tool is developed by the Department of the Built Environment (BUILD) at Aalborg university in Denmark. The scope of the tool is mainly financial. It helps decision-makers compare two or more alternatives that have different cost profiles over time. The tool combines Life Cycle Cost (LCC) and Life Cycle Assessment (LCA) calculations, and includes functions for qualitative criteria assessment, providing a comprehensive basis for sustainable building decisions. It is focused on life-cycle costing, CO_2 shadow prices, net present value and total cost of ownership. The target group is foremost professional users such as advisors, designers, building owners and urban planners. The files and data is saved in an open standard format, accessible for everyone (BUILD, n.d. b).

The tool combines financial life-cycle cost analysis and environmental impact assessment (CO_2 emissions) in a single tool. It also calculates shadow prices for carbon emissions, helping to quantify environmental costs in economic terms. In addition, it automates complex life cycle calculations with built-in standard values and parameters, making it accessible for regular use in construction planning. This also enables systematic comparison between different solutions considering both economic and environmental impacts over time. Finally, it allows for customising of parameters and calculations to suit specific project needs while maintaining standardized comparison formats.

A limitation is that the tool requires initial time investment to understand both the financial and environmental assessment parameters. Another limitation is that its content library is primarily focused on Danish market conditions and standards.

Life cycle assessment

One Click LCA

One Click LCA is an easy-to-use software for the compilation of information and analysis of results facilitating the integration of sustainability aspects in the decision-making process. One Click LCA is also a company that started in 2001 that has developed end-to-end sustainability platform with the same name for construction and manufacturing. It offers a cloud-based AI-driven software for conducting LCA (Life Cycle Assessment) and LCC (Life Cycle Cost) analyses, with data stored, managed, and accessible via the internet. One Click LCA contains generic LCA data and based on product-specific Environmental Product Declarations (EPDs), it provides access to most LCA databases worldwide. It is compatible with most tools used in building design, such as Revit etc (One Click LCA, n.d.)

The major advantage of One-click LCA is integration with BIM and other tools and compliant with over 80 global and regional certification systems. It is AI-powered and can be used throughout all project phases. One Click-LCA is linked to the world´s largest construction databases. Furthermore, it is linked several differentiating tools.

A significant limitation is however that One-click LCA is not focused on historic buildings. The use of the tool also requires a high level of expertise and could be expensive and therefore out of reach for small scale firms.

LCAbyg

LCAbyg is developed by BUILD at Aalborg University, Denmark as a free software to facilitate LCA calculations when the regulation of whole life carbon in new buildings was introduced in 2021. The tool calculates CO_2 emissions in a whole life span based on the Danish Building Regulations and Danish energy emission factors. It can be used both for early decision phase and for final LCA reporting, depending on the level of precision provided by the user. The tools are available open access through a website (BUILDb, n.d. a).

The tool is easy to use, with a user-friendly interface. A strength is that it is possible to import new/other EPDs to the tool if the ones in LCAbyg are not enough in that way the user can "update" the tool continously to fit his/her own needs.

Limitations are however, that it is not being updated on a regularly basis, is mainly developed with the focus on new buildings and only is available in Danish.

3.2.2. Multi-dimension tools

This part of the inventory is focused on tools that take into consideration multiple dimensions of the implementation of energy retrofits in historic buildings, such as the heritage dimension, the economic dimension and the energy dimension, in line with the standard EN 16883:2017. The number of dimensions and its emphasis differs from tool to tool. Within this category we distinct two kinds of tools: Digital decision-making tools and Guidelines.

Digital decision support tools

Web-based decision-making tools have been inventoried and analysed according to the parameters listed in chapter 2 (see also annex 1). Some of these tools also include more descriptive parts which have similarities with guidelines. However, in this context they are combined with interactive digital systems. Only three of the identified tools in the annex are still accessible for use and therefore assessable and useful in the context of the development of a *FuturHist* toolkit. A short analysis of each of these tools is given as well as an identification of their advantages and limitations. These are; The Responsible retrofit guidance wheel, the HIBERtool and the RIBuild step-by-step guide and Insulation Calculator Tool.

Responsible Retrofit Guidance Wheel

This tool was developed by the Sustainable Traditional Building Alliance (STBA) in English while a French language version was made by CREBA. The tool combines the following aspects; technical concerns, heritage concerns and energy concerns. The main purpose of the tool is to identify the advantages of a specific retrofit solution. For each solution it generates risks levels in relation to technical, heritage and energy concerns and interconnections. The digital tool is structured as a wheel, where the user can explore the retrofit solutions linked to each segment. It considers interventions to fabric and services and behavior range. The wheel requires input data in the form of heritage value and condition of the building, the exposure level to wind-driven rain, energy use, the number of exposed sides of the building or the ventilated sides, and the occupant's interest in the building. It is possible to look further into technical consequences and benefits for each solution as well as energy savings and heritage issues. Finally, it is possible to download a report which presents a list of proposed solutions. The provided information derives from real cases and tests (see STBA 2013). The tool is available open access through a web page specifically dedicated to the tool.

Fig. 8 Interface of the STBA guidance wheel (STBA, 2013).

The strengths of the tool are that it offers information on the risks associated with a retrofit and that it considers individual solutions and their interaction with other current planned solutions. This gives the designer relevant information for the development of energy retrofits in the context of a wider risk-management process as well as the possibility to compare different solutions in a proper way.

The tool is mainly tailored for the UK and French building stock depending on the version (Buda et al. 2022). In addition, there are no publications that test the use of the tool according to academic parameters.

HiBERtool

This tool was developed in the context of the project Interreg AlpineSpace ATLAS and IEA-SHC Task 59 (EURAC 2019). It is based on 130 documented retrofit solutions, to a large part based on practice examples of the HIBERATLAS database, collected by project partners. The tool covers four groups of solutions: wall insulation, window solutions, solar systems, and ventilation. The user is guided through a query with easy to answer questions on the technical and heritage characteristics of the case. The query is used to select and display solutions, and the user can select the relevant ones. The documentation is made available in a pdf that can be downloaded at the end of the process. Consequently, the tool is mainly useful for supporting steps 10.3 and 10.4 of the EN 16883 decision-making process (Fig. 1). The tool is available open access and targets both professionals and non-professionals. Since it does not actively guide the user in the decision-making process the tool has to be seen as a repository tool that provides different solutions (EURAC 2019).

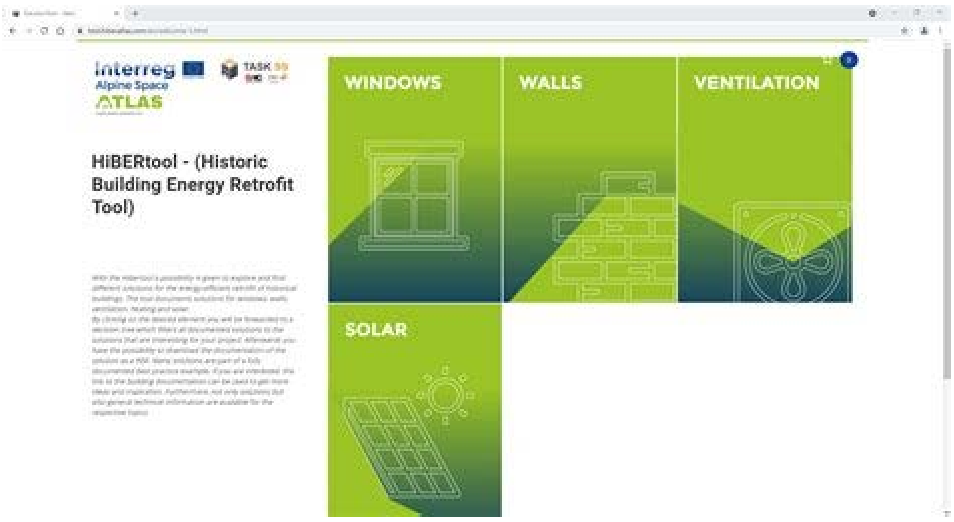

Fig.9 Start screen of HiBERtool showing the build-up of the interface (EURAC, 2019)

A major strength of HiBERtool is that it provides a detailed assessment that paves the way for a well-informed selection and decision process. It provides comprehensive information on a long list of solutions so that the user gets a proper overview of the solutions in only a short amount of time. Furthermore, the simple interface makes the tool easy to use.

Since there are only four types of solutions included the tool is rather limited in its scope. In addition, the tool mainly relates to traditional regional alpine architecture, posing difficulties if it is to be used in other built environments (Buda et al., 2022).

RIBuild step-by-step guide and Insulation Calculator Tool

This step-by-step guide and calculation tool are a result the RIBuild Horizon project finished in 2020 (www.ribuild.eu). The guide starts with setting the goal for the renovation (step 1), followed by a description of how visual assessment is to be carried out and what to look for to decide whether the building is suited for internal insulation (step 2). Based on those two steps a decision can be made on what kind of insulation system to select, based on descriptions of their characteristics (step 3). Step 4 presents a way to evaluate the environmental impact and the life cycle costs of the solutions (RIBuild 2020a).

For the Insulation Calculator Tool, a limited amount of input is needed to be able to consider solutions for a specific building. The tool uses a probabilistic computer-based precalculated data analysis approach to represent variations and thereby indicates the risks of the application of specific solutions. The more detailed the inputs are, the less solutions the tool will suggest. The tool has a general focus on historic buildings, both statutory and non-statutory, and targets building owners, professionals and researchers. The tool is available open access and covers EN 16883 step 7 until 10.4 (RIBuild 2020b). It is maintained but not updated.

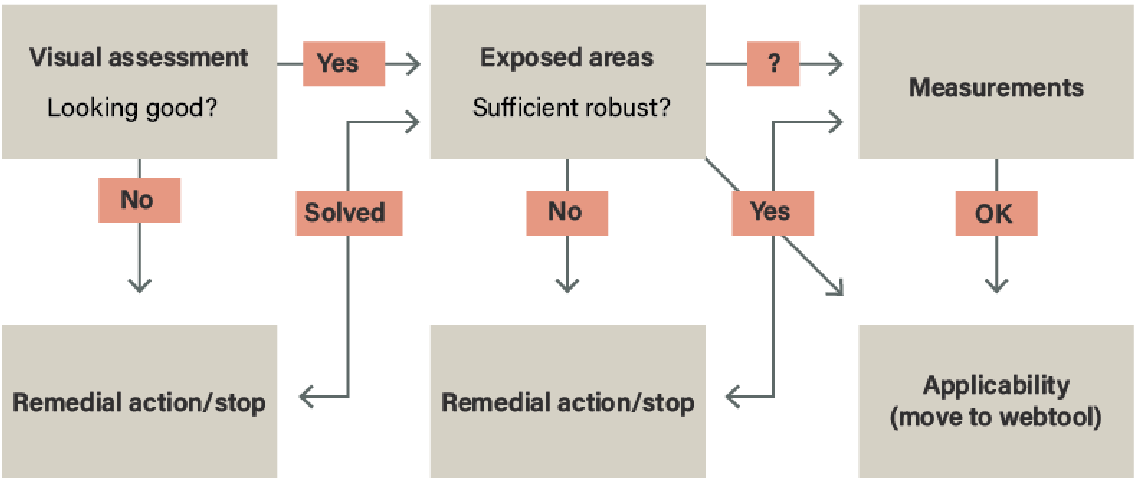

Fig. 10 Structure of the RIBuild step-by-step guide, based on (de Place Hansen et al. 2020). The webtool refers to the Insulation Calculator Tool.

The RIBuild step-by-step guide can support decision-makers significantly when it comes to assessment and insulation solutions. Its interface is easy to use and provides details and tailor-made suggestions and solutions.

The use of the Insulation Calculator tool is limited as it does not cover all failure modes for moisture-related damage. Frost damage is not included, mainly because there are no reliable models that can be used for simulation of that type of degradation. This severely limits the use of the tool in countries with heavy winters. Further, although many pre-calculations lie behind the tool, it does not cover all locations, orientations and wall types. In addition, there are no publications attesting the use of the tool, apart from a test involving case studies performed as part of the RIBuild project (Møller, Perkov and Hansen, 2020).

Historeno

This decision making tool is multi-dimensional in the way that it is linking energy renovation to local authorities' energy planning strategies by using digital technologies (web platform & geolocalised data (GIS layers)) to support the various stakeholders (private property owners and local authorities in particular) in reducing the energy and climate footprint of the building stock, particularly older buildings with heritage value.

Guidelines

This inventory of guidelines is derived from a broad range of different actors, among them non-profit organisations and commercial companies. The majority, however, stems from heritage authorities as almost every national and/or regional authority has some kind of guidelines for implementation of energy retrofits in historic buildings. Since these guidelines are often context specific for a certain country or region (for example on local buildings traditions, weather circumstances or specific natural landscape characteristics) it is hard to determine which guidelines would work the 'best.' This inventory has therefore to be seen as an attempt to show different approaches to the creation of guidelines rather than the fact that these guidelines are by definition the best ones.

Although the amount of (functioning) web-based tools remains limited, the past decades have seen a large-scale emergent of different kinds of guidelines regarding energy retrofits for historic buildings. Within the scope of this project, we have focused on guidelines that can or are meant to be used as decision-making tools.

Multiple guidelines were identified in different European countries. Each of these tools were structured differently, but all of them complied with the European standard EN 16883. Some of them referred to the standard directly, but most of them just follow more or less the steps as defined in the standard. In general, most of these guidelines cover more steps in the process than the web-based tools do. At the same time the extent to which they actively supported the decision-making process differs significantly from tool to tool. The guidelines presented in this section were identified as largely supporting the decision-making process, based on structure and the extent of guidance.

Historic England advice note 18: Adapting Historic Buildings for Energy and Carbon Efficiency

This advice note, published in 2024, offers a comprehensive framework for adapting historic buildings to improve energy efficiency while addressing the climate crisis. The guidelines emphasize an approach which involves thoroughly understanding the unique characteristics, materials, and historic significance of a structure before applying energy-efficient upgrades or interventions. They are designed to balance the goals of carbon reduction and sustainability with the preservation of heritage values. Key recommendations include advice on insulation, heating systems, and the integration of renewable energy technologies, such as solar panels and heat pumps. The guidelines are aimed at local planning authorities, heritage consultants, property owners, and others involved in managing historic buildings (Historic England, 2024).

Additionally, they clarify permissions, such as when listed building consent is required, and provide practical examples through case studies that showcase successful adaptations. They also address common misconceptions about modifying listed buildings or properties in conservation areas, making the information accessible to both professionals and property owners. By fostering sustainable use and reuse, the guidelines aim to ensure that historic buildings contribute to a greener future without compromising their cultural and historical value.

Renovation and retrofitting of old buildings in times of climate crisis

These guidelines developed by the Sendzimir Foundation and the Croatia Green Building Council, emphasize sustainable strategies for enhancing the energy performance of old buildings while preserving their historical value. This document aims to reduce the environmental impact of the construction sector by improving the efficiency and lifespan of existing structures by enhancing conservation of their cultural heritage.

It provides guidance on enhancing the welfare, wellbeing, and quality of life in older buildings while simultaneously reducing their carbon footprint. It offers practical advice on effective interior ventilation, mitigating dampness, and minimizing risks of inundation and flooding. These measures aim to lower heating costs, reduce dust pollution, and cut CO_2 emissions, all contributing to a healthier and more sustainable environment. Additionally, the book emphasizes the importance of preserving the historic and aesthetic value of older structures. It advocates for interventions that ensure their durability and usability for future generations, positioning them as vital elements of cultural heritage while adapting to contemporary environmental challenges (Jelenski, 2022).

Stakeholder engagement is encouraged to ensure community involvement and integrate local knowledge into the retrofitting process. These principles aim to demonstrate that heritage preservation and climate action can coexist, setting an example for similar projects globally.

DEMI MORE

Developed by INTEREG Flanders-Netherlands as part of the DEMI MORE project in 2020. Demi More consists of two parts: a visual decision support tool (which is more of a checklist if you look at it) and an integrated description of the conservation process. Both parts work complimentary to each other. The visual decision tool guides the user through all the steps of EN 16883:2017. It starts with questions on ambition and objective. This is followed by the second part containing a building survey, selection and assessment of solutions, design implementation, completion and post occupancy evaluation, operation and maintenance. Steps can be mandatory or optional (DEMI MORE, 2020).

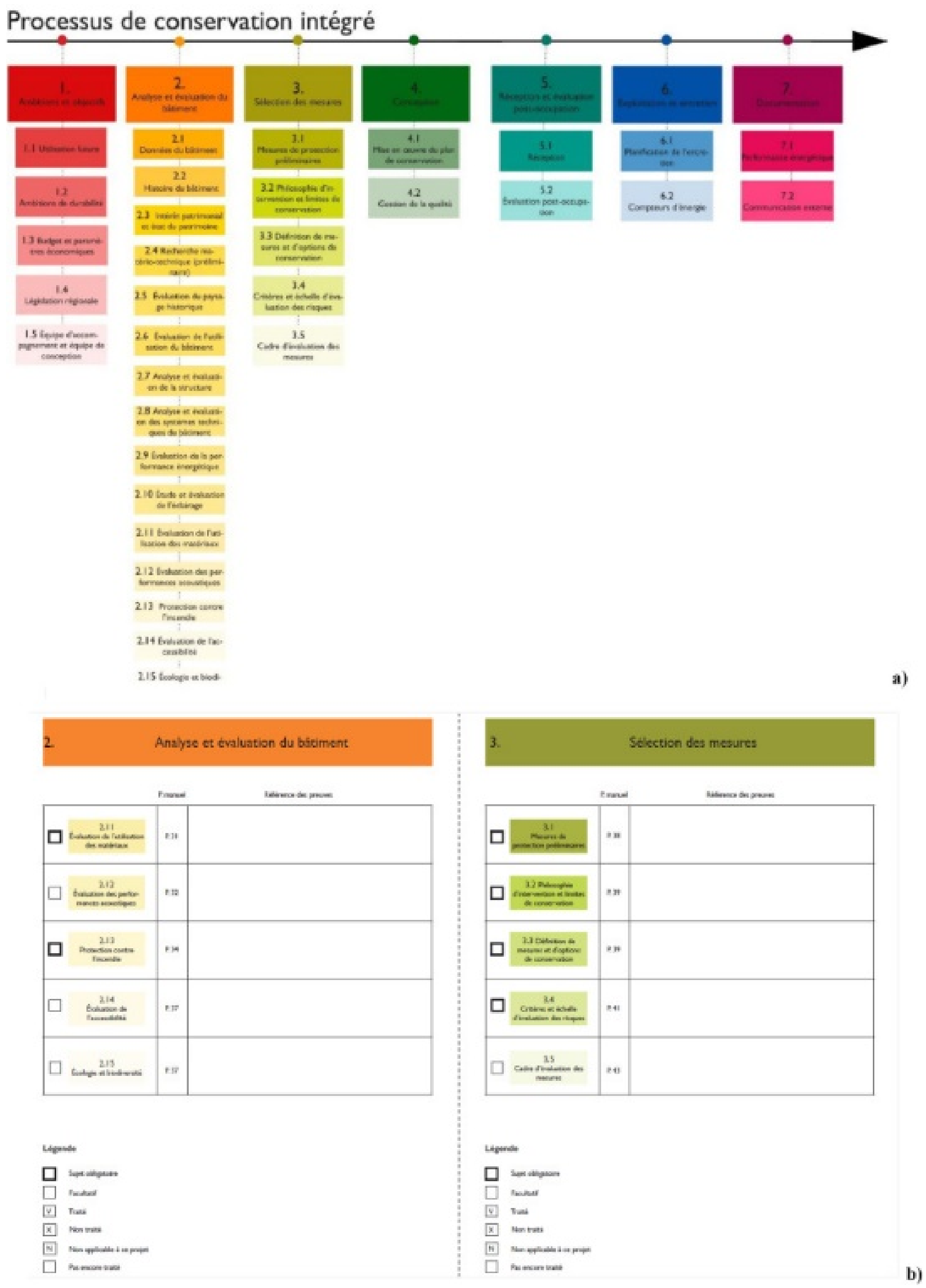

Fig.11 Outline of DEMI MORE’s visual component. This functions as an template that has to be filled in by the user (DEMI MORE, 2020).

The tool is mainly focused on guiding the user through the process instead of presenting solutions. In this fashion, it mainly works as a checklist in relation to existing standards in Belgium and the Netherlands. The tool was tested in the form of different case studies throughout the south of the Netherlands and Belgium.

The fact that the tool covers all the steps from the European standard EN 16883 must be seen as its major strength.

The major limitation of Demi More is, that it is not an all-in-one tool. It does not guide the user directly to concrete solutions, but it requires the users to consult it together with other documents (Buda et al, 2022). Furthermore, there are no publications available that assess the use of the tool.

LETI Climate Emergency Retrofit Guide

This guide's major objective is to illustrate how we can retrofit our homes in the context of the Net Zero targets of the United Kingdom. It is developed by the Low Energy Transformation Initiative, LETI, a voluntary network gathering environment professionals, to put UK and the planet on the path to a zero carbon future. Being a decision support guide it helps the user to define energy targets for existing homes and provide actual guidance on how to achieve them. The guide aims to inform a wide scope of professions such as architects, engineers, local authorities, social landlords, energy professionals, contractors and clients looking for guidance and is available open access.'The guidance is mainly driven by best practice in connection to the LETI targets and covers step 6 until 11.2 of EN 16883 (LETI 2021).

Major strengths of the tool are that it takes a whole building approach, works with benchmarks of energy performance per building archetype and that it works with a concept of constrained retrofit values.

Its use is limited by the small repository and the lack of detailed information.

Sustainable Renovation - Improving homes for energy, health and environment

Developed by the Scottish Ecological Design Association, SEDA, and authored by Chris Morgan, these guidelines are being structured in another way than most guidelines, as this tool presents ten ways on how to retrofit and renovate a home. Besides achieving a better energy performance, this tool also aims to connect its content with the broader picture by linking it actively to sustainability benefits and goals. The tool is focused on the existing building stock, but not necessarily on historic buildings.

With its repository character it has a wide target group (everybody in the retrofit sector). The guide can be bought in book form but is also available open access online (Morgan 2023). Its structure makes it easy to read and gives a solid overview of different possibilities.

However, given its repository character it does not actively guide the user through the decision-making process. Furthermore, the guide is foremost focused on the Scottish building stock and only of limited use outside the UK context.

DESIGN INSTRUCTIONS Energy management of construction projects

These guide instructions, developed by the Swedish Property Board, give information on how to achieve climate improving measures in construction projects. They elaborate on how to use EPD's and does give recommendations for the execution of climate calculations. In addition, they provide information on how to report climate calculations as well as how to follow-up these calculations. Consequently, these instructions connect mainly to step 7 of EN 16883. The instructions are mainly purposed for internal use within the Swedish property board as well as for partners when construction work must be done at one of the board's properties. Since The Swedish property board is a government agency these instructions are available for the public as well.

The major strength of these instructions is that they provide comprehensive support in the decision-making process and provide templates to support this (Statens Fastighetsverk, 2024).

Limiting is, however, the fact that only one section of the instructions is focused on energy retrofits, making its scope rather small. Furthermore, it does not provide concrete solutions and is focused on the properties managed by the Swedish property board.

Energieeffizienz am Baudenkmal

These guidelines are issued by the Austrian heritage board. It helps to initiate, plan and implement energy retrofits in historic buildings. By using a color code, the guide does estimate what impact the given measurement will have on the historic fabric. The guide covers step 7 until 11.2 of EN 16883 and has a mainly repository character. With its wide scope the guide targets both professionals and non-professionals and is therefore available open access (Bundesdenkmalambt 2021).

The major strength of the guide is the comprehensive way in which it is structured and how it uses an indication system to show the impact of each measurement on the heritage value. The fact that the guidelines are specifically focused on the Austrian building stock, however, limits the use of them severely.

Renovate energy effectively (Renovera energieffektivt)

This tool was developed by a network for energy-efficient housing, BeBo, driven by the Swedish national energy agency. The web-based guidelines offer a step-by-step guide for property owners of multifamily buildings to guide them through the process of energy renovations. The tool divides the process into three different phases: 1) preparation, 2) execution and 3) finishing up. Each of these phases consists of different steps. The tool even provides information on the organizational aspects of energy renovations. The tool focuses on non-statutory multifamily residential buildings with heritage value, and it has a repository character. The tool mainly targets homeowners and real-estate managers and does not require in-depth knowledge on the topic before using the tool. By covering steps 6 to 11.4 of EN 16883 it covers a wide range of steps in the decision making phases (BEBO, 2023).

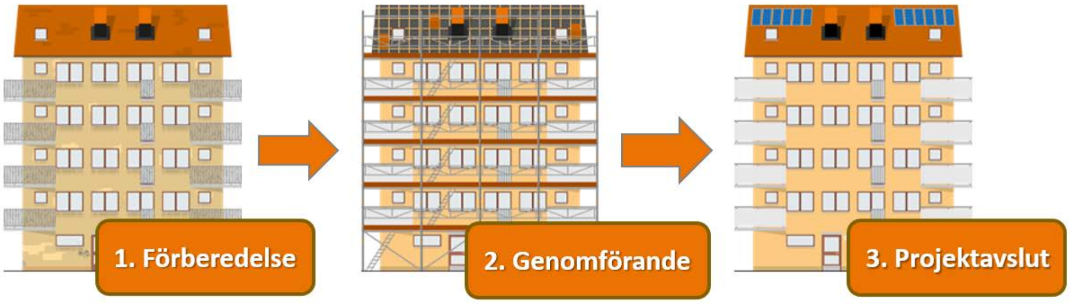

Fig.12 *Illustrations depicting the three phases of Renovera energieffektivt (BEBO, 2023)*

The major strength of the tool is the fact that it is easily accessible for everyone, both people with and without knowledge on the topic.

A major limitation is that the system does not work with data input and therefore does not provide tailormade advice or solutions for specific types of buildings. A limitation is also that the tool solely focuses on multifamily residences. Other limitations are that the tool is only available in Swedish and that it refers to documents that need to be updated. In the preparation phase there is limited guidance for the heritage aspect of the planned renovation. It is primarily a matter of remembering to examine the heritage conditions so that the laws and regulations that may be attached to the specific building are not forgotten. When it comes to managing heritage values and making decisions based on an assessment of which values could be relevant in the specific case this tool is rather weak.

4. Conclusions and Outlook

The inventory and analysis of tools and guidelines show that there are several tools and guidelines available that can help to support the decision-making process and that will be beneficial for the future development of a *FuturHist* toolkit.

Many single-dimension tools and guidelines for heritage assessment and combability are available, however limited in scope and often linked to specific countries, geographical contexts and building types. The tools are often developed as part of research and development projects while the guidelines often are the result of the work from authorities. It is also difficult to divide single dimension tools between the energy efficiency dimension and the economic dimension. It is from this perspective hard to recommend or pick out the best guideline and/or tool since they serve different contexts. The inventory provides us, however, with an overview and map over relevant guidelines and tools that will inspire and help in the development of the *FuturHist* toolkit. In Table 1 the single dimension tools and guidelines are gathered that best matched the identified needs based on the results from the interviews, questionnaire and the workshops. The number of tools considering heritage assessment has been reduced from the number of presented tools or methods in the report in order to focus on the tools that would benefit the development of the *FuturHist* toolkit.

Furthermore, it is important to note that, while in this deliverable a distinction is made between single and multi-dimensional tools, this distinction is difficult in practice. Most tools that prioritise one dimension also take into consideration other dimensions. For example, the energy performance dimension is closely connected to the financial dimension. At the same time, no multi-dimensional tool takes every dimension into consideration.

Table 1. List of single dimension tools divided into the three dimensions; heritage, energy financial and life cycle assessment.

Type		Name/ organisation	Dimensions/ focus	EN16883 steps	Target groups	Accessibility	Limitations
Single dimension tools	Heritage assessment	P-Renewal Tool/UC Louvain	Heritage significance Planning	7, 10.4-10.5	Heritage experts	Open Access	Checklist, non-rating, not web based
		Arches project /Getty Conservation Insitute	Heritage significance Documentation	7, 10.4-10.5	Heritage organisations Urban planners Policy makers Researchers	Open Source	No specific focus on energy
		DoMu Monumental score/NIBE	Heritage significance Listed buildings	7, 10.4-10.5	Heritage experts	Available	Listed buildings Not web based
		SAVE Survey of Architectural Values in the Environment/ Danish Ministry of Environment and Energy	Architectural values Planning	7, 10.4-10.5	Urban planners Heritage experts	Available	Not web based
	Energy assessment	Minoro/ Grimshaw WBCSD	General building stock Carbon management	7, 10.5-10.7	Architects Engineers Planners	Open Access/source	Not specific for historic buildings
		Autodesk Green building studio/Autodesk Inc	Energy performance	7, 10.5-10.7	Architects Engineers	Need subscription	Need subscription
		HERB The Healthy and efficient retrofitted building tool/C40	General building stock Energy efficiency	7, 10.5-10.7	Municipalities	Open Access	Building stock level
		UBAKUS/Ralf Plag	Building components U-values	7, 10.5-10.7	Architects Engineers	Open Access	Advanced versions for subscription
	Financial assessment	CraveZero/AEE	Net zero buildings	7, 10.5-10.7	Architects Engineers	Open Access	Not specific for historic buildings Advanced versions for subscription
		RETScreen/NRCan	Energy efficiency Reduced cost	10	Energy experts Facility managers Policy makers Project developers	Need subscription	Not specific for historic buildings Need subscription
		LCCByg/BUILD AAU	Buildings/Building components Life Cycle costs	10	Architects Engineers Building owners, Town planners	Open Access	Focus on Danish context

Only three available digital decision-making tools are identified, that are still running are considered useful for a *FuturHist* toolkit: Retrofit Guidance Wheel, HIBERtool and RIBuild. A summary of these are presented in Table 2.

Table 2. List of multi-dimension decision making tools that are also available digitally.

Type	Name/ organisation	Dimensions/ focus	EN16883 steps	Target groups	Accessibility	Limitations
Multi-dimension tools	Responsible Retrofit Guidance Wheel/ STBA/CREBA	Historic buildings Energy Technique	10.3 -10.7	Architects, educators	Open access	Tailored for UK and France
	HIBERtool/Eurac	Historic buildings Energy Renovation	10.3 -10.4	Non-experts	Open Access	Focus on the alpine area
	RIBuild step-by-step guide /BUILD AAU	Historic buildings Interior insulation	7 -10.4	Building owners, professionals and researchers	Open Access	Limited geographic reach

Also, a large number of multidimensional guidelines for the implementation of energy retrofits in historic buildings exists. Although some highly relevant guidelines have been identified they lack active support in the decision-making process. Also, the geographical focus of these tools limits their use in the context of a potential *FuturHist* toolkit. In Table 3 a list of the guidelines that is beneficial for the *FuturHist* project are listed.

Interactive digital web tools seem to work the best but do often lack a level of complexity. Example of such o tool is the Responsible retrofit guidance wheel. Especially, there is a need for more elaborate DSS systems. Tools with a repository character are less needed since knowledge about possible retrofit solutions is often already present or can be generated in other ways, according to the results from the workshop. Furthermore, repository tools require constant updating and a high amount of maintenance, an aspect that especially many multi-dimensional tools seem to struggle with, compromising their function. Step 6 until 9 in EN 16883:2017, covering the initiation of the planning process until the actual decision-making, are barely covered by any tool at all. Increased focus on this part of the decision-making process in future tools is therefore needed.

Table 3. List of relevant guidelines.

Type	Name/ organisation	Dimensions/ focus	EN16883 steps	Target groups	Accessibility	Limitations
Guidelines	Advice note 18: Adapting Historic Buildings for Energy and Carbon Efficiency/Historic England UK	Historic buildings Energy efficiency Whole house approach Checklist	7	Heritage experts Planners	Available	Tailored for UK
	Renovation and retrofitting of old buildings in times of climate crisis/Sendizmir Foundation/ Croatia Green Building Council	Historic buildings Best practice	7-9	Heritage experts Planners Public authorities	Available	No guide through the decision process
	DEMI MORE/Intereg Vlaanderen-Nederland	Historic Buildings Checklist guiding the user through the decision process	All steps	Heritage experts Energy experts	Available	DS process in focus, need support from other documents
	LETI Climate Emergency Retrofit Guide/LETI	General building stock Building archetypes Whole house approach	6 -11.2	Architects Engineers Energy experts	Available	Information is general and not detailed.
	Sustainable Renovation - Improving homes for energy, health and environment/SEDA, Chris Morgan	General building stock	7 -10.4	Experts to homeowners	Available in book form	No guide through the decision process

Even though tools and guidelines that have been described in this deliverable has focused on processes for energy efficiency in historic buildings, there is a lack of guidance on how to actually assess the heritage values that should be considered in the decision-making processes. There has been attempts to develop these kind of assessment methods and implement them in digital tools. This was the aim of the Effesus project but it was never finalised as a tool. The methodology that was developed is available through Eriksson, et al. This might seem as a paradox but how to assess heritage values is built on deep knowledge about heritage assets and their historic, social, technical etc. context which implies that this assessment need to be done by a built heritage expert and is hard to incorporate in a digital tool.

Another major problem that has been identified is the longevity of these tools. Although all the inventoried tools did work from the beginning several of them are not available anymore while a significant part of the available tools haven't been updated in many years. The tools that seem to work the best are the tools which have been constantly updated or if it is a tool that is not web-based. Maintenance and long-term updates therefore seem of essential importance in the development of a tool and the most prominent problem with the currently existing tools. Only then it is possible to cover a multi-facetted palette of issues and aspect such as policy and legislation, technical and practical issues and financial aspects.

The web-based European portal for energy efficiency and renewable energy in buildings, BUILD UP, contained useful information and resources and was an important source for identifying for *FuturHist* interesting tools and guidelines. The portal is a useful resource for researchers and professionals in the field. As such, and in order to make the knowledge gathered here more easily accessible, the tools and guidelines not yet in the repository will be shared and documented. In agreement with the editorial team of the website, these tools will uploaded by the FuturHist project partners regularly, with a frequency of 2 tools a month. Tools are currently categorised by type of content and themes, but these do not include terms regarding “historic buildings”. Although this cannot be change in the short term, it would be a target for the *FuturHist* consortium to aim for.

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6. Annex

Annex 1: The full inventory of guidelines and tools related to the *FuturHist* scope.

Digital decision making tools

Name and identification	Description						Advantages	Limitations
	Function	*Focus*	*Steps in the process*	*Repository or DSS*	*Target Group*	*Availability*		
EFFESUS DSD/RE2H **Year:** 2015 **Country:** Spain **Organisation:** TECNALIA **Link:** https://www.imw.fraunhofer.de/en/research/technology-transfer/innovation-acceptance/projects/completed-projects/effesus.html	Does concist of multiple tools: Categorisation tool: Categorises the building stock for the identification of representative building typologies in the historic urban environment. The categorisation is based on 3D models. Expert system: Guides decision-makers in selction of the best tools for a retrofit. The two tools are to be combined abd can in this way adress different levels of actions. Here four levels of decsiion-making is proposed (LoDM). The inputs provided by the user and query the solutions repository to generate possible solutions. A 0-4 scale is used to characterise teh generated solutions. At the end of the process the most suitable solutions and their impact are provided.	Historic buildings	6 to 10.4	DDS	Heritage professionalls and energy experts	Free (currently unavailable	* Covers many steps Eurppean standard. * Both guides trough the process and generates possible solutions.	* Need for a 3D model to be able to use the tool * Hard to use without a certain thenical knowledge. * Only used within test cases, never used in ´real` practice.
Responsible Retrofit Guidance Wheel **Year:** 2013 **Country:** United Kingdom/ France **Organisation:** STBA/CREBA **Link:** https://www.responsible-retrofit.org/greenwheel/	Aims to identift the advantages of a specific retrofit solution. For these solutions it generates riskas and he level , types of technical, heirtage and energy concerns and interconnections. The digital tool is tructured as a wheel, where the user can explore the retrofit solutions linked to each segment. It considers interventions to fabric and services and behaviour range. The wheel requires input data in the form of heriatge value, its condition, the exposure level to wind-driven energy use, the number of exposed sides gor ventilation, the occupant's energy use and intreest in the building. It is possible to look further into tecjnical consequences and benefits for each solution as well as anergy savings and heritage issues. In the end, it is possible to download a report which presents a list with propsoed solutions. The provided information derives from real cases .	Traditional buildings	10.3 until 10.7	Repository	Architects and educators	Available open acces	* Offers information on the rsisk associated with with a retrofit. * Considers individual solutions and their interaction with other current or planned solutions. * Gives the designer the relevant information for the devlopment of energy retrofits in the context of a wider risk-managemnt process. * Gives possibility to compare different solutions.	* Tailored to building stock in the Uk adn France, so informed adpatation is needed if you wnat to apply it in another context. * No publications about use of the tool.
TOOL FOR EVALUATION OF ENERGY REHABILITATION MEASURES FOR HISTORIC RESIDENTIAL BUILDINGS IN ANDALUSIA **Year:** 2020 **Country:** Spain **Organisation:** Violet (Intereg Europe) **Link:** https://projects2014-2020.interregeurope.eu/violet/	A European funded project, the tool is published in Spanish but an english translation has been done. It is mainly focused on qualitively assesing the energy effeicency improvement emasures of heirtage residential buildings. The tool can support the initial pahse of the renovation project drafting.	Heritage residential building	6 until 10.7	DDS	Drafting technicians	Currently unavailable	* Covers a almost all steps. * Works with an comprehensive metod.	* Used repository is only limted. * Specifically focused on residential buildings in Andalusia. * require advanced technical knowledge to use.
Renovera energieffektivt **Year:** 2023 **Country:** Sweden **Organisation:** BEBO- Energimyndighetens nätverk för energieffektiva bostäder **Link:** https://www.bebostad.se/renovera-energieffektivt	A step by step guide for property owners of multifamily buildings to guide them through the process of energy renovations. The tool does divide the process in three different phases: 1) preparation, 2) execution and 3) finnishing up. Each of these phases concists of different steps. The tool even provides information on the organisational aspects of energy renovations.	Residential buildings	6 until 11.4	Repository	Homeowners and real-estate managers	Available open acces	* Does cover all steps. * Comprehensive webtool tahts easy to use.	* Does not propose concrete solutions based on input.
HIBERtool **Year:** **Country:** Italy **Organisation:** EURAC **Link:** https://www.tool.hiberatlas.com/en/welcome-1.html	Based on 130 documented retorfit solutions, to a large part based on practice examples of the HiBERatlas database. There are four groupsb within the set of solutions: wall insulation, window solutions, solar systems, and HVAC. The user is guided through a query with easy to answer questions on the tacjnical and heritage characteristics of the case. The query is used to select solutions. The relevent solutions will be displayed and the user can select the relevant ones. The documentation is made available in a pdf that can be downloaded at the end of the process.	Historic buildings	10.3 until 10.4	Repository	Non-experts	Available open acces	* Detailed assesment that paves the way for a slection and decision process. * Provides comprehensive information of the long list of solutions in a very short time	* Much dependeny on the limited number of documeted solutions. * Refers mostly to traditional regional alpine architecture.
PETRA **Year:** 2013 **Country:** Switzerland **Organisation:** SUSPI **Link:** https://www.petraweb.ch/	Uses a database on sustianable building renovation, whie being structured by a step-to-step project. The web tool porposes solutions for individual building elements. : 1) Information 2) Diagnosis 3) Energy 4) Scenarios 5.) Analysis Detailed information on the building needs to be entered at the beginning of the process. The tool allows to to enter descriptive cmments and to define the building's heirtage value according to the Swiss heirtage classes.	Historic buildings	Covers all steps	DDS	Experts	License needed, currently unavailable	* One of the only tolls that cover the whole process.	* Calculation of thermal balance and the estitmation of intervention costs are not specifically targeted at historic buildings. * Last updated 2013. * Considers only the swiss market.
exDDS **Year:** 2014 **Country:** Germany **Organisation:** Frauenhofer **Link:** https://www.imw.fraunhofer.de/en/research/technology-transfer/innovation-acceptance/projects/completed-projects/ClimateforCulture.html	The tool is divided in three part: future outlook, risk assesment and indoor cliamte control methods. To be able to use the system an input in the form of the type of building, artwork collection and historic climate pre-retrofit. The en udes is then provided with advice on hygrothermal risks. Information resulting from an extensive analysis of climate control methods that was doen in the context of the climate for culture project is used as basis for the tool.	Historic buildings	7 until 10.4	DSS	Experts	Currently unavailable	* The tool is very usefull to follow and support EN 16883:2017 from 7 until 10.4.	* Only hygrothermal risk analysis included in the DDS. * Has not been updated since 2015. * Only a limted number of solutions.

Digital decision making tools

Name and identification	Description						Advantages	Limitations
	Function	*Focus*	*Steps in the process*	*Repository or DSS*	*Target Group*	*Availability*		
Historeno **Year:** 2022 **Country:** Switzerland/ France **Organisation:** Intereg France-Suisse **Link:** https://historeno.eu/en/about/	This project aims to develop an integrated cross-border platform to support renovation of historic urban centres. The main aims are to decarbonise and reduce energy demands and local air polution with historical buildings. The platform concist of a webpages as well as an energy potential calculation tool in web format that can be integrated within GIS. By combining adminstrative, technical and heritage requirements the platform includes analysis grides to support planners in energy renovation projects of old buildings. Analysis and feedback sheets for buildings can be generated. With the calucaltion relevant geodata can be generated. It make sit posisble to contribute to the energy pre-audit phase of you building drawing on best practice.	Historic buildings from before 1946 as well as those who benefut from protection measures)	Unkown	Unkown	Planners	Unknown	* Can be integrated within GIS. * Contains an calculation tool.	* Specifically focused on historic urban centres that are designated. * Mainly focused on the pre-audit phase.
RiBuild **Year:** 2016 **Country:** Danmark **Organisation:** Aalborg University **Link:** https://www.ribuild.eu/home	RiBuild uses a computer-based data analysis approach. t starts with settting the goal for the renovation (step 1), followed by a description of how visual assesment is to be carried out and what to look for to decide whether the buildings is suited for intenral insulation (step 2). Based on those two steps a decsion can be made on what kind of insulation system to select, based on the provided descriptions of their characteristics (step 3). Step 4 presents a way to evaluate the envirnmental impact and the life cycle costs of the solutions. A limted number input is needed to bea bake to consider solutions for a specific building. The tool makes use of a probablistic approach to represenr cariations and thereby indicating the risks of the application of specific solutions. The more detailed the inputs are, the less solutions the tool will suggest.	Historic buildings	7 until 10.4	DSS	Building owners, professionals and resreachers	Available open acces	* Can support decision-makers significantly when it comes to assessment and insulation solutions. * Interface is easy to use and provides details and tailor-made suggestions and solutions.	* Does not cover all afilure modes for moisture-related damages. Frost damage are not included since there is an absence of reliable models suitable for simulation of degradation. * Based on limted weather data that does not cover all locations and orientations. * There are no publications attesting the use of RiBuild, apart from the case studies included in the project on-site monitoring activities.

Guidelines tools

Name and identification	Description						Advantages	Limitations
	Function	*Focus*	*Steps in the process*	*Repository or DSS*	*Target Group*	*Availability*		
Guide to Energy Retrofit of Traditional Buildings **HES energy-retrofit-short-guide** **Year:** 2023 (update) **Country:** United Kingdom **Organisation:** HES **Link:** chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://media.methodist.org.uk/media/documents/energy-retrofit-short-guide-2021-1_9nCpae1.pdf	This guide describes retrofit measures which can be used to improve the energy efficiency of traditional buildings, whilst maintaining as much of their historic fabric and creating healthy indoor environments. These measures are backed up by research and showcased in various case studies, as trialled by Historic Environment Scotland. The guide also looks at compatibility with the existing fabric, compliance with building standards and the planning process. The purpose of the guide is to inform and provide guidance to homeowners, local authority building control officers, architects, designers and installers on how to approach the refurbishment of such buildings and balance various requirements	Traditional buildings	8 until 10.4	Repository	Homeowners, local authority building control officers, architects, designers and installers	Available open acces	*Gives an extensive overview of possible retrofit solutions *Gives solid background information *Accesible for non-experts	* Focused on key interventions and principles - rather than guidance on structured retrofit process * Removed mention of EPS beads product
IHBC Guidance Notes - Retrofitting of Traditional Buildings **Year:** 2022 **Country:** United Kingdom **Organisation:** IHBC **Link:** chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://ihbc.org.uk/toolbox/guidance_notes/PDF/Retrofitting%20in%20Traditional%20Buildings%20GN2022_2_v090322.pdf	This IHBC Guidance Note goes beyond retrofit and expresses the holistic approach to improving the energy performance of buildings based on BS7913.' 'This has now been updated to take account of the recent review of PAS2035, the BSI standard for retrofitting dwellings and publication of BSI PAS2038, the standard for non-domestic buildings which is also referenced.'	Historic building	7 until 10.7	DSS	Non-experts	Available open acces	* Well integrated with British building standards * Guides the user through the process * Also understandable for non-experts	*Guidelines do not give in-depth information and solutions * Lacks interactivity with user
LETI Climate Emergency Retrofit Guide **Year:** 2021 **Country:** United Kingsdom **Organisation:** LETI **Link:** https://www.leti.uk/retrofit#:~:text=%27,-Marianne%20Heaslip%20Associate&text=%27LETI%27s%20new%20Retrofit%20Guide%20publication,and%20built%20environment%20professionals%20alike.	LETI's Climate Emergency Retrofit Guide shows how we can retrofit our homes to make them fit for the future and support the UK's Net Zero targets. We define energy use targets for existing homes and provide practical guidance on how to achieve them. The guide is useful for architects, engineers, Local Authorities, social landlords, energy professionals, contractors and clients looking for guidance about best practice retrofit.	General building stock	6 until 11.2	DDS	Architects, engineers, Local Authorities, social landlords, energy professionals, contractors and clients	Available open acces	* Whole house approach * Benchmark of energy performance per building archetypes * LETI Retrofit Process * Concept of 'constrained' retrofit values *Flow chart to determine the appropriate LETI target and approach (consider protected buildings - 'heritage') Retrofit standards and when to use them Typical house archetype examples Piecemeal versus whole house approach diagram. A Retrofit Plan for the whole building * Annexes include examples of ventilation and insulation strategies	*Has a limted repository * Lack of detailed infromation
Planning responsible retrofit of traditional buildings **Year:** 2015 **Country:** United Kingdom **Organisation:** STBA **Link:** https://historicengland.org.uk/images-books/publications/planning-responsible-retrofit-of-traditional-buildings/	This guide is for anyone involved in a project aiming to reduce the energy use of a traditional building through technical interventions. This is what is primarily meant by 'retrofit'. The guidance will be useful for: • Building owners, managers and occupiers • Architects, assessors and designers • Project managers • Building contractors It is to enable people to reduce energy use in buildings in an effective way, which is also good for health, heritage and the natural environment. This is what we mean by responsible retrofit	Traditional buildings	6 until 8	DDS	Building owners, managers and occupiers • Architects, assessors and designers • Project managers • Building contractors	Available open acces	* Focus on traditional and protceted buildings whole house approach * Fine analysis of potential risks depending on combination of measures + action to mitigate those * Whole Building Approach in a Joined-Up Process	* Does not help woth identifying slutions * Mainly focused on beginning of process
Advice note 18: Adapting Historic Buildings for Energy and Carbon Efficiency **Year: 2024** **Country:** United Kingdom **Organisation:** Historic England **Link:** https://historicengland.org.uk/images-books/publications/adapting-historic-buildings-energy-carbon-efficiency-advice-note-18/	This guidance is for anyone who wishes to improve energy efficiency in an historic building. A logical and systematic process of energy planning underpins the 'whole building approach'. This guidance describes the key stages of the process, illuminating any problems that might occur and providing solutions. It also includes checklists of practical measures that might be considered, along with links to sources of more detailed information about how to install these measures.	Traditional buildings	7	DDS	LPAs, heritage consultants and other parties directly involved in the planning process	Available open acces	Whole house approach Targetting histoirc buildings Checklist of measures sorted by level of risk and costs (low some high)	Weighing up the cost and benefits of various measures examples of KPIs for retrofit

Guidelines tools

Name and identification	Description						Advantages	Limitations
	Function	*Focus*	*Steps in the process*	*Repository or DSS*	*Target Group*	*Availability*		
Renovation and retrofitting of old buildings in times of climate crisis **Year:** 2022 **Country:** Poland/Croatia **Organisation:** Sendizmir Foundation/ Croatia Green Building Counsil **Link:** https://sendzimir.org.pl/en/projects/climate-mitigation-in-heritage-buildings/renovation-and-retrofitting-of-old-buildings-in-times-of-climate-crisis/	Presents a wide range of solutions that can be implemented in old buildings to optimise the energy efficiency, while at the same time respecting heritage values. Includes also a tool called ' The alghoritims for the optimal range of energy renovation' It points out mistakes commonly made during the process and generates optimal solutions while taking into consideration the given limitations, sepcific factors and building conditions.	Old buildings	7 until 9	Repository	Public and private investors, employees of local government.	Available open acces	Extensive overview of different solutions Usefull for experts and non-experts Includes tool that provide solutions adapted to specific situations	Does not guide use through decsion process
Sustainable Renovation - Improving homes for energy, health and environment **Year:** 2018/2023 (Update) **Country:** United Kingdom **Organisation:** SEDA and Chris Morgan **Link:** chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.thepebbletrust.org/wp-content/uploads/2023/08/230814_SRG-ed2_Digital-V2_compressed.pdf	Describes ten ways on how to retrofit and renovate a home, with a primary focus on the Scottish building stock. Besides achieving better energy performance this guide also aims to controbute to wider sustainabillity benefits.	General building stock	7 until 10.4	Repository	Everybody in the retrofit sector from homeowners interested in upgrading their homes to architects, builders, surveyors as well as those working in government, housing associations and councils	Needs to be bought in book form	* Easy Accessible * Gives a good overview of the possibilities	Does not guide use through decsion process
Improving energy efficiency in traditinal buildings - Guidance for specifiers and installers **Year:** 2023 **Country:** Ireland **Organisation:** Government of Ireland **Link:** https://www.gov.ie/en/publication/18cb9-improving-energy-efficiency-in-traditional-buildings-guidance-for-specifers-and-installers-2023/	Gives an ver view on how upgrading of traditional buuldinsg can be done in appropriate and sustianable ways. The guideliesn are mainly focused on giving advise on energy effciency measurements. Staring by giving a proper contex, the guide continious by giving knowledge on taditional building tecniques, specifying safe and effective ennergy-upgrading measures, and giving insights on low-carbon heating and renewable energy sources.	Traditional buildings	6 until 10.4	Repository	Experts and non-experts	Available open acces	* Presents a lot of information * Does cover many of the steps	Does not actively support the user in theb dicision making process
DESIGN INSTRUCTIONS Energy management of construction projects **Year:** 2024 **Country:** Sweden **Organisation:** The Swedish Property Board **Link:** Contact Petra for access	Instructions for companies engaged in projects on buildings owned by the Swedish Property board. They give information on energy renovations and energy conntrol in historic buildings in general and the enrgy processes are being explained. In addition, instructions are given to for energy control and decsion-making.	Buildings owned by the Swedish property board	6 until 11.4	DDS	Employees of the Swedish property board	Available open acces	* Gives comprehensive instructions in the decisiomaking. * Provides a template.	* Only a section is dedicated to the implementation of energy retrofits, making its scope rather small. * Does not provide concrete solutions. * Exclusively fcoused on the properties managed by the property board.
DESIGN INSTRUCTIONS Climate calculations and climate improvements in construction projects **Year:** 2024 **Country:** Sweden **Organisation:** The Swedish Property Board **Link:** Contact Petra for access	Instructions for companies engaged in projects on buildings owned by the Swedish Property board. They give information on climate calculations and climate improvements in construction projects. It elaborates on how to use EPD's and does give reccomedations for the execution of climate calcualtions. In addition it provides information on how to report climate calculations as well as how to follow-up these calculations.	Buildings owned by the Swedish property board	7	DDS	Employees of the Swedish property board	Available open acces	* Does provide accesbale information on climate calculations.	* Supports only step 7 (only partially). * Exclusively focused on the properties managed by the property board.
Bruka, Bevara och energieffektivisera **Year:** 2015 **Country:** Sweden **Organisation:** Offentliga fastigheter **Link:** http://eprints.sparaochbevara.se/920/	A simple handbook on how to plan for energy efficiency in public Swedish buildings. It provides the suer with an short introduction to legal frameworks and state of teh art, presents an methodlogy to select and implement enery retrofits and presents some best practice.	Buildings of cultural significance	6 until 11.4	Repository	Non-experts	Available open acces	* Can inform the user with important information in connection to step 7.	* Rather limted in its scope. * Does not provide enough support to make informed decisions.
Charte de la rehabilitation responsable du bati ancien **Year:** 2019 **Country:** France **Organisation:** CREBA **Link:** https://www.effinergie.org/web/images/attach/base_doc/3245/CREBA_charte_rehabilitation.pdf	Gives information on the implementation of energy effciency measurements in historic buuldings. The guid einforms the user about the importance of heritage comservation and anergy retrofits and presents different tios, tricks and solutions to implement measurments. It will guide the user to the ,ost appropriate measures ti be introduced in the subsequent energy model. Its scopes is on the integrla rehabilitation of the building there the idea is to bring the building as close to an NZEB as possible.	Monumental buildings	6 to 10.4	Repository	Experts and non-experts	Available open acces	* Gives a solid introduction into energy retrofits in historic buildings.	* Only very limted in scale and mostly basic infromation. * Ony focused on designated buildings.

Guidelines tools

Name and identification	Description						Advantages	Limitations
	Function	*Focus*	*Steps in the process*	*Repository or DSS*	*Target Group*	*Availability*		
LINEE DI INDIRIZZO PER IL MIGLIORAMENTO DELL'EFFICIENZA ENERGETICA NEL PATRIMONIO CULTURALE **Year:** 2015 **Country:** Italy **Organisation:** MiBACT **Link:** https://www.soprintendenzapdve.beniculturali.it/la-soprintendenza-informa/atti-di-indirizzo/linee-guida-di-indirizzo-per-il-miglioramento-dellefficienza-energetica-nel-patrimonio-culturale/	Guidliesn produced by the Italaind ministry of cultural tourism and heritage. The document provides guidlines to implement energy effciency measurements in historic buildings.	Monumental buildings	7 until 9	Repository	Experts	Available open acces	* Gives a lot of information	* Hard to use. * Mostly theoretical approach: * Does not actively support the decsion process.
Energieeffizienz am Baudenkmal **Year:** 2021 **Country: Austria** **Organisation:** Bundesdenkmalambt **Link:** https://www.bda.gv.at/dam/jcr:544db343-26b3-44ad-bcb7-e619703ead8f/Standards%20Energieeffizienz%20am%20Baudenkmal%202021_final_BF.pdf	Guide that helps to intiate, plan and implement energy retrofits in historuc buildings. By using a color code, the guide does estimate what impact the given measurment will have on th historic fabric.	Historic buildings	7 untill 11.2	Repository	Experts and non-experts	Available open acces	* Well structured * Used indication system to show he impact of each measurments on the heritage value.	* Does not actively support the user in theb dicision making process. * Mainly focused on the Austrian building stock.
Energy Efficiency and retrofit in historic buildings - The whole building approach **Year:** 2024 **Country:** United Kingdom **Organisation:** Historic England **Link:** https://historicengland.org.uk/advice/technical-advice/retrofit-and-energy-efficiency-in-historic-buildings/whole-building-approach-for-historic-buildings/	Webpages that guide the user step wise through five stages for making historic buildings more energy efficent and resilient.	Historic buildings	7-10.7	Repository	Experts and non-experts	Available on the web site of the author	Whole building approach Well structured Solid information Guides the user to other documents mainly on the website of Historic England	Long texts that require a lot of scrolling before reaching the information
Demi More **Year:** 2020 **Country:** Belgium/ The Netherlands **Organisation:** Intereg Vlaanderen-Nederland **Link:** https://interregvlaned.eu/demi-more/over-ons	Visual decsion tool that guides the user through all the steps of EN 16883:2017. It starts with questions on ambition and objective. This is followed by a building survey, selection and assesment of solutions, design implementation, completion and post ooccupancy evaluation, opertion and maintenaince. Steps can be mandatory or optional. The tool is mainly focused on guiding the user through the process instead of presenting solutions.	Historic buildings	Covers all steps	DDS	Heritage professionalls and energy experts	Available open acces	* Fits EN 16883:2017 very well.	* Not an all-in-one tool that guides a user towards possible solutions. * Needs to be consulted togehter with other documents.

Heritage assessment

Name and identification	Description					Advantages	Limitations
	Function	*Focus*	*Steps in the process*	*Target Group*	*Availability*		
MAHT - Monitoring and Assessment Heritage tool **Year:** 2023 **Organisation: /** **Country:** Portugal **Link:** https://doi.org/10.1016/j.cities.2023.104274 (article)	MAHT is a strategic framework designed to evaluate, monitor, and manage cultural and natural heritage sites. It combines technical and community-based approaches to ensure that heritage sites are preserved effectively and sustainably. The primary function of MAHT is to systematically monitor and assess the condition, risks, and management of heritage assets. It aids stakeholders in identifying vulnerabilities, prioritizing interventions, and maintaining the integrity of heritage sites.	Historic buildings	7, 10.4-10.5	Heritage site managers. Governmental and non-governmental organizations. Conservation professionals. Policy-makers involved in cultural and natural heritage management	Available open acces	*Offers a systematic approach to heritage management, covering diverse risks and conditions. *Leverages data repositories or DSS tools to inform policies and interventions. *Encourages practices that balance conservation with socio-economic development. *Facilitates stakeholder engagement, improving collective stewardship. *Can be customized to different types of heritage sites and contexts.	*Effectiveness relies heavily on the quality and availability of data, which may be limited in some regions. * Larger or more complex heritage sites may face issues in scaling the tool effectively.
Burra Charter Method **Year:** 1979 **Organisation:** Australia ICOMOS **Country:** Australia **Link:** https://australia.icomos.org/publications/burra-charter-practice-notes/illustrated-burra-charter/	The Burra Charter Method serves as a guide for assessing, conserving, and managing cultural heritage sites. It is widely applied in projects requiring sensitivity to cultural and historical values while ensuring sustainability and practical use.	Conservation of significance Inclusive decision-making Adaptive management	7, 10.4-10.5	Heritage professionals (architects, archaeologists, historians, planners). Community stakeholders (indigenous groups, local communities, NGOs). Government and non-government conservation bodies.	Available open acces	*Considers tangible and intangible values. *Involves multiple stakeholders for holistic decision-making. *Adaptable to various cultural contexts and site-specific challenges. *Maintains historical authenticity while allowing for practical use. *Emphasizes long-term care and minimal intervention.	*Can be costly and time-consuming due to detailed assessments and consultations. *Multiple stakeholder involvement can slow progress and lead to conflicts. *Terms like "cultural significance" may be open to interpretation, causing inconsistencies. *Limited reliance on technological tools may hinder efficiency in modern contexts.
Conservation Principles, Policies, and Guidance – Historic England **Year:**2008 **Organisation:** Historic England (formerly English Heritage). **Country:** United Kingdom **Link:** https://historicengland.org.uk/images-books/publications/conservation-principles-sustainable-management-historic-environment/	The document provides a framework for decision-making regarding the conservation of historic places in England. It outlines principles and methods to ensure heritage assets are managed and conserved sustainably.	The guidance focuses on ensuring the long-term preservation of cultural heritage while accommodating change. It aims to balance societal, economic, and environmental factors with conservation needs	7, 10.4-10.5	Local authorities Property owners Heritage professionals (e.g., architects, archaeologists) Developers Community groups	Available open acces	*Provides a clear, principle-based framework adaptable to diverse heritage contexts. *Supports sustainable decision-making that respects heritage significance. *Freely accessible and comprehensive. *Encourages collaboration between stakeholders. *Emphasizes the importance of ongoing maintenance.	*May require expert interpretation, which can be costly. *Balancing conservation with modern needs can be contentious and challenging. *Some ambiguity in applying principles to specific cases. *Resource-intensive for small-scale organizations or private owners.
DIVE – Urban Heritage Analysis **Year:** 2008 **Organization:** Norwegian Directorate for Cultural Heritage (Riksantikvaren). **Country:** Norway **Link:** https://ra.brage.unit.no/ra-xmlui/handle/11250/176994	The tool supports decision-making in urban planning by identifying, evaluating, and integrating cultural heritage values into development projects.	DIVE emphasizes sustainable urban development that respects cultural heritage, fostering collaboration between planners, policymakers, and local communities.	7, 10.4-10.5	Urban planners Architects Heritage professionals Local governments Community organizations	Available open acces	*Encourages collaboration between stakeholders. *Flexible and adaptable to various urban contexts. *Promotes sustainable urban planning that respects cultural heritage. *Enhances awareness of the historical and cultural significance of urban areas.	*Relies on expert input for interpretation and valuation, which may increase costs. *Lack of digital tools for automation may make it less efficient than software-based methods. *Subjectivity in valuating heritage assets can lead to disputes among stakeholders.
SAVE – Survey of Architectural Values in the Environment **Year:** 1990s. **Organization:** Danish Ministry of Environment and Energy **Country:** Denmark **Link:** https://slks.dk/fileadmin/publikationer/Kulturarv/InterSave_english.pdf	SAVE is a systematic method for evaluating and documenting the architectural and environmental value of buildings and urban environments. It helps prioritize preservation efforts and supports local planning decisions by identifying buildings worthy of protection.	historical buildings	7, 10.4-10.5	Local governments, urban planners, conservation professionals, and heritage organizations	Available open acces	*Provides a standardized, transparent evaluation method. *Supports integration of heritage conservation in urban planning. *Helps prioritize limited resources for the most valuable assets. *Encourages community engagement in heritage preservation.	*Limited in-depth analysis for individual buildings, focusing more on broader urban and environmental contexts. *Resource-intensive for large-scale surveys. *Relies on subjective scoring, which may vary between evaluators.
Fiche d'etat sanitaire du patrimoine **Year: /** **Organisation:** Agence Wallone du Patrimoine (AWaP) **Country:** Belgium **Link:** https://agencewallonnedupatrimoine.be/restauration/	Contains a survey focused on assesing thecondition of the heritage value of a building. This survey is to be used once it is esthablished that there are heritage values present. The survey does distinct different building elements and does asses their condition through awarding them an urgency score.	historical buildings	7, 10.4-10.5	Heritage managers and heritage authorities	Not publicly available, tool used for internal activities within AWaP	*Gives a structured layout of determining the heirtage condition * Allows to esthablish the condition in a structured and holistic way	* Is soley focused on determining the heritage condition * Does not asses heritage value * Requires in depth knowledge of heritage values * Exclusively focused on materialistic elements
DoMu Monumental score **Year:** **Organisation:** NIBE **Country:** The Netherlands **Link:** https://www.dumoprestatie.nl/	Developped by NIBE, the Domu score is used to asses the combination of heritage value and sustianability for heritage buildings. To be able to genrate a DoMu score, first a monumental score has to be assesed. The monumental score in this context is esthablished by using a specific template. The heritage value of the building is here divided in four categories, each concisting of serveral subcategories. Within each catgory a score has to be awarded, with an on forehand decided maximum score for each category. By adding up the scores from the different categories, a Monumental score is generated.	Monumental buildings	7, 10.4-10.5	Heritage consultants	Publicly available	* Combines qualitative qith quantitative analysis	* Requires an qualified evaluator * Is mainly focsed on listed buildings * Priosritises the historic fabric
Value Assesment Tool (VAT) **Year:** 2017 **Organisation:** MedINA **Country:** Greece **Link:** https://increate.med-ina.org/static/assets/uploads/share/Step3-tools/INCREAte-VAT-manual-v-1-0.pdf	Tool focused on assesing both natural and cultural heirtage values. The tool is structured acoording to two tables. The first table, the record and justification of values table, focuses on the recording of diverse values of individual natural and cultural assets. By doing so, it uses a given set of values categories as a framwork to be able to justify each value and asset. The second table, the overall record and assesment of assets and values table, is aimed at listing values that stand out form the rest. These values should be numbered acoording a simple sytem to eb able to prioritise the assets.	Natural and cultural heritage	7, 10.4-10.5	Experts form the heritage sector	Publicly available	* Integrates cultural heritage in its natural context * Easy to use paper template	* Misses in-depth assesment on building level * Focussed on the mediteranian area

Heritage assessment

Name and identification	Description					Advantages	Limitations
	Function	*Focus*	*Steps in the process*	*Target Group*	*Availability*		
ARCHES PROJECT **Year:** 2013 **Organisation:** Getty Conservation Institute (GCI) and the World Monuments Fund (WMF). **Country:** USA **Link:** https://www.archesproject.org/	The Arches Project is a heritage inventory and management system that allows users to collect, store, and analyze data about cultural heritage sites. It combines geospatial and relational database technology to map and describe heritage assets comprehensively.	Heritage Documentation Data Sharing Decision Support	7, 10.4-10.5	Heritage organizations (governmental and non-governmental). Urban planners and policymakers. Academics and researchers in cultural heritage. Community groups and citizen scientists	Free to download and use (open-source model).	*Open-Source and Customizable *Standards-Based *Geospatial Integration *Scalable and Flexible *Community Support (shared resources and knowledge)	*Technical Expertise Required *Resource Intensive for Setup *Not complete and ready to operate
P-Renewal **Year:** / **Organisation:** UC Louvain **Country:** Belgium **Link:** https://www.p-renewal.be/	The P-Renewal project aims at supporting the assesment of building heirtage value. It considers eleven interests that should be considered as "seperate and complemantary" analytical tools focusing on different building characteristics. These are to be matched with four indicators of quality. For all the selected interests the heirtage value is assed against these four criteria. To be able to math the interests with the four indicators a summary table can be used.	Built heritage	7, 10.4-10.5		Available open access	* Provides a comprhensive table * Does match interests with indicators * Focus on building element level	* Does not take in consideration immaterial values * Does not work with a rating system

Financial tools

Name and identification	Description						Advantages	Limitations
	Function	*Focus*	*Steps in the process*	*Repository or DSS*	*Target Group*	*Availability*		
RETScreen (Renewable Energy and Energy Efficiency Software) **Year:** 2016 **Organisation:** Natural Resources Canada (NRCan) **Country:** Canada **Link:** https://natural-resources.canada.ca/science-data/science-research/data-analysis/geospatial-data-portals-tools-services/retscreen	It is a clean energy management software platform used to analyze the viability and performance of renewable energy, energy efficiency, and cogeneration projects. It helps users assess technical and financial feasibility, monitor ongoing performance, and plan for greenhouse gas (GHG) emission reductions.	The tool focuses on providing decision-makers with data and analysis to improve energy efficiency, reduce costs, and lower carbon footprints.	10	DSS	Energy consultants Facility managers Policy makers Project developers Government and non-governmental organizations Financial institutions evaluating clean energy investments	subscription model, approximately $500 per year	*Supports a wide variety of energy efficiency and renewable energy projects. *Provides a wealth of built-in resources (climate data, technology costs, etc.), reducing the need for external tools. *Flexible and applicable across different project scales and sectors. *Easy to use with a well-organized interface and customizable reporting options. *Enables GHG emissions tracking, aligning with sustainability goals. *Cost-effective, especially compared to more specialized tools.	*Requires training or familiarity to fully utilize advanced features. *May not offer the same depth of analysis as specialized tools for specific energy systems (e.g., HVAC modeling). *Annual subscription fee might deter smaller organizations or individuals. *Primarily designed for economic feasibility rather than detailed design simulations.
LCCbyg **Organisation:** BUILD **Country:** Denmark **Link:** lccbyg.dk	LCCbyg is a tool that calculates life-cycle costs for either an entire building or individual building components. It helps decision-makers compare two or more alternatives that have different cost profiles over time. The tool combines Life Cycle Cost (LCC) and Life Cycle Assessment (LCA) calculations, and includes functions for qualitative criteria assessment, providing a comprehensive basis for sustainable building decisions.	Life Cycle Costing, CO2 shadowprices, Netpresent Value, Total cost of ownership	10	DSS	Professional users: advisors/designers, Building owners, Town planners	Forever free. Files and data saved in an Open standard format	* Combines both financial life-cycle cost analysis and environmental impact assessment (CO2 emissions) in a single tool * Calculates shadow prices for carbon emissions, helping quantify environmental costs in economic terms * Automates complex life-cycle calculations with built-in standard values and parameters, making it accessible for regular use in construction planning * Enables systematic comparison between different solutions considering both economic and environmental impacts over time * Allows customization of parameters and calculations to suit specific project needs while maintaining standardized comparison formats	* Requires initial time investment to understand both the financial and environmental assessment parameters * Current library primarily focused on Danish market conditions and standards.

Energy assesment

Name and identification	Description						Advantages	Limitations
	Function	*Focus*	*Steps in the process*	*Repository or DSS*	*Target Group*	*Availability*		
Passive Housing Planning Package **Year:** 1998 **Country:** United Kingdom **Organisation:** Passive House Institute **Link:** https://passivehouse.com/04_phpp/04_phpp.htm	The PHPP is an easy to use planning tool for energy efficiency for the use of architects and planning experts. The reliability of the calculation results and ease of use of this planning tool has already been experienced by several thousand users The PHPP based on Excel was introduced for the first time in 1998 and has been continually further developed ever since. Calculation sheets for space heating balances (annual and monthly methods), and for heat distribution and supply as well as for the electricity and primary energy demand, constitute the main features of this tool. Essential modules were successively supplemented for the practical planning of energy efficiency projects throughout the world, including the calculation of characteristic values of windows, shading, heating load and summer behaviour, cooling and dehumidification demand, ventilation for large objects and non-residential buildings, taking into account of renewable energy sources, and EnerPHit certification (retrofitting of existing buildings). The PHPP is continually being validated and extended on the basis of measured values and new research findings.	General building stock	7, 10.5-10.7	Repository	Not clear	Templates need to be bought: €240	*Allows to do specific calculations *Excel inetgration * Is continously updated	*Advanced technical kowledge is required *Serves mostly as calculation tool *Lacks focus on historic buidling stock
Minoro **Year:** 2024 **Country:** United Kingdom **Organisation: Grimshaw** WBCSD **Link:** https://www.minoro.org/	Minoro is an online web-base d toool that guides the user through implementing carbon reduction in the built environment. The tool is structured in different steps to identify key actions and responsibilities at different stages of the process. The tool touches upon different carbon measurements strategies, including energy retrofits, user and optimilising operational systems.	General building stock	7, 10.5-10.7	Repository	Architects, engineers and planners	Avialble open acces as web resource	* Gives detailed overview of the steps to be take in the carbon mangement process * Easy to use and widely accesibale interface * Includes a broader approach to sustainable development	* Does have a broader focus than energy retrofits only * Does not use an input or produce circumsized solutions
IsZEB certify **Year:** 2020 **Country:** Greece **Organisation:** IsZEB **Link:** https://iszeb.gr/iszeb-certify	Developed in Greece as part of an EU funded project, under the flag of IsZEB. The tool conscists of three components: 1. Buidlings's Energy Performance assesements and Energy Perfromance Certificates (EPCs) issuance. 2. Buildings' Smartness Readiness assesments and Smartness Readiness Indicator (SRI) Certificates issuance. 3. Buildings' holistic evaluation and certification based on the IsZEB Standard within various tecjnical levels.	General building stock	7, 10.5-10.7	Repository	Retrofit professionals (not entirely clear)	Software package need to be bought	* Easy to use interface * Possibility for BIM integration * Can generate technical reports * Includes Smart readiness indicator	* Mainly focused on greek stadards (although integration with european standards is possible as well) * Focus on certification * Not yet fully avaialble (under development)
IESVE **Year:** 1994. **Organization:** Integrated Environmental Solutions (IES) **Country:** United Kingdom **Link:** https://www.iesve.com/software/virtual-environment	A comprehensive building performance simulation software designed to predict and optimize energy use, comfort, and sustainability in buildings throughout their lifecycle. It supports building modeling for energy efficiency, carbon reduction, and compliance with green building standards.	energy performance	7, 10.5-10.7	Repository	Architects, engineers, contractors, facility managers, and researchers focusing on sustainable design and building operation.	Pricing depends on the selected modules and license type (e.g., subscription or perpetual). Training and support are available but may incur additional costs.	*Comprehensive integration of various building performance simulations on one platform. *Real-time feedback on design decisions. *Compatible with multiple global green certifications like LEED and BREEAM. *Supports electrification and decarbonization efforts.	*High computational requirements *Steep learning curve for beginners
Autodesk Green Building Studio (GBS) **Year:** 2010s **Organization:** Autodesk Inc. **Country:** United States (headquartered in San Rafael, California) Link: **https://gbs.autodesk.com/gbs**	Web-based building performance simulation software designed to assist architects, engineers, and designers in creating energy-efficient and sustainable buildings. It performs energy modeling and carbon analysis to optimize design decisions	energy performance	7, 10.5-10.7	Repository	architects, engineers, and sustainability consultants involved in green building design and certification processes.	part of Autodesk's subscription model	* Works with Autodesk Revit and other BIM tools, enabling easy data flow. * Reduces the computational load on local machines by running simulations on Autodesk's servers. * Provides comprehensive energy, water, and carbon data for decision-making. * Facilitates compliance with green building standards and certifications such as LEED.	* Requires an ongoing Autodesk subscription, which can be costly for small firms. * Users need training or experience with Autodesk tools for effective use. * Requires a stable internet connection for simulations and accessing data.
VABI **Year:** 1972 **Organization:** Initially part of a government initiative, it is now operated by Vitec Software Group, which acquired it in 2021. **Country:** Netherlands **Link:** https://www.vabi.nl/about-vabi/	Provides tools to support sustainable energy management, building simulation, energy certification, and advisory services for real estate and property management	energy performance	7, 10.5-10.7	DSS	Building owners, managers, engineers, and consultants, primarily in the Netherlands but with broader applications globally.	Pricing varies based on specific modules and services	*Supports compliance with energy certifications and standards (e.g., EPC, DEC). *Detailed simulations help optimize building energy use. *User-friendly interface with options for advanced geometry and HVAC modeling. *Aligns with sustainability goals and offers a robust tool for property managers	*Primarily designed for the Dutch market; customization may be needed elsewhere. *Requires skilled users to interpret outputs effectively. For further details, you can explore VABI's official website or related resources on energy management software.
HERB **Year:** / **Country:** / **Organisation:** C40 **Link:** https://www.c40knowledgehub.org/s/article/Healthy-and-Efficient-Retrofitted-Buildings-Tool-HERB?language=en_US	The Healthy and Efficient Retrofitted Buildings Tool (HERB) supports the user in the process of using evidence to make compalling cases for building retrofits. The tool can be used universally and can be applied to a single buildings as well as a group of multiple buildings and larger urban areas. It covers healt benefits, socio-economic benefits and climate an polution benefits. The tool concists of an excelsheet and comes with a supporting technical manual tool. By filling in the data ragrding the retrofits project, the template calculates the benefits that the retrofit potentially can provide.	General building stock (mostly on area level)	7, 10.5-10.7	DSS	Cities and municipalities	Available open access	* Driven by a strong cooperation between different actors that plan to keep the tool updated. * Easy to use. * Can be used offline. * Does also inlcude social benefits.	* Mainly focused on area and city scale (although it also can be used for single buildings. * To large extent reliant on the consequent updating of the multipliers. * Does only calcualte benefits.
Crave Zero **Year:** 2020 **Country:** Austria **Organisation:** AEE- Institute for sustianable technologies **Link:** https://cravezero.eu/	CraveZero aims to reduce costs and improve net zero buildings under the different stages of its lifecylce by focusing on both new and proven approaches. The main aim is to gett rid of extra costs due to inefficencies in the process and different forms of technology while at the same time stimualting innovative business models. The cost-effectivenes of all stakeholders are taken into account. CraveZero aims to do this by presenting an organsied and transperant indertdisciplinary process. It takes both environmental and economic aspects into consideration while searching for enegry saving potential. This has lead to the development of differnet forms of guidleines and process discriptions that can be used. On top of this the CraevZero pinboard was developped to provide an interactive web-based structured framework that organises all the required information and different tools that can be used.	Net zero buildings	7, 10.5-10.7	DSS	Architects, engineers, energy retrofit experts	Available open access	* Does cover different phases of the lifecycle * Includes both economic and envirnometal considerations in in terms of energy saving * Easy accesible web platform	* Pinboard is only available in BETA version * Does not have a focus on historic buildings * Requires a high level of expertise within energy retrofits and life cycles

Energy assesment

Name and identification	Description						Advantages	Limitations
	Function	*Focus*	*Steps in the process*	*Repository or DSS*	*Target Group*	*Availability*		
Ubakus **Year:** 2009 **Organisation:** Private person **Country:** Gemrany **Link:** https://www.ubakus.de	This webtool is aimed to calclate U-values when differnent laters of buildings materials are combined. An input is required where you enter the mateiral and the mm. A u-value for thes emateirals is the generated as wel as a life cycle, moisture and heta analysys in relation to the selected materials. The rool include graphic depictions to clarify the results and to make it more user-friendly. It both includes an option for new buildings as well as an option for refurbishments.	Building components	7, 10.5-10.7	Repository	Architect, engineers	Both free and paid versions	* Easy to use * Contains a large inventory from differnet buildings materials to pick from, includinge many traditional materials * Available in different languages, among them German, English, French and Dutch * Not much expertise needed for use * Specifically focused at historic buildings	* For more advanced use a paid version is required (free access for education pruposes * Results are not as exact

Life cycle tools

Name/product and identification	Type	Description	Advantages	Limitations
One Click LCA **Country:** United Kingdom **Year:** / **Organisation:** One Click LCA **Link:** https://oneclicklca.com/	Software	One-click-LCA is an easy-to-use software for the compilation of information and analysis of results facilitating the integration of sustainability aspects in the decision making process. It is a cloud-based software for conducting LCA (Life Cycle Assessment) and LCC (Life Cycle Costing) analyses, with data stored, managed, and accessible via the internet. One Click LCA contains generic LCA data, and based on product-specific Environmental Product Declarations (EPDs), it provides access to most LCA databases worldwide. It is compatible with the majority of tools used in building design, such as Revit.	*Integration with BIM and other tools and compliant with over 80 global and regional certification systems. * Can be used throughout all project phases. * AI-powered * Powered by the world's largest consturction production database * Includes several differentiating tools	* No specific focus on historic buildings * Expensive tool * Requires a high level of expertise
Renobuild **Country:** Sweden **Year:** 2017 **Organisation:** RISE **Link:** https://renobuild.se/	Excel and a userguide	A tools for evaluating sustainability in renovation. It supports decision-making by comparing the effects of alternative renovation scenarios in economic, environmental, and social terms. The tool is generally most suitable for use early in the planning process of a renovation project. It can be used to evaluate widely different options, such as only addressing the most necessary repairs versus implementing energy efficiency measures like additional insulation and/or upgrading the ventilation system, or even undertaking a major reconstruction. The results can be used as a basis for discussions and decisions on which actions to proceed with. It is also possible to perform an initial rough evaluation to eliminate some options before seeking more detailed information on the remaining alternatives for a more refined assessment. The results illustrate the long-term sustainability of the different alternatives in relation to each other. The primary outcome of the economic analysis is the life cycle cost, indicating the expected cost over a selected life cycle period. However, the evaluation also provides insights into the distribution of costs across investment, reinvestment, and annual operating expenses. The environmental analysis can highlight the environmental impacts of reduced energy use or changes in energy sources but also includes the effects of the materials used in the renovation, i.e., environmental impact from a life cycle perspective.		* Only in Swedish. Was latest updated in 2018
Building circular hotspots **Country:** United Kingdom **Year:** / **Organisation:** Circular Buildings Coalition **Link:** https://www.circularbuildingscoalition.org/hotspots	Online platform	The Building circular hotspots tool is an online platform that gathers succesfull examples of circular economy practices within the built environment. All examples are areas demonstrating a high concentration of circular economy activities. The database provides case spanning buildings , policies and business models.	*Available open access *Large datbas eof best practices	* Still under devlopment (only BETA version avialable * Gives only examples, does not actively support the decision making process
LCAbyg **Country:** Denmark **Year:** / **Organisation:** BUILD **Link:** https://lcabyg.dk/en/download/	Software	LCAbyg is developed by BUILD on Aalborg University as a free software to facilitate LCA calculations when the regulation of whole life carbon in new buildings was introduced in 2021. The tool calculates CO2 emissions in a whole life span based on the danish regulation and danish energy emission factors. It can be used both for early decision phase and for final LCA reporting, depending on the level of precision provided by the user.	* Open access * Big database of building parts and material, and possibility import further EPDs * Follows LCA standard * Is maintained and updated regularly	* In danish * not developed for retrofits (a calculation of retrofit with LCAbyg is possible, but require one to make assumptions for calculation, eg which contruction parts to include) * Moderately user friendly
Kvikberegneren **Country:** Denmark **Year:** / **Organisation:** ERIK **Link:** Contact Signe for access to the tool	Excel sheet	Tool developed by ERIK for a danish housing association. The user provides simple information about the building, and the tool calculates CO2 and economy based on simple assumptions. The tool is designed for early decision phase.	* quite user friendly and easy to use * Gives quick estimates based on simple user inputs * Provides estimation of both CO2 and economy	* Only rough estimations * Not open access. We can probably share internally in FH, as it is developed by ERIK.
Arkitektens CO2 kompas **Country:** Denmark **Year:** / **Organisation:** Danske Arkitektvirksomheder **Link:** https://www.danskeark.dk/page/arkitektens-co2-kompas	Online platform	This tool provides a rough CO2 calculation based on very simple assumptions. The user can choose typologies and "strategy" for material choice, and later change and compare choises on a more detailed level. The tool is not made for official LCA reporting, but provides input for designer to support decision making in early phase.	* open access, free to use * easy to use, and user friendly graphics and overview * simple typologies and simple decision tree that might serve as inspiration for Futurhist	* Probably not being updated * developed for new buildings * in danish
Materialepyramiden **Country:** Denmark **Year:** / **Organisation:** Royal Danish Academy **Link: https://materialepyramiden.dk/**	Online platform	The Pyramid is developed by CINARK on the School of Architecture in Copenhagen. It iwas an attempt to generate focus on embodied carbon and differences between materials in regards to climate impact, and was launched while the dicussion of embodied/whole life carbon had not yet turned into regulation in Denmark. The pyramid does not provide input on a building level, but allows the user to get an overview of impacts on climate from common construction materials and compare materials within different groups. The user can either just gain inspiration of the pyramid as it is, or go into slightly more detail within certain materials. The pyramid's shape refer to the known "food-pyramid", and as for this earlier version, it encourages the user to "use less from the top and most from the bottom". Materialepyramiden is probably more a tool designed for creating debate and awareness than a serious tool for professional users, but it does however provide input and calculations of the embodied carbon in materials.	* Open and free access * user friendly graphics and clear&simple guidance * still being updated	* probably too simple in regards to FuturHist needs * Only covers phase A1-A3 * In danish

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FuturHist

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

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