FuturHist

Conservation compatible passive retrofit solutions

Project Overview

Principal Authors
Marianna Muchorowska (UIBK), Alexandra Troi (EURAC)

Contributing authors
Daniel Herrera-Avellanosa, Federico Trentin, Elena Poma (EURAC), Michele Bianchi Janetti (UIBK), Ernst Jan de Place Hansen, Nickolaj Feldt Jensen (AAU), Yann Grandgirard (EWH), Kinga Racoń-Leja, Filip Suchoń, Krzysztof Barnaś (PK), Stefan Möller (HOMA)

Internal reviewers
Marzena Nowak-Ocłoń (PK), Tomasz Jeleński (PK)

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Executive Summary

This report presents a compilation of passive retrofit solutions that can be applied to historic buildings subjected to conservation requirements. The aim is to gather the most common strategies and provide a general overview of their key characteristics, enabling a meaningful comparison and supporting the selection of the most appropriate solutions for different building contexts. Each solution is assessed based on a set of parameters, including general information, technical specifications, and aspects related to sustainability and lifecycle performance. The collected solutions are presented in summary tables within this report, while an Excel version is available in the annex to facilitate filtering and sorting. In total, the report includes 80 insulation retrofit solutions and 76 window retrofit variants.

In addition, an assessment of collected retrofit solutions was made for each building typology defined in Deliverable 1.2. This selection was carried out through a collaborative workshop with project partners from FuturHist. The choice of solutions was based on several criteria, including building construction characteristics, local regulations, and regional retrofit approaches. The outcome of this process is a list identifying retrofit solutions that are most appropriate for the specific needs and constraints of each typology.

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Disclaimer

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Abbreviations and definitions

Box-type window	Also called double window: two windows with an air space in between which are opened separately, one after the other
Building envelope	The "skin" of a building, consisting of exterior facing walls, roof, windows, and lower floor slab.
Building typology	A set of buildings with common properties (e.g., age of construction, geometry, thermo-physical properties, and energy performance) (IEE Project TABULA, 2012).
Coupled window	Consists of two window layers connected by a wide wooden frame. To open the window they are moved together – but the two layers can also be opened up for cleaning.
Demonstrator building	A real building belonging to a typology which is used to demonstrate retrofitting solutions (also referred to as "demo case" - DC).
Embodied energy	Embodied energy is the energy consumed by all of the processes associated with the production of a building, from the mining and processing of natural resources to manufacturing, transport and product delivery. embodied energy does not include the operation and disposal of the building material.
Energy consumption for heating and cooling	Energy input required to satisfy the heating and cooling demand of a building. This quantity considers also efficiency and losses of systems and user behaviour (Hotmaps, 2020).
Energy demand for heating and cooling	Calculated amount of energy required to cover heating and cooling of a building (Hotmaps, 2020).
Energy retrofit	A general concept for all types of renovations where reduced energy consumption is the main goal for the renovation (Eriksson, 2021). It is used for the entire renovation process, from planning to evaluation, and is closely related to sustainable renovation (Thuvander et al., 2012). Sustainable renovation of existing buildings is a way of extending the lifespan of a building and improving its living and working conditions, which includes lowering the energy used for those purposes (Asdrubali and Desideri, 2018, chapter 9).
EU	European Union
g-value	The g-value measures the transmittance of solar gain through glazing and windows – how much heat is transmitted through glass from the sun's rays
Heritage value	Aspect of importance that individuals or society assign(s) to a building (EN 16883:2017). Note 1 to entry: Heritage values can be of aesthetic, historic, scientific, cultural, social or spiritual nature. These types of heritage values include various aspects, for example: architectural, artistic, economic,

	symbolic, technological, use, etc. Note 2 to entry: The heritage assigned value can change according to circumstance, e.g., how the judgement is made, the context and the moment in time. Value should always be indicated by its qualifying type.
HiBERatlas	Historic Building Energy Retrofit Atlas
Historic building (HB)	Building of heritage significance (EN 16883:2011) Note 1 to entry: A historic building does not necessarily have to be statutorily designated as cultural heritage. Note 2 to entry: Historic buildings are a specific form of objects, as defined in EN 15898:2011, 3.1.3.
HVAC	Heating, ventilation, and air conditioning
Low-e glazing	Glazing with a coating with low emissivity, the glass will thus emit less radiation, the energy factor at the surface is higher.
R-value	Thermal resistance factor – the reciprocal of the U-value
U-value	Thermal transmittance value, i.e., the rate of transfer of heat through a structure
WP	Work Package
WWR	Window-to-wall ratio
ψ	Linear Thermal Transmittance measured in W/mK, i.e. the rate of heat transfer through a thermal bridge in addition to the heat losse described by the U-value

1. Introduction

1.1. Background

FuturHist addresses a major challenge in Europe's path to climate neutrality: the energy retrofitting of historic buildings. Representing a significant share of the European building stock, many of these buildings remain in active use as homes, offices, cultural institutions, and public facilities. Despite their cultural and architectural value, they often have poor energy performance due to outdated construction and limited thermal efficiency. FuturHist aims to demonstrate that energy efficiency and heritage preservation are not mutually exclusive but can be successfully combined through the application of well-adapted retrofit strategies.

Reducing the energy demand of historic buildings can be approached from two complementary directions. On one hand, improvements to passive systems—such as better insulation of the building envelope, including walls, roofs, basements, and windows—can significantly reduce heat loss and improve indoor comfort. On the other hand, optimising active systems such as heating, ventilation, and air conditioning (HVAC) can further enhance energy performance, particularly when these systems are designed to work efficiently within the constraints of heritage buildings.

The principal goal of FuturHist is to facilitate the mass renovation of historic buildings across Europe, regardless of whether they fall under strict conservation regulations or not. While there are already many examples of successful retrofitting projects in historic buildings, these are often site-specific and rely heavily on expert knowledge and bespoke solutions. This makes it difficult to scale such interventions or to develop broadly applicable guidelines. FuturHist addresses this challenge by developing a methodology based on building typologies—groups of buildings that share common features such as construction period, climatic conditions, size, and architectural geometry.

By focusing on typologies, the project aims to create tailored intervention strategies that can be applied more systematically, on a larger scale, while still respecting the unique character of each building. This typology-based approach makes it possible to recommend retrofit solutions that are both effective and compatible with heritage values, thus bridging the gap between energy performance and conservation.

Ultimately, FuturHist contributes to the broader goal of the sustainable transformation of Europe’s existing building stock. Its outcomes are designed to support practitioners—such as architects, engineers, and building owners—as well as policymakers, including planners and heritage authorities, in making informed decisions about energy retrofits. Researchers will also benefit from the databases and tools made available by the project to facilitate effective and sensitive renovation strategies for historic buildings across Europe.

1.2. Objectives

The objectives of Task 2.1 are to review, identify and assess existing solutions for the retrofit of the building envelope, focusing on measures that are already in use and compatible with historic buildings. This includes insulation solutions specifically for walls, roofs, floors, basements and foundations, as well as windows. The task aims to create a comprehensive database of such solutions, which will serve as a foundation for the following phases of FuturHist. Additionally, a comparative analysis of the collected solutions is conducted, assessing their suitability and performance. Finally, the identified solutions are evaluated in relation to the building typologies defined earlier in Task 1.2 of FuturHist, ensuring their relevance to specific architectural and regional contexts.

1.3. Organization of this report

This report is structured as follows: Chapter 2 outlines the methodology used to select and parameterise the various retrofit solutions. Different approaches were taken for assessing insulation systems and windows, which are described using different sets of parameters. Chapter 3 presents the analysis of results, while the full list of collected solutions along with their parameters is included in the Annex. Chapter 4 explores the potential applications and limitations of these solutions in relation to the building typologies defined in Task 1.2 of FuturHist. Finally, Chapter 5 reports conclusions and an outlook for future work.

2. Methodology

2.1 Selection of solutions

Solutions and their parameters were primarily sourced from existing demonstration cases compiled in European research projects:

- **ATLAS.** *Advanced Tools for Low-carbon, high-value development of historic architecture in the Alpine Space* (2014-2020), with an online database HiBERatlas - Historic Building Energy Retrofit Atlas
- **3ENCULT Project.** *Efficient Energy for EU Cultural Heritage* (2007-2013)
- **RIBuild.** *Robust Internal Thermal Insulation of Historic Buildings* (2015-2020)

Additional most common solutions were gathered from various sources, including journal articles, books, reports, and online platforms. Technical data on insulation materials was obtained from manufacturers' databases, such as technical specifications and Environmental Product Declarations (EPD). Specific sources are referenced in the Excel table.

The selection of solutions focused on commonly used systems, with existing buildings from the sources chosen for review. Consequently, the solutions presented do not cover every possible system, but rather a selection of the most widely applied ones.

The solutions are categorized into five groups:

- Internal wall insulation
- External wall insulation
- Roof insulation
- Basement and foundation insulation
- Windows’ retrofitting

While insulation systems are described in a consistent manner as reported in Section 2.2, a different approach is adopted to assess windows’ retrofit solutions, as detailed below in Section 2.3.

2.2 Selection and definition of parameters for insulation systems

The choice of parameters used to describe insulation systems resulted from discussions among partners working on Task 2.1. The primary aim was to provide a general characterization of each solution, regardless of the specific building in which the system was used (if taken from an existing building). This approach ensures that the data collected in Task 2.1 can be applied to other buildings as well.

Each insulation system was categorized using the parameters listed in Table 1. Parameters specific to certain solution groups (e.g., *internal wall insulation, external wall insulation, roof insulation, basement and foundation insulation*) were marked accordingly.

Each solution was placed into one category based on the main insulation material:

- Mineral wool-based (e.g., rock/stone wool, glass wool)
- Mineral board-based (e.g., calcium silicate, perlite, Multipor)
- Oil-based polymers (e.g., Expanded Polystyrene [EPS], Extruded Polystyrene [XPS], polyurethane [PUR], polyisocyanurate [PIR])
- Biobased materials (e.g., wood fibre, hemp fibre, cellulose, sheep wool, cork)
- Insulation plasters
- Other materials (e.g., Vacuum Insulation Panels, aerogel, foam glass)

Whenever possible, an example of the application and the potential supplier of the solution or insulation was noted. Additionally, the technical specifications for each solution were described, including system thicknesses and thermal conductivity values based on the analysed sources. It is important to note that other materials with different values may exist, but the focus was on common and reasonable values or ranges. The final value must be estimated for each individual system once the exact elements are selected.

The average thermal conductivity is determined by dividing the system thickness by its thermal resistance. It can be calculated only for existing retrofit examples, where the exact construction of a new insulation system is known. In cases where calculating the average thermal conductivity was not possible due to insufficient information about system components, the thermal conductivity of the insulation material was provided in ranges.

Fire protection class was described according to EN 13501-1, based on data for the systems or insulation materials. All fire classes found in the sources were listed.

Further details were provided on the sustainability and lifecycle of the solutions. Information was included on whether the materials are based on natural, biobased materials, such as those derived from plants and other renewable sources. Some systems categorized as biobased may include materials that are not fully biobased due to additional components, while others categorized as "Other" or "Insulation plasters" may have some biobased content.

The embodied energy of the main insulation materials was estimated based on available Environmental Product Declarations (EPDs) for representative materials. Embodied energy was calculated as the sum of ‘Total use of renewable primary energy resources’ (PERT) and ‘Total use of non-renewable primary energy resources’ (PERNT), with the values covering the product life cycle stages A1-A3, packaging (A5), and end-of-life stages (C1-C4). Transportation (Module A4) was excluded because it depends on the construction site. Life Cycle D, which accounts for reuse, recovery, and recycling potential, was also excluded. The embodied energy values were expressed in MJ/kg to allow comparisons across materials with different properties.

The average lifetime and recyclability of the insulation materials were also derived from EPDs, describing the parameters of the primary insulation materials. The properties of additional layers, such as finishes or renders, were described in general terms, making it difficult to estimate their exact properties.

Additional information included whether the solution could be prefabricated. It could be fully prefabricated (requiring only installation on-site), require on-site installation layer by layer, or involve parts that can be pre-prepared and mounted on-site.

Information on whether the solution is reversible was also considered. Reversibility means that the original construction is not damaged (e.g., by cutting or drilling). In some cases, the reversibility of a solution depends on the installation approach.

Lastly, the cost of each solution was estimated in a similar way to embodied energy. The exemplary price of the main insulation material was gathered and recalculated to €/m2. The cost for each solution within a group was compared and classified on a scale of low-medium-high.

For *Internal wall insulation*, two additional parameters were added. The system type specifies whether the system is vapour-tight or vapour-open, reflecting the movement of vapour. Vapour-tight systems were further divided into those that are vapour-tight due to the insulation material itself or those that are vapour-open but include a vapour barrier (or vapour retarder). Similarly, vapour-open systems were categorized as vapour-open due to capillary activity or due to high diffusion resistance. The second additional parameter for internal wall insulation was capillary activity, classified as highly, moderately or not active.

For *Roof insulation*, additional parameters were introduced to better describe the system. The system type specifies the position of the structural construction in relation to the insulation. In a cold roof, the insulation is placed beneath the roof, leaving the main structure exposed to external temperature variations. In a warm roof, the insulation is applied on the exterior of the main structural construction. Another option is the attic space, where insulation is applied below the roof construction, either on the attic floor or below the attic ceiling. Furthermore, an additional parameter was added to describe the application layer of the insulation system in the roof. The insulation can be applied above the existing construction, below the existing construction, or between the roof rafters, depending on the design and the specific requirements of the roof insulation solution.

For *Basement and foundation insulation*, an additional parameter regarding the application was introduced. These solutions include *external insulation* of the foundation (vertical), which is derived from external wall insulation and can be applied either underground or above ground level. In cases where the floor is on the ground, there is no possibility to access the floor from below the floor slab, so the insulation is applied directly on top of the floor. For internal floor insulation, new layers are added above the existing floor to enhance thermal protection. Internal ceiling insulation involves adding new layers of insulation below the existing ceiling or within the existing ceiling structure, such as between wood joints. This approach provides a more detailed classification of basement and foundation insulation based on their specific applications.

For many parameters, the exact information depends on the specific materials chosen for each layer of the solution, which may vary from the values presented in this report. However, the properties provided here allow for comparison of different solutions at the planning stage, when exact data may not yet be available.

Table 1. Defining parameters to describe insulation systems in Task 2.1.

Type	Nr	Parameter	Definition of the Parameter
General Information	1	Solution name	*Description*
	2	Category	*Single choice:* • *Mineral wool based* • *Mineral board based* • *Oil based polymers* • *Biobased* • *Insulation plasters* • *Other*
	3	Example of application	*Link to existing retrofitted building*
	4	Possible supplier	*Names of producers of systems/insulation materials*
Technical Specifications	5	Composition (from inside to outside)	*General description of composition from inside to outside*
	6	System thickness	*Possible range in mm*
	7	Av. thermal conductivity	*Possible range in W/mK*
	8	Thermal conductivity of ins. layer	*Possible range in W/mK*
	9	Fire protection class	*Based on EN 13501-1*
	10	System type (1)	*Only for Internal wall insulation* *Single choice:* • *Vapour-tight (ins. material)* • *Vapour-tight (vapour barrier)* • *Vapour-open (capillary active)* • *Vapour-open (high diff. resistance)*
	11	System type (2)	*Only for Roof insulation* *Single choice:* • *Cold roof* • *Warm roof* • *Attic space*
	12	Capillary active	*Only for Internal wall insulation* *Single choice:* • *Yes (highly)* • *Yes (moderately)* • *No*
	13	Application (1)	*Only for Roof insulation* *Single choice:* • *Above existing construction* • *Below existing construction* • *Between roof rafters*
	14	Application (2)	*Only for Basement and foundation insulation* *Multiple choice:* • *Floor on ground* • *Floor above basement* • *Basement ceiling* • *External wall insulation*
	15	Roof type	*Only for Roof insulation* *Multiple choice:* • *Flat roof* • *Pitched roof* • *Attic floor/ceiling*

Sustainability and Lifecycle	16	Based on natural materials	*Single choice:* • *Yes* • *No* • *Partially*
	17	Embodied energy	*Single choice:* • *< 25 MJ/kg* • *> 25, <50 MJ/kg* • *> 50 MJ/kg*
	18	Average lifetime	*Range in years*
	19	Recyclability	*Description of recyclability options*
	20	Prefabricated solution	*Single choice:* • *Yes* • *No* • *Partially*
	21	Reversible system	*Multiple choice:* • *Yes* • *No* • *Depends on installation*
	22	Installation	*Description of the installation process*
	23	Cost	*Single choice:* • *Low (€)* • *Medium (€€)* • *High (€€€)*

2.3 Selection and definition of parameters for window retrofit

The choice of parameters used to describe window retrofit options resulted from experiences within the IEA SHC Task 59 and discussions among partners working on Task 2.1. The primary aim was to provide a general characterization of each solution, regardless of the specific building in which the system was used (if taken from an existing building). This approach ensures that the data collected in Task 2.1 can be applied to other buildings as well.

The documentation of window retrofit solutions differentiates between

- *type of solution* (i) – in terms of e.g., replacing glazing, adding a layer or replacing the whole window (see Table 2)
- *type of product* (ii) which is used for this solution – in terms of e.g., coated single glazing, thin double glazing, minimized window (see Table 3).

Table 2. Categorisation for window retrofit solutions according (i) solution type

Solution type (i)	**Label**
Repairing window	*1A*
Inserting a sealing strip	*1B*
Adding foils/coating to the glass	*1C*
Repair or replace lost shutters	*1D*
Replacing inner glazing	*2A*
Adding an additional glass layer on the inside covering the whole window	*2B*
Adding an additional glass layer on the inside	*2C*
Upgrade existing glazing	*2G*
Adding a new window on the inside	*2D*
Replacing the window sashes on the inside	*2E*
Adding solar shading inside	*2F*
Replacing (outer) glazing	*3A*
Adding a new window on the outside	*3B*
Replacing the window sashes on the outside	*3C*
Adding solar shading outside	*3D*
Adding solar shading between window/glazing layers	*3E*
Substitute the window with a replica	*4A*
Substitute the window	*4B*
Add a window	*4C*
Upgrade existing glazing	*UG*
not specified	*XX*

Table 3. Categorisation for window retrofit solutions according (ii) product type

Product type (ii)	**Label**
seal	*a*
softcoating	*b*
glazing	
low-e single glazing	*c*
double glazing	*d*
thin double glazing	*e*
triple glazing	*f*
thin triple glazing	*g*
vacuum glazing	*h*
window	
minimised window with single low-e glazing	*i*
minimised window with single vacuum glazing	*j*
wooden window with single glazing	*k*
wooden window with single low-e glazing	*l*
wooden window with double glazing	*m*
wooden window with triple glazing	*n*
wooden window with thin double glazing	*o*
wooden window with thin triple glazing	*p*
wooden window with vacuum glazing	*q*
wooden coupled window with double insulating glazing	*r*
wooden box-type window with double insulating glazing	*s*
wooden coupled window with thin triple glazing	*t*
wooden box-type window with thin triple glazing	*u*
n.a.	*v*

The reason for this differentiation was that on the one side more products can be used to implement one solution: "replacing the inner glazing" of a box type window can be done with coated single glazing, double glazing, thin double glazing, thin triple glazing or vacuum glazing, each resulting in different energy performance, cost, embodied energy and impact on aesthetics and materials. On the other side, one product can be used to implement more than one solution: thin triple glazing e.g., can be used to replace the inner glazing of box type window, or the only glazing in a single window.

What furthermore influences the energy performance after retrofit as well as the applicability of specific solutions and their aesthetic and material impact is *the starting point*: is it a single window, with single or double glazing? A coupled window? A box type or winter window? Does it have one or more sashes?

Single window	Coupled window	Box-type window	Winter window
...consists of one window plane with single glazing and, like all other window types, can have one or more sashes.	...consists of two adjacent window layers that are directly connected to each other but can be separated for cleaning purposes.	...has two window layers connected by a wide wooden frame (box). The double structure is reflected in the view.	...are a variant of the box-type windows: in winter, an additional window layer is placed on the outside. It can be substituted in summer with a shutter.
Uw-value old: 4,8 W/m²K	**Uw-value old: 2,6 W/m²K**	**Uw-value old: 2,4 W/m²K**	**Uw-value old: 2,4 W/m²K**

Fig. 1 Different starting points for window retrofit (source ATLAS Guideline for the retrofit of historic buildings | windows - https://webassets.eurac.edu/31538/1679039478-windows-web.pdf)

The documented solutions are described specifically for the starting point they are applied to and the product which is applied. This means that e.g., *"replacing the single glazing of the inner layer in a box type window with double glazing"* is different from *"replacing the single glazing of the inner layer in a box type window with vacuum glazing"* which again is different from *"replacing the glazing in a single window with vacuum glazing"*. This because the achievable energy performance, the impact and other parameters differ considerably.

Furthermore, example applications from the literature and the HiBERatlas have been documented in the background and can feed into the determination of typical U-values, areas and frame factors.

For the documentation type "solutions", the U_w value before retrofit is chosen depending on the starting point the solution is applied to, the U_w value after retrofit is determined based on (i) the solution type and (ii) the applied product type following the equations in EN ISO 10077-1: (2) for the calculation of the overall U_w of one window layer, (4) for the calculation of U_w of a box type window and (5) for the calculation of the adapted U_g of a coupled window. U_w of the starting point is the one reported in Fig. 1. In addition to these as a fourth starting point for single window with an old double glazing without gas filling U_w=2.8 W/m²K is considered. In the version of the database presented here, the thermal bridge-value is omitted. Within Task 2.5 more data are collected, so that this will be included in future updates and in a potential calculation tool included in the WP4 toolbox.

For products, the *U-value of the glazing* U_g is reported, together with the *composition* of the glazing from inside to outside: [thickness of glazing 1]–[thickness of intermediate space & material]-[thickness of glazing 2] etc. Thicknesses are reported in mm, coatings are added with the letter e at the right position, the material/gas in the intermediate space is noted with no letter for air, “a” for Argon, “k” for Krypton, “x” for Xenon and “v” for vacuum.

The *U-value for the frame* U_f and the *frame factor f* (defined as the glazed area divided by the total area of the window) and the *material of the frame* are described on product level and for examples.

The *g-value* of products or solutions is estimated based on the number of glass layers and the presence of coatings where applicable. For products, where the g-value is provided by manufacturers, this value is used.

The value for the *thermal bridge of the glass edge* depends mainly on the spacer of the glazing and the frame. Where for the considered examples specific values have been calculated, these have been reported. The change of the *thermal bridge* in the window *installation* is evaluated in a qualitative way: changing from a single window to a box type window, the thermal bridge will be reduced.

The *weight* of the solutions depends mainly on the number and thickness of glass layers and has been estimated for 4mm glazing, unless differently defined. It is added as parameter since it might be a constraining factor especially if the glazing should be replaced in an existing frame, but also in case of sliding windows.

In line with EN 16883 aesthetic, material and spatial impact are assessed. For the description of the *aesthetic impact*, a differentiation has been made between impact (a) from the inside and (b) from the outside and in both cases, it can be pointed out, whether there is impact, but just minor. The *material impact* is described as none, minor, partial or complete loss of original material. For *spatial impact* it is possible to point out, whether the position of the window in the wall (in terms of depth) changes.

Average lifetime and recyclability have been foreseen in the data structure but not yet filled information.

The *embodied energy* is described in a qualitative way ranging from very low to high, based on the kind and quantity of material(s) added and a background calculation based on EPDs for a range of windows, frames and glazing systems. The *cost* was estimated in a similar way as the embodied energy, based on the kind and quantity of material(s) added and the manufacturing/installation time.

As many parameters as possible were kept the same or similar to the parameters chosen for the collection of insulation systems. The *matrix like categorisation* together with the *calculation of the final energy performance* after intervention based on typical values but adaptable to the insertion of specific values was chosen in view of

a) the *tools* and *toolbox* which will be provided in FuturHist (WP4), and can be based on the here implemented calculation method
b) a *continued documentation of solutions* also within Task 2.5 of FuturHist, specifically dedicated to window upgrade
c) providing a *frame for inserting new examples* for implemented solutions during FuturHist and beyond, and thus *refining* the *default values* in a potential tool

To support the systematic documentation and evaluation of window retrofit solutions, a comprehensive set of parameters was defined. These parameters are used to describe each solution in terms of technical performance, material impact, aesthetic compatibility, cost, and sustainability. Table 4 below presents the full list of parameters considered in Task 2.1, categorized by type and indicating which apply to products (P), solutions (S), and examples (E).

Table 4. Defining parameters to describe window retrofit solutions in Task 2.1.

Type	Nr	Parameter	Definition of the Parameter	P	S	E
General Information	1	Code		x	x	x
	2	Solution name	*Description*	x	x	x
	3	Documentation type	*Single choice:* • *Product* • *Solution* • *Example*	x	x	x
	4	Category (solution type)	*Single choice:* *see Table 2*		x	x
	5	Applicable to/ applied to	*Single choice:* • *single window with single glazing* • *single window with double glazing* • *coupled window* • *box type window* • *winter window* • *all types* *not specified*		x	x
	6	Category (product type)	*Single choice:* *See Table 3*	x	x	x
	7	Source	*Reference or link to information source*	x	x	x
	8	Example	*Link to example application*		x	x

Type	Nr	Parameter	Definition of the Parameter	P	S	E
	9	Suppliers	*List or description of possible suppliers*	x	x	
Technical Specifications	10	U_W-value before	*Typical value for the window in W/m²K*		x	x
	11	U_W value after	*Typical value for the window in W/m²K*		x	x
	12a/b	Additional R	*Typical value in m²K/W for glazing or, window*	x	x	
	13	Ug	*Typical value for the glazing in W/m²K*	x		x
	14	Composition	*Thicknesses, coatings and gas of glazing*	x	x	
	15	Uf	*Typical value for the frame in W/m²K*	x		x
	16	f	*Frame factor*	x	x	x
	17	Frame material	*Frame material*	x		x
	18	ψ_g	*Typical value for the thermal bridge at the glass edge W/mK*	x	x	x
	19	ψ_{inst}	*Typical value for the thermal bridge of the installation W/mK*		x	x
	20	g-value	*Typical value or range in -*	x	x	x
	21	Weight	*Typical value or range in kg/m²*	x	x	x
Sustainability and Lifecycle	22	Aesthetic impact	*Single choice:* • *no* • *minor from the inside* • *from the inside* • *minor from the outside* • *from the outside* • *minor from both sides* • *from both sides*		x	x
	23	Material impact	*Single choice:* • *no* • *minor loss of original material* • *partial loss of original material* • *complete loss of original material*		x	x
	24	Spatial impact	*Single choice:* • *no* • *position of window changes*		x	x
	25	Embodied energy impact	*Single choice:* • *very low* • *low* • *medium* • *rather high* • *high*	x	x	x
	26	Average lifetime	*Range in years*		x	x
	27	Recyclability	*Description of recyclability options*	x	x	x
	28	Reversibility	*Single choice:* • *Yes* • *No* • *Partially*		x	x
	29	Cost	*Single choice:* • *Low (€)* • *Medium (€€)* • *High (€€€)*	x	x	x

3. Analysis of collected solutions

Review of passive retrofit solutions is described in Annex 1.

3.1. Analysis of insulation systems list

A total of 80 insulation systems were identified and accurately described in Annex 1. The allocation of each solution to specific building envelope components is illustrated in Table 5. In the table and later in this report, each solution is univocally identified by an alphanumeric label referring to the building envelope element (internal wall insulation: IWI, external wall insulation: EWI, roof insulation: RI and basement insulation: BFI). The investigated solutions are moreover classified according to the employed insulation materials whose thermal conductivity is reported in Fig. 2.

Fig. 3 shows the distribution of the identified solutions over the different envelope's elements. Most solutions pertain to *Internal wall insulation.* Internal insulation solutions require particular attention due to moisture-related risks. In such cases, retrofit strategies must be carefully adapted to the existing construction and indoor hygrothermal conditions, resulting in a broader range of case-specific solutions. In comparison, *External insulation of walls*, *Roof insulation*, and *Basement and foundation insulation* exhibit more standardized retrofit measures, with all three categories comprising a comparable number of available solutions.

Table 5. Investigated solutions classified according to the employed insulation material and the building envelope element in which they are applied. Each solution is univocally identified by an alphanumeric label referring to the building element (internal insulation: IWI, external insulation: EWI, roof insulation: RI, basement insulation: BFI). A detailed description of the identified solutions is reported in Annex 1.

Insulation material/layer	**Internal wall insulation**	**External wall insulation**	**Roof insulation**	**Basement insulation**
BIOBASED				
Cellulose	IWI-7 IWI-8 IWI-9 IWI-29	EWI-3 EWI-12	RI-1 RI-3	BFI-2
Clay panels			RI-2	
Clay+cork board	IWI-10			
Cork	IWI-11	EWI-6		
Cotton fibre			RI-5	
Expanded clay				BFI-8
Flax fibre	IWI-12			
Hemp+lime insulation	IWI-15			BFI-10

Hemp fibre	IWI-14	EWI-5	RI-5	
Reed insulation	IWI-23	EWI-13		
Sheep wool	IWI-24		RI-6	
Wood fibre / wood wool	IWI-30 IWI-31	EWI-16	RI-7 RI-14 RI-15 RI-16	BFI-17
INSULATION PLASTERS				
Aerogel insulating plaster	IWI-3	EWI-1		
Thermal insulation plaster	IWI-26	EWI-14		
MINERAL BOARD BASED				
Autoclaved cellular concrete	IWI-4	EWI-7		BFI-5
Boards with calcium silicate and core	IWI-6			
Calcium silicate	IWI-5			
Perlite	IWI-17			
MINERAL WOOL BASED				
Mineral wool	IWI-16	EWI-2 EWI-8	RI-4 RI-11 RI-12 RI-13	BFI-11 BFI-12 BFI-13
OIL-BASED POLYMERS				
Phenolic foam	IWI-18	EWI-9		
Polystyrene/EPS/XPS	IWI-19	EWI-10	RI-8 RI-10	BFI-3 BFI-14 BFI-15
Polyurethane (PIR/PUR)	IWI-20	EWI-11	RI-10	BFI-16
PU-foam with CaSi channels	IWI-21			
OTHER				
Aerogel	IWI-1 IWI-2			BFI-1
Foam glass	IWI-13	EWI-4	RI-9	BFI-4 BFI-7
Insulating concrete with additives				BFI-9
Recycled textile	IWI-22			
Thermal insulation glazing	IWI-25			
Thermoreflective insulation	IWI-27			
Vacuum Insulation Panel (VIP)	IWI-28	EWI-15		BFI-6

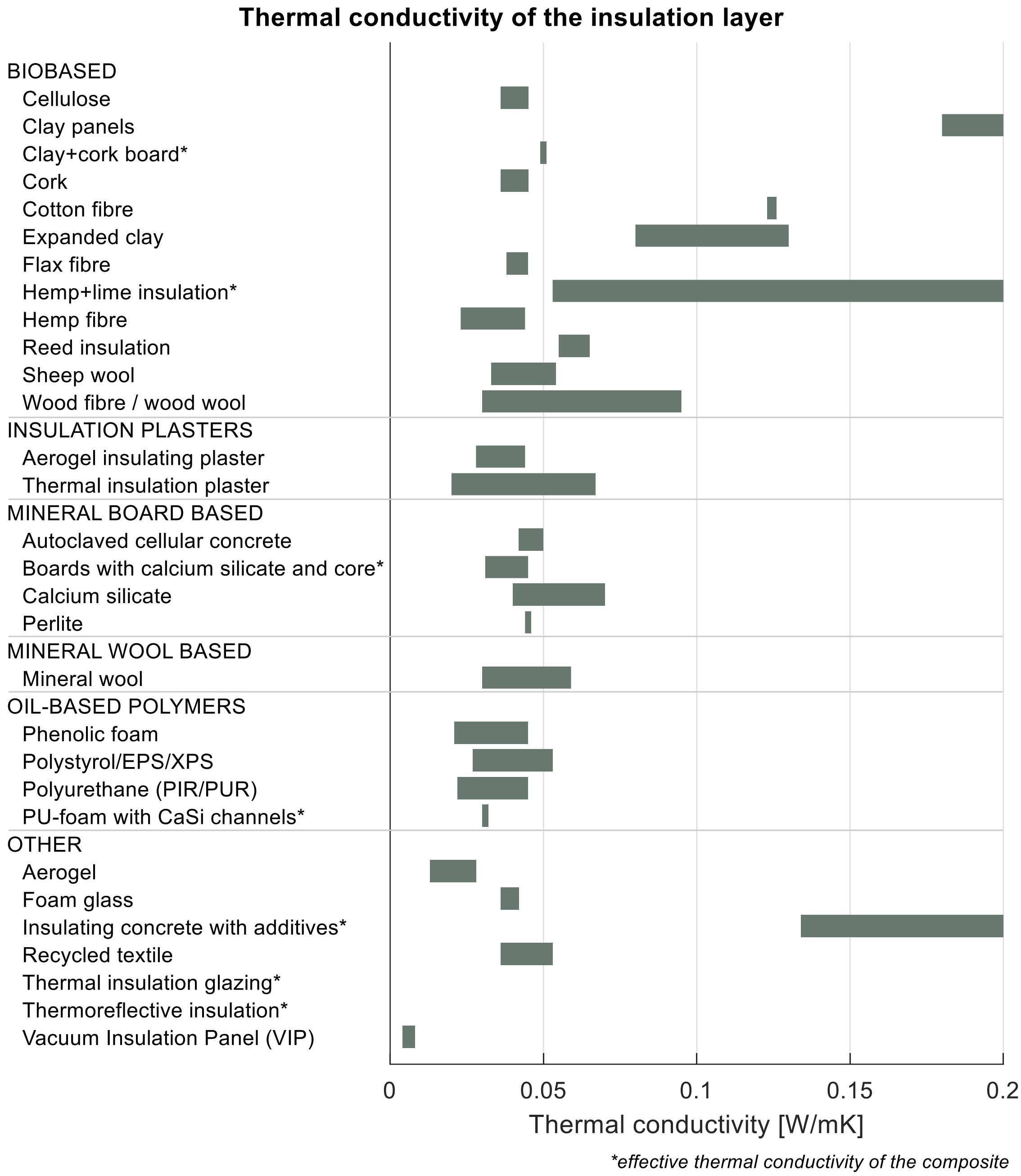

Fig. 2. Thermal conductivity of the reviewed insulation materials.

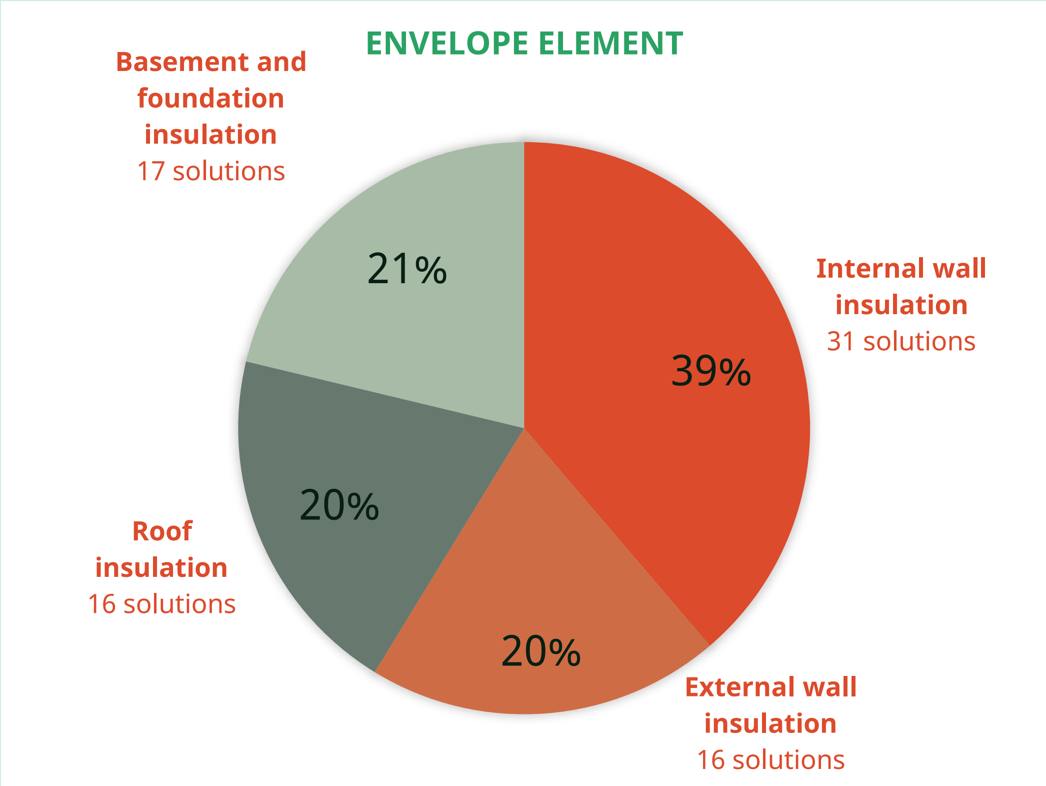

Fig. 3 Distribution of the gathered retrofit solutions by building envelope element.

As previously mentioned, internal wall insulation represents a special case due to the occurrence of moisture-related issues. Various strategies have been developed to address these challenges, including both vapour-open (e.g., *IWI-5*) and vapour-tight systems (e.g., *IWI-16*, *IWI-13*). The list of solutions compiled in this study contains a comparable number of both system types, as well as an even distribution between vapour-open (capillary-active) and vapour-tight systems.

The solutions for roof insulation are relatively diverse and can be applied to various roof configurations, including flat (*e.g., RI-8*) and pitched roofs (e.g., *RI-4*), as well as attic floors (e.g., *RI-3*). An equal number of solutions are designed for installation either above the existing construction (e.g., *RI-15*) or below/within it (e.g., *RI-16*)—for example, by adding insulation between the rafters (e.g., *RI-7*). However, few retrofit-specific roof solutions were identified in the sources, as it is common practice to replace the entire roof structure during renovation. This is particularly the case when the existing wooden components are damaged or degraded.

Approximately half of the identified solutions for basement and foundation insulation can be applied either to ground-level floors or to floors located above basements (e.g., *BFI-12*). Some solutions are intended for installation on the basement ceiling from below (e.g., *BFI-13*), provided sufficient space is available. Additionally, a few systems were collected for insulating the external basement wall, which can be used in the base area of the building (e.g., *BFI-6*). For internal basement wall insulation, suitable solutions can be selected from the group of internal wall insulation systems (e.g., *IWI-5*). The most frequently documented approaches involve the use of polystyrene or polyurethane insulation on (e.g., *BFI-14*), as well as wood fibre-based insulation systems (e.g., *BFI-17*).

Fig. 4 presents the percentage distribution of the gathered insulation solutions by material category, including all building elements. The largest group of solutions falls under the category *Biobased*. This does not indicate it is the most commonly used category, but rather the most diverse. It includes materials such as wood fibre, sheep wool, hemp, and cork. Biobased solutions also show the widest range of applicability across different envelope components, including walls, roofs, and basements.

Similarly, *Mineral wool based* and *Oil-based polymers* insulation systems can be applied to various envelope elements. However, these categories exhibit fewer variations in solution types compared to the *Biobased* group.

More specialised categories include *Mineral board based* insulation, such as calcium silicate, which is predominantly used for internal wall insulation and is rarely applied to other components (e.g., *IWI-4, IWI-17*). *Insulation plasters* represent another specialised group, primarily intended for wall insulation, though some formulations may also be suitable for basement walls.

The category *Other* includes solutions that cannot be clearly classified into the above material groups, such as vacuum insulation panels (e.g., *IWI-28*) and aerogel-based products (e.g., *IWI-2*). This group accounts for approximately 20% of all collected solutions.

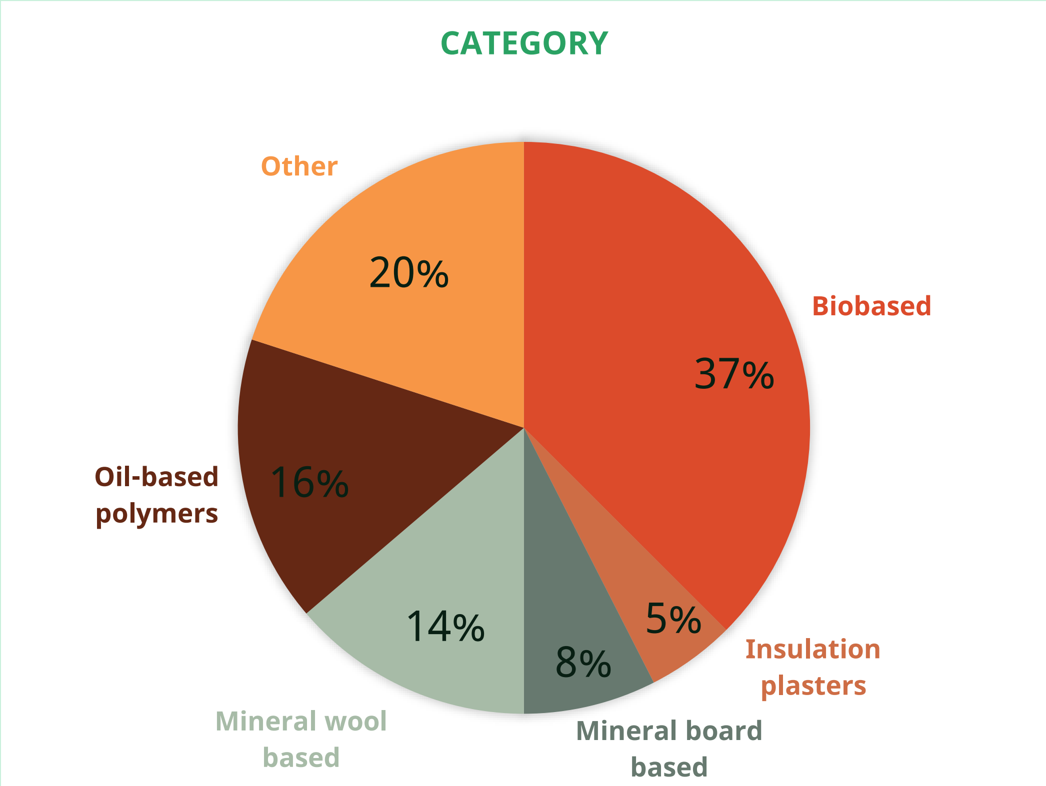

Fig. 4 Distribution of the gathered insulation solutions by material category.

Most of the gathered examples involve insulation materials such as mineral wool, cellulose, wood fibre, or polystyrene (EPS/XPS), which are widely known and commonly used in retrofit applications (e.g., *IWI-16*, *IWI-19*, *RI-7*). Internal wall insulation stands out as a special case, frequently addressed in demonstration projects and scientific literature with highly specialised solutions. These include systems based on aerogel (e.g., *IWI-1*), autoclaved aerated concrete (e.g., *IWI-4*), calcium silicate boards (*IWI-5*), polyurethane foam with integrated calcium silicate channels (*IWI-21*), and thermal insulation plasters (e.g., *IWI-26*).

The highest number of potential suppliers was identified for calcium silicate boards, thermal insulation plasters, polystyrene, and wood fibre in various forms. Other commonly available materials include mineral wool and cellulose. These insulation materials are generally accessible across multiple countries. In contrast, 13 of the collected solutions have either no known supplier or only one, indicating that they are highly specialised, less commercially available, and harder to source.

Most insulation systems cover a broad range of available thicknesses, allowing them to be adapted to diverse retrofit needs and performance requirements. The minimum available thickness for many systems starts at just a few centimetres. A smaller group of systems—particularly in internal wall insulation—have narrower thickness ranges, which is typically intentional. These include solutions such as aerogel blankets (*e.g., IWI-1*), where the primary benefit is their minimal thickness. A limitation of the market is that most insulation materials are produced in predefined formats, and their thickness can only be adapted in increments of 10 mm or more.

The fire protection class of each insulation system depends on the materials employed (Fig. 5). The classifications listed in the accompanying table (Annex 1) resulting from the performed literature review often include multiple fire classes for a single solution. Among the collected solutions, the full spectrum of fire protection classes is represented. The most common classes are A (non-combustible or limited combustibility) and E (flammable). Class A is typically associated with materials such as mineral wool, calcium silicate, and foam glass, while class E generally applies to polystyrene and many biobased insulation materials.

Fig. 6 presents additional statistics on the collected solutions. These include the proportion of systems using natural insulation materials, embodied energy ranges for selected materials, the number of prefabricated and reversible systems, and a basic price comparison.

Approximately half of the solutions are based on non-natural (inorganic and/or synthetic) materials, primarily mineral wool and oil-derived polymers. Natural insulation materials include organic (cork, hemp, sheep wool, and wood fibre) and inorganic (e.g., clay) materials. Some materials, such as cellulose, may contain synthetic inorganic additives; therefore, they are categorised as “partially natural.”

It was not feasible to determine the embodied energy of complete solution systems without detailed knowledge of the layer compositions. For this reason, the values reported refer to the embodied energy of exemplary insulation materials, expressed in MJ/kg. Most materials analysed have an embodied energy below 50 MJ/kg, with biobased options typically below 25 MJ/kg. Higher values are characteristic of polystyrene, polyurethane, aerogel, and vacuum insulation panels (VIPs).

Most of the identified retrofit solutions are not prefabricated, which implies longer installation times and higher labour requirements on site. Prefabricated options—such as thermal insulation glazing (e.g., *IWI-25*) or modular insulation panels (e.g., *EWI-12*)—are often custom-designed for specific cases and are generally more expensive.

Regarding reversibility, most systems are glued onto the existing structure, which makes them potentially reversible (e.g., *EWI-7*, *RI-3*). Non-reversible systems include those that are mechanically fixed (e.g., screwed, *IWI-30, EWI-11*) or in other way require modifications to the existing construction. For approximately 20% of the solutions, reversibility depends on the installation method, as the insulation can be glued or screwed. The possibility of removing adhesives or renders after installation was not considered in this evaluation.

Further key statistics on insulation solutions are shown in Fig. 6, such as: natural materials, embodied energy, prefabrication, reversibility, and cost. The cost of insulation systems varies by material choice, shipping and installation costs as well as regional market conditions and labour costs. In this study, the cost comparison is based on the insulation material itself, rather than on the full system. The lowest-cost solutions are typically those using polystyrene (e.g., *IWI-19, EWI-10*). In roof insulation, the most cost-effective options involve installing new insulation between the existing structural elements (e.g., *RI-1*, *RI-5)*. Medium-cost solutions include those based on calcium silicate or biobased materials (e.g., *IWI-5*, *IWI-9*). The most expensive systems are highly specialised and less common, such as aerogel, foam glass, or VIPs (e.g., *IWI-13*, *IWI-28*).

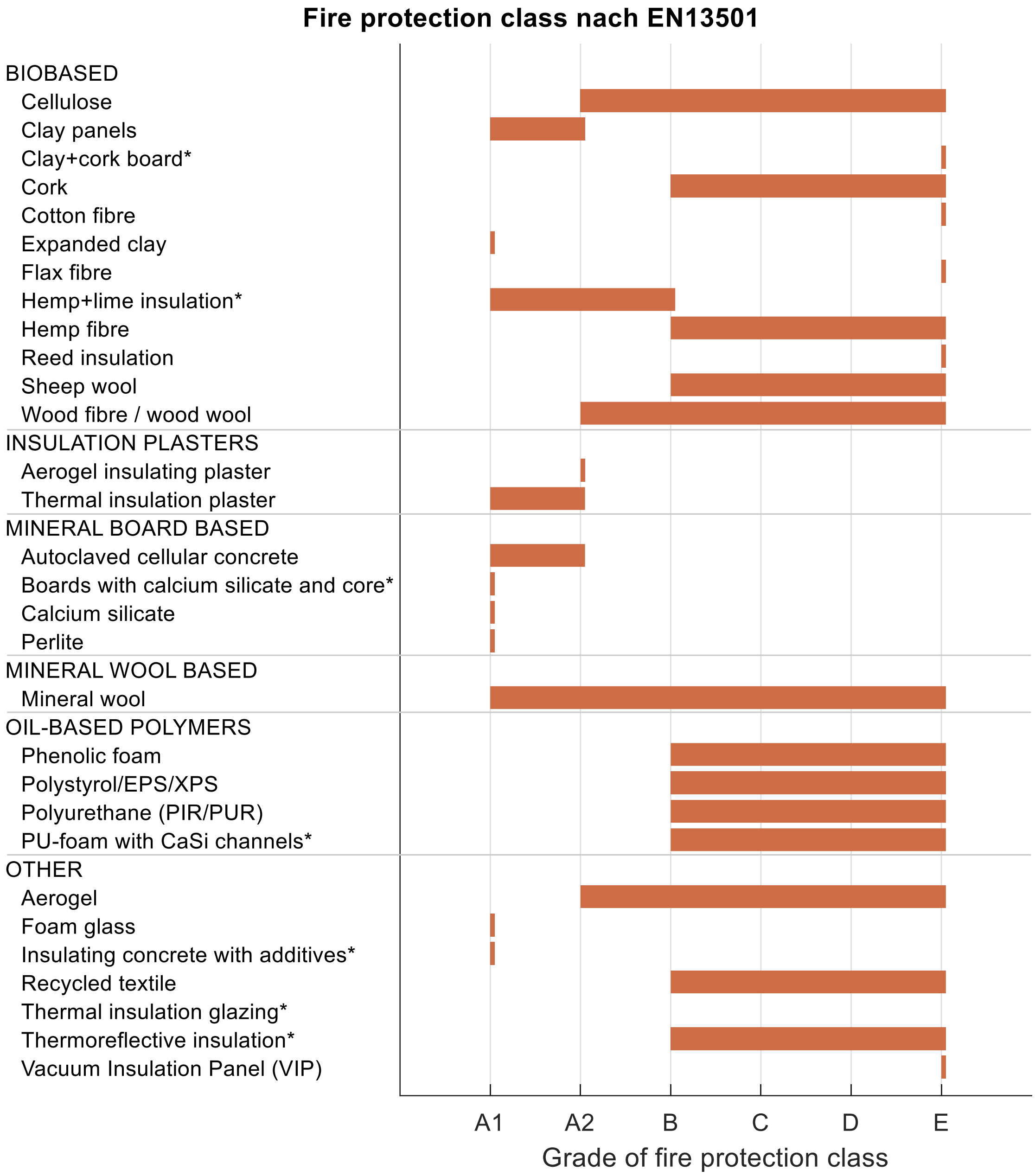

Fig. 5. Fire protection class of the considered insulation types.

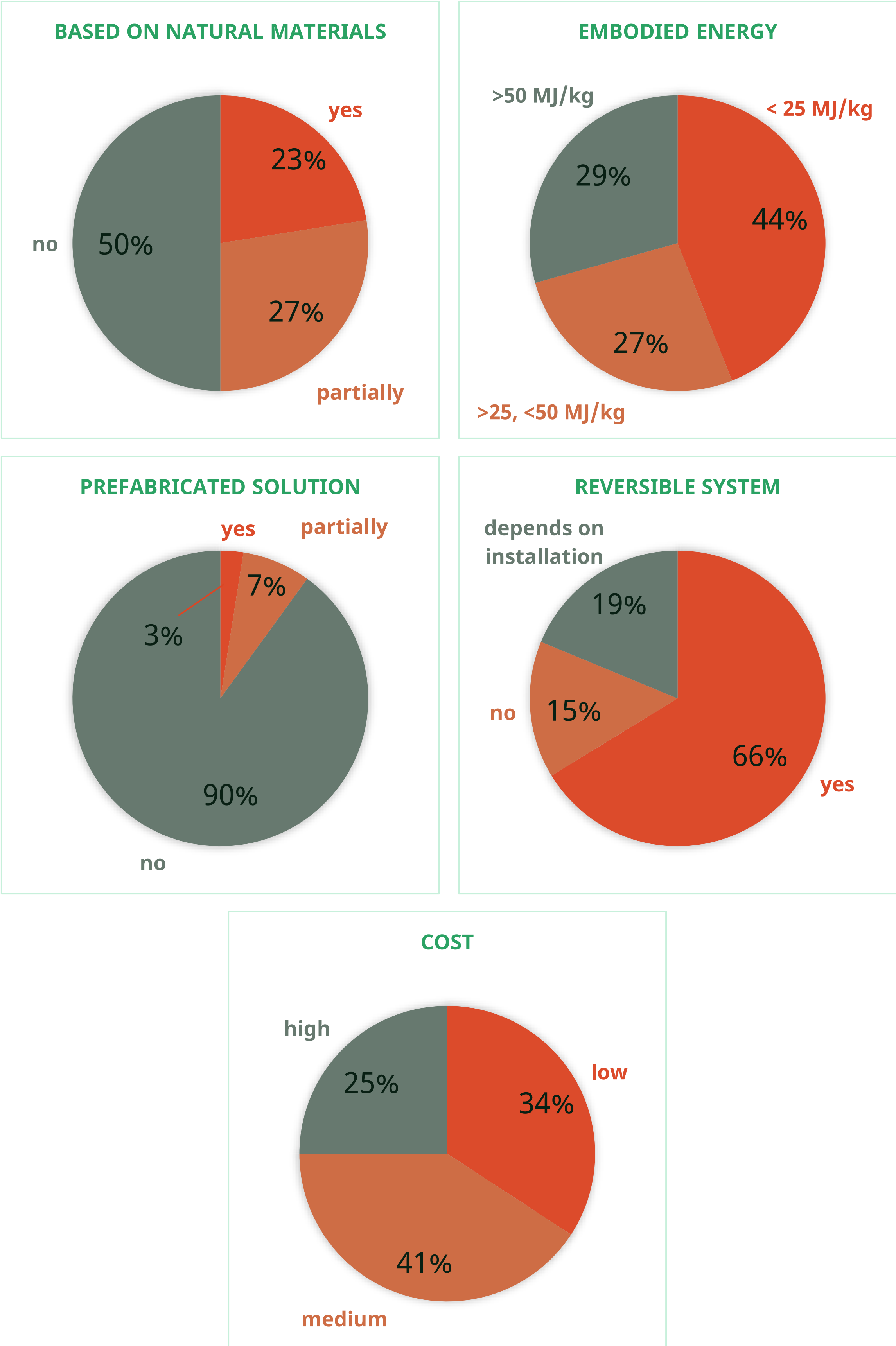

Fig. 6 Key statistics on insulation solutions: natural materials, embodied energy, prefabrication, reversibility, and cost.

3.2. Analysis of window retrofit solutions list

A total of 76 solutions, 17 products and 22 examples were identified and documented.

As regards the *products*, no standard products as double glazing and triple glazing – the glazing itself or the overall window – were documented in detail, as these can be considered general knowledge. Only those very specifically related to the retrofit of historic windows – thanks for example to limited thickness and weight – were included:

- *vacuum glazing*, with a U_g-value of 0.7 W/m^{2}K, a thickness of 8 to 12 mm, weight 20 - 27.5 kg/m^2 and the possibility to include not standard glass (p.215,215)
- *thin double glazing*, with glass thicknesses typically 2 or 3 mm (but however one layer in many cases still 4 mm) and distance between the layers ranging from 4 to 7 mm, thus resulting in product thicknesses of 8 to 13 mm, weight of 10 to 17.5 kg/m^2 and U_g-varying from 1.3 to 1.9 W/m^{2}K depending on the depth and filling of the space between the layers (p.209,210-212,213-214)
- *single glazing with low-e coating*, with a thickness of typically 4 mm (up to 9 mm if laminate of float with hand drawn resp. cylinder glass), weight of 10 kg/m^2 (17.5 to 20 for the laminated version) and U_g of 3.6 W/m^{2}K (p.212,213,216)
- *minimised windows*, which are usually (coated) single glazing with a minimal frame to be added to the existing window in the manner of a coupled window – 4 mm, 10 kg/m^2 and 3.6 W/m^{2}K. Recently minimised windows are also offered with vacuum glazing. (p.216,217,217)

Table 6. Assumed U-values of glazing (U_g) and corresponding overall window U-values (U_w) for typical wooden window configurations

Glazing	U_g W/m²K	Window	U_w W/m²K
		Wooden with single glazing	4.80
Low e single	3.78	Wooden with single low e glazing	3.25
Double glazing	1.10	Wooden window with double glazing	1.37
		Wooden coupled window with double glazing	1.05
		Wooden box-type window with double glazing	1.05
Thin double glazing	1.30	Wooden window with thin double glazing	1.51
Triple glazing	0.60	Wooden window with triple glazing	1.02
Thin triple glazing	0.70	Wooden window with thin triple glazing	1.09
		Wooden coupled window with thin triple glazing	0.70
		Wooden box type window w. thin triple glazing	0.70
Vacuum glazing	0.90	Wooden window with vacuum glazing	1.23

For the more standard products the U-values (which are needed for the calculation of the U_w after interventions of the solutions) have been assumed as shown in Table 6, U_w being calculated from U_g with a frame factor of 0.7 and U_f of 2 W/m²K. This should be implemented as an adaptable parameter in a future tool – providing default values and guidance in how to adapt them which can be derived from the growing number of documented examples.

A special position among the solutions have the *upgrades of existing glazing* (code UG— see pp .179-186 as proposed by FuturHist partner HOMA (Holzmanufaktur Rottweil) and described in Braun and Klos (2021). With the different variants of REVETRO® they propose the upgrade of an original single glazing to a double or triple insulating glazing - with (i) an additional single glazing with low-e coating, spacer and gas in the space between glass layers reaching a U-value of the glazing U_g=1.9 W/m²K and a weight of ~15 kg/m² for the 3+3 mm, with (ii) an additional vacuum glass reaching U_g=0,6 W/m²K, with a higher weight of 25 to 30 kg/m² however, with (iii) an additional double glazing connected to the original single glass with spacer and gas filling reaching U_g=0.5 W/m²K, with again a weight ~25 kg/m² which can be reduced by (iv) replacing the middle glas with a foil still reaching a similarly good U_g with weight~15 kg/m². HOMA has also started to propose a similar approach for the upgrade of existing double glazing, RETHERMO® reaching Ug between 0.6 W/m²K and 0.9 W/m²K. The latter solutions differ also in terms of keeping the original glazing with its spacer, and just adding additional layers, or disassembling and reassembling the double glazing. The upgraded glazing can be applied to different "starting points" and should in a future tool be treated in a similar way as products are dealt with – i.e., applied within other solutions.

As regards the other solutions, the achievable U-values are shown in Fig. 7 – ordered firstly by the U_w before retrofit and secondly by the U_w after retrofit. It can be noted that achievable U-values depend of course on the starting point – is the status pre retrofit a single glazed single window? A single window with double glazing? A box-type or a coupled window? However, in all cases values below 1.5 W/m²K and further can be reached by applying a variety of solutions.

How do these solutions leading to comparable energy performance differ? Do they differ in impact – be it from the conservation point of view in terms of aesthetical, material, and spatial impact, but also in terms of embodied energy, and cost? To answer this question, two types of charts are used: on the one hand side overlays of these parameters over Fig. 7, on the other hand side in form of tables which show the impact in terms of colour for the solutions ordered in a matrix for solution category, product category and starting point (i.e., where the solution is applied to).

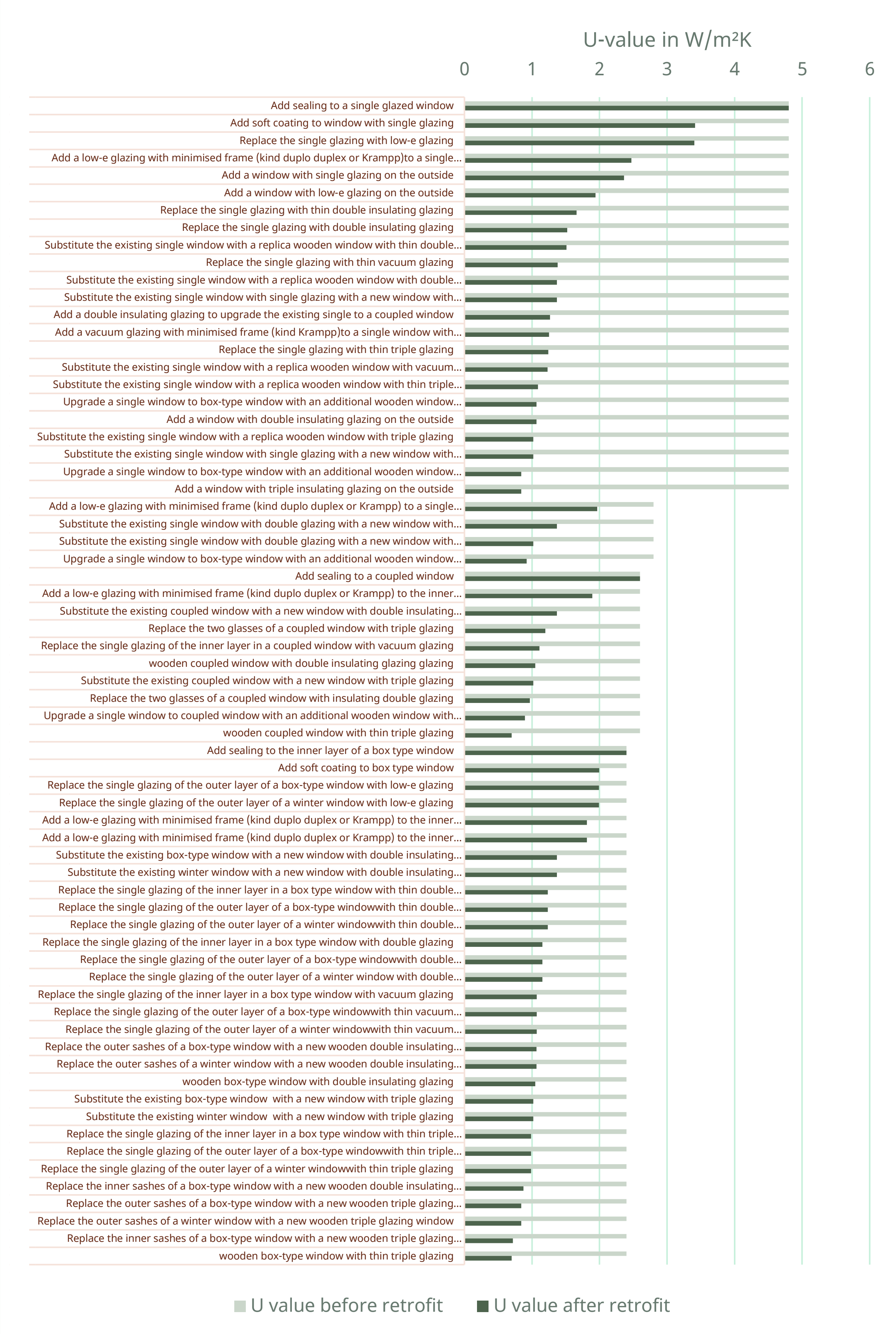

Fig. 7 Achievable U_W values with different solutions compared to the U_W - before intervention

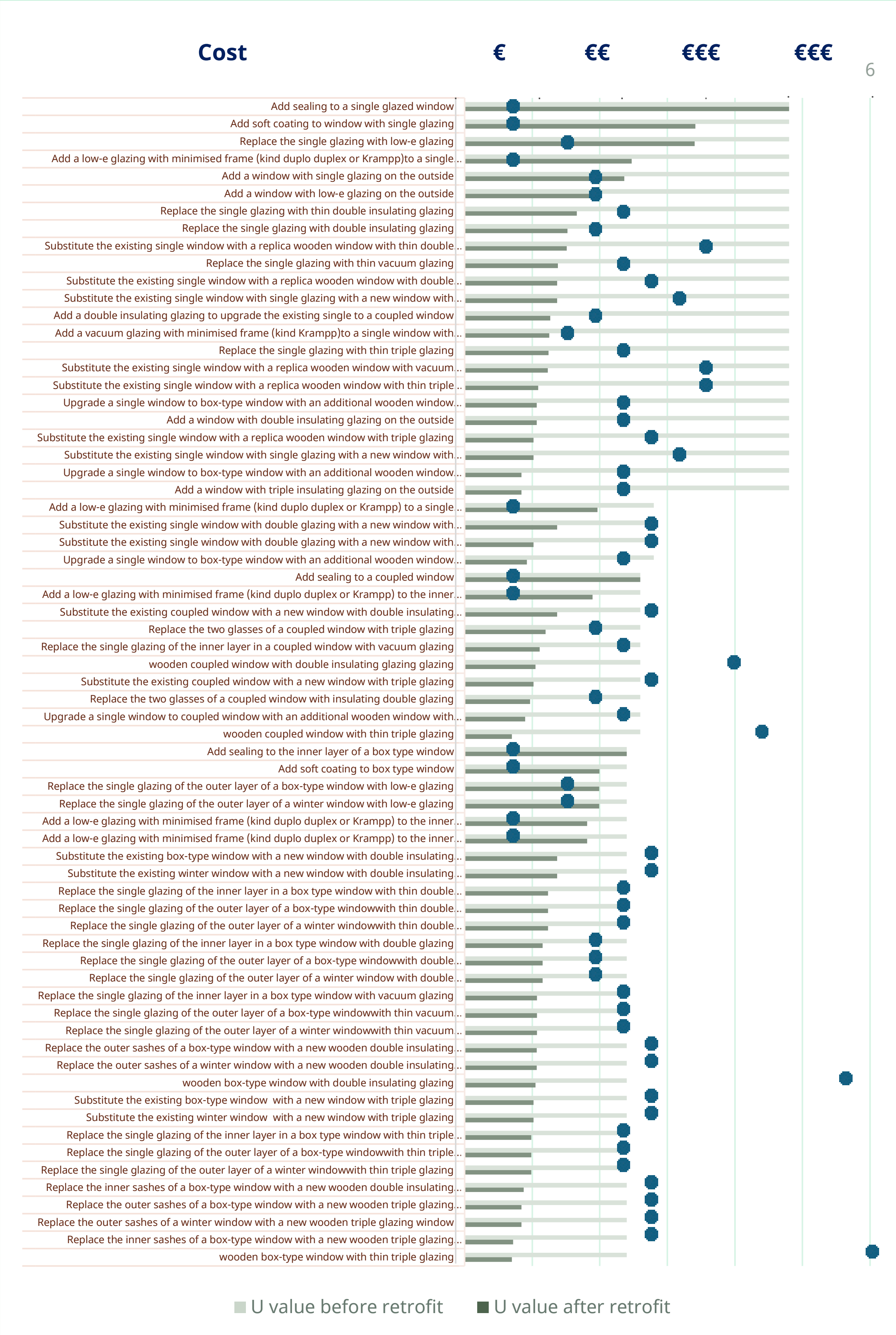

Fig. 8 Overlay of cost information over the chart from Fig. 7

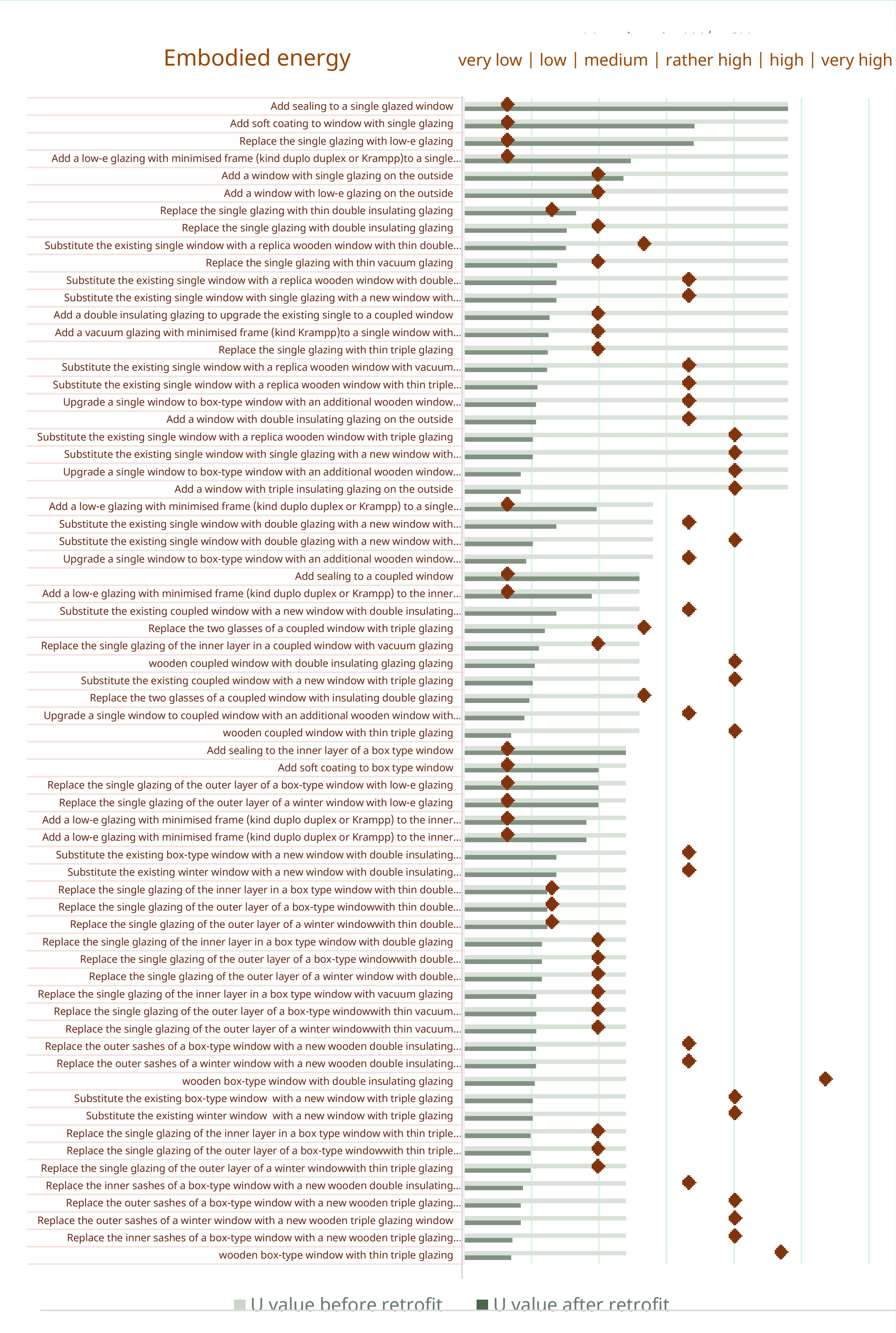

Fig. 9 Overlay of embodied energy information over the chart from Fig. 7

The *estimated cost* as shown in Fig. 8 does vary considerably. The highest cost can be observed for the cases where new box-type windows are installed, be they standard or replica, since here actually two windows have to be produced. It can also be noticed that there is no strict correlation in terms of solutions leading to better U-values necessarily costing more. There are, however, other aspects to be considered when improving windows in historic buildings besides energy performance and cost:

Table 7 for example shows the *material impact* of different solutions, which will be of major importance in listed buildings and where valuable original windows have been preserved to date. Reachable U-value with “no material impact” solution can be as low as U_w=0.9 W/m²K and as high as U_w=3.4 W/m²K, cost varies between € and €€ - higher investment usually need to reach U-values below 1.8 W/m²K. No material impact needs however in some cases space und it does not necessarily come without visual impact. Partial loss of original material – usually associated to solutions replacing the glazing and preserving the frame reach U-value down to U_w=1.0 – 2.0 W/m²K (with one exception: the mere replacement of a single glazing in a single window with low-e-glazing result in U_w=3.4 W/m²K) depending on the starting point.

Another aspect important in historic buildings the *aesthetic impact* – shown in Table 8. There are a variety of solutions which impact visually only from the inside – adding minimized windows e.g. which can lead to an improvement of the U-value down to U_w=1.8 – 2.5 W/m²K depending on whether the starting point is a single glazing or already box-type window (or coupled resp. winter window). Actually, while the reachable U-vale is as expected higher for the single window with single glazing, the relative reduction is more pronounced going the U-value down from 4.8 W/m²K to 2.5 W/m²K. Also replacing the inner glazing of a box-type or coupled window can still considered a minor visual impact if well done and allows to reach U-value down to U_w=1.0 – 1.3 W/m²K. Replacing the inner sashes with new double or triple glazed windows can lead to U-value below U_w=1.0 W/m²K. For a single window these options are not viable, however in this case adding an additional window at the inside does also lead to U-value around U_w=1.0 W/m²K and does furthermore diminish the thermal bridge between window and wall considerably.

The *embodied energy* as shown in Fig. 9 is lowest for the solutions which however do still have low energy performance – over the life cycle it will be worthwhile to invest a bit more energy at the beginning and avoid energy losses for the many years the window will be in use. For medium energy performance the invested embodied energy varies considerably – this might in those cases be one of the decision factors. The tool to be developed could help evaluate the life cycle performance in terms of embodied and operational energy, for the specific climate and for the specific energy source.

Table 7 Material impact: no, minor, partial and complete loss of original material

Applied to à âsolution type	Single window	Box type window	Coupled window	Winter window
Repairing window	Repair			
Adding foils/coating to the glass	Add foil/coating	Add foil/coating		
Inserting a sealing strip	Seal	Seal inner layer	Seal	
Replacing inner glazing		Double	Vacuum	
		Thin double		
		Thin triple		
		Vacuum		
Adding an additional glass layer on the inside	Minimised window	Minimised window	Minimised window	Minimised window
	Double glazing			
	Minimised vacuum			
Adding a new window on the inside	Wood.Window with double glazing		Wood.Window with double glazing	
	Wood.Window with triple glazing			
Replacing the window sashes on the inside		Wood.Window with double glazing		
		Wood.Window with triple glazing		
Replacing (outer) glazing	Low-e single	Low-e single		Low-e single
	Double	Double	Double	Double
	Thin double	Thin double		Thin double
	Triple	Triple	Triple	Triple
	Thin triple	Thin triple		Thin triple
	Vacuum	Vacuum		Vacuum
Adding a new window on the outside	Wood.Wind with single glasing			
	Wood.Wind with low-e glazing			
	Wood.Wind with double glazing			
	Wood.Wind with triple glazing			
Replacing the window sashes on the outside		Wood.Window with double glazing		Wood.Window with double glazing
		Wood.Window with triple glazing		Wood.Window with triple glazing
Substitute the window with a replica	Wood.Wind with double glazing			
	Wood.Wind with thin double glazing			
	Wood.Wind with triple glazing			
	Wood.Wind with thin triple glazing	Box-type window w. thin triple glazing	Coupled window w. thin triple glazing	
	Wood.Wind with vacuum glazing			
Substitute the window	Wood.Window with double glazing	Wood.Window with double glazing	Wood.Window with double glazing	Wood.Window with double glazing
	Wood.Window with triple glazing	Wood.Window with triple glazing	Wood.Window with triple glazing	Wood.Window with triple glazing

*Table 8 Aesthetic impact: **from inside** | **from outside** | **from both side***

Applied to à âsolution type	Single window	Box type window	Coupled window	Winter window
Repairing window	Repair			
Adding foils/coating to the glass	Add foil/coating	Add foil/coating		
Inserting a sealing strip	Seal	Seal inner layer	Seal	
Replacing inner glazing		Double	Vacuum	
		Thin double		
		Thin triple		
		Vacuum		
Adding an additional glass layer on the inside	Minimised window	Minimised window	Minimised window	Minimised window
	Double glazing			
	Minimised vacuum			
Adding a new window on the inside	Wood.Window with double glazing		Wood.Window with double glazing	
	Wood.Window with triple glazing			
Replacing the window sashes on the inside		Wood.Window with double glazing		
		Wood.Window with triple glazing		
Replacing (outer) glazing	Low-e single	Low-e single	Double	Low-e single
	Double	Double		Double
	Thin double	Thin double		Thin double
	Thin triple	Thin triple	Triple	Thin triple
	Vacuum	Vacuum		Vacuum
Adding a new window on the outside	Wood.Wind with single glazing			
	Wood.Wind with low-e glazing			
	Wood.Wind with double glazing			
	Wood.Wind with triple glazing			
Replacing the window sashes on the outside		Wood.Window with double glazing		Wood.Window with double glazing
		Wood.Window with triple glazing		Wood.Window with triple glazing
Substitute the window with a replica	Wood.Wind with double glazing	Box-type window with double glazing	Coupled window with double glazing	
	Wood.Wind with thin double glazing			
	Wood.Wind with triple glazing			
	Wood.Wind with thin triple glazing	Box-type window w. thin triple glazing	Coupled window w. thin triple glazing	
	Wood.Wind with vacuum glazing			
Substitute the window	Wood.Window with double glazing	Wood.Window with double glazing	Wood.Window with double glazing	Wood.Window with double glazing
	Wood.Window with triple glazing	Wood.Window with triple glazing	Wood.Window with triple glazing	Wood.Window with triple glazing

Table 9 List of window solution with selected parameters

code	Solution Name	Uw before	Uw after	Ψ-value (inst.)	Visual impact	Material impact	Rev.	Emb. energy	Cost
[1]	[2]	[10]	[11]	[19]	[22]	[23]	[28]	[25]	[29]
1B1a	Add sealing to a single glazed window	4,8	4,80	no change		partial	no	very low	€
1C1b	Add soft coating to window with single glazing	4,8	3,41	no change		complete	no	very low	€
3A1c	Replace the single glazing with low-e glazing	4,8	3,40	small change	minor both	complete	no	very low	€€
2C1i	Add a low-e glazing with minimised frame (kind duplo duplex or Krampp)to a single window with single glazing	4,8	2,47	no change		no	yes	very low	€
3B1k	Add to a single window with single glazing a window with single glazing on the outside	4,8	2,36	no change	outside	no	yes	medium	€€
3B1l	Add to a single window with single glazing a window with low-e glazing on the outside	4,8	1,94	no change	outside	partial	yes	medium	€€
3A1e	Replace the single glazing with thin double insulating glazing	4,8	1,66	no change	minor both	complete	no	low	€€
3A1d	Replace the single glazing with double insulating glazing	4,8	1,52	no change	minor both	complete	no	medium	€€
4A1o	Substitute the existing single window with a replica wooden window with thin double glazing	4,8	1,51	decreases consid.	minor both	no	no	medium	€€€
3A1h	Replace the single glazing with vacuum glazing	4,8	1,38	decreases consid.	minor both	no	no	medium	€€
4B1m	Substitute the existing single window with single glazing with a new window with double insulating glazing	4,8	1,37	small change	both sides	complete	no	rather high	€€
4A1m	Substitute the existing single window with a replica wooden window with double glazing	4,8	1,37	no change	minor both	complete	no	rather high	€€€
2C1d	Add a double insulating glazing to upgrade the existing single to a coupled window	4,8	1,27	decreases consid.	inside	no	yes	medium	€€
2C1j	Add a vacuum glazing with minimised frame (kind Krampp)to a single window with single glazing	4,8	1,25	decreases consid.	minor inside	no	yes	medium	€€

[1]	[2]	[10]	[11]	[19]	[22]	[23]	[28]	[25]	[29]
3A1g	Replace the single glazing with thin triple glazing	4,8	1,24	no change	minor both	no	no	medium	€€
4A1q	Substitute the existing single window with a replica wooden window with vacuum glazing	4,8	1,23	small change	minor both	complete	no	rather high	€€€
4A1p	Substitute the existing single window with a replica wooden window with thin triple glazing	4,8	1,09	small change	minor both	complete	no	rather high	€€€
2D1m	Upgrade a single window with single glazing to box-type window with an additional wooden window with double insulating glazing on the inside	4,8	1,07	decreases consid.	inside	no	yes	rather high	€€
3B1m	Add to a single window with single glazing a window with double insulating glazing on the outside	4,8	1,07	no change	outside	minor	yes	rather high	€€
4B1n	Substitute the existing single window with single glazing with a new window with triple glazing	4,8	1,02	small change	both sides	complete	no	high	€€
4A1n	Substitute the existing single window with a replica wooden window with triple glazing	4,8	1,02	no change	minor both	no	no	high	€€€
2D1n	Upgrade a single window with single glazing to box-type window with an additional wooden window with triple glazing on the inside	4,8	0,84	no change	inside	partial	yes	high	€€
3B1n	Add to a single window with single glazing a window with triple insulating glazing on the outside	4,8	0,84	no change	outside	partial	yes	high	€€
2C2i	Add a low-e glazing with minimised frame (kind duplo duplex or Krampp) to a single window with double glazing	2,8	1,97	no change	minor inside	complete	yes	very low	€
4B2m	Substitute the existing single window with double glazing with a new window with double insulating glazing	2,8	1,37	small change	both sides	complete	no	rather high	€€
4B2n	Substitute the existing single window with double glazing with a new window with triple glazing	2,8	1,02	no change	both sides	partial	no	high	€€
2D2m	Upgrade a single window with double glazing to box-type window with an additional wooden window with double insulating glazing on the inside	2,8	0,92	decreases consid.	inside	no	yes	rather high	€€
1B3a	Add sealing to a coupled window	2,6	2,60	no change		complete	no	very low	€
2C3i	Add a low-e glazing with minimised frame (kind duplo duplex or Krampp) to the inner layer of a coupled window	2,6	1,89	no change	minor inside	minor	yes	very low	€

[1]	[2]	[10]	[11]	[19]	[22]	[23]	[28]	[25]	[29]
4B3m	Substitute the existing coupled window with a new window with double insulating glazing	2,6	1,37	no change	both sides	no	no	rather high	€€
3A3d	Replace the two glasses of a coupled window with insulating double glazing	2,6	1,20	minimal change	minor outside	partial	no	mediu m	€€
2A3h	Replace the single glazing of the inner layer in a coupled window with vacuum glazing	2,6	1,11	minimal change	minor inside	partial	no	mediu m	€€
4A3r	Substitute the existing coupled window with a replica wooden coupled window with double insulating glazing	2,6	1,05	minimal change	minor both	no	no	high	€€€
4B3n	Substitute the existing coupled window with a new window with triple glazing	2,6	1,02	minimal change	both sides	no	no	high	€€
3A3f	Replace the two glasses of a coupled window with triple glazing	2,6	0,97	increases consid.	minor outside	complete	no	mediu m	€€
2D3m	Upgrade a coupled window to box-type window with an add. window with double insulating glazing on the inside	2,6	0,90	increases consid.	inside	complete	yes	rather high	€€
4A3t	Substitute the existing coupled window with a replica wooden coupled window with thin triple glazing	2,6	0,70	minimal change	minor both	partial	no	high	€€€
1B4a	Add sealing to the inner layer of a box type window	2,4	2,40	minimal change		partial	no	very low	€
1C4b	Add soft coating to box type window	2,4	2,00	minimal change	minor inside	partial	no	very low	€
3A4c	Replace the single glazing of the outer layer of a box-type window with low-e glazing	2,4	1,99	minimal change	minor outside	partial	no	very low	€€
3A5c	Replace the single glazing of the outer layer of a winter window with low-e glazing	2,4	1,99	minimal change	minor outside	partial	no	very low	€€
2C4i	Add a low-e glazing with minimised frame (kind duplo duplex or Krampp) to the inner layer of a box-type window	2,4	1,81	minimal change	minor inside	partial	yes	very low	€
2C5i	Add a low-e glazing with minimised frame (kind duplo duplex or Krampp) to the inner layer of a winter window	2,4	1,81	minimal change	minor inside	partial	yes	very low	€
4B4m	Substitute the existing box-type window with a new window with double insulating glazing	2,4	1,37	minimal change	both sides	partial	no	rather high	€€
4B5m	Substitute the existing winter window with a new window with double insulating glazing	2,4	1,37	minimal change	both sides	partial	no	rather high	€€

[1]	[2]	[10]	[11]	[19]	[22]	[23]	[28]	[25]	[29]
2A4e	Replace the single glazing of the inner layer in a box type window with thin double glazing	2,4	1,23	minimal change	minor inside	partial	no	low	€€
3A4e	Replace the single glazing of the outer layer of a box-type window with thin double insulating glazing	2,4	1,23	minimal change	minor outside	partial	no	low	€€
3A5e	Replace the single glazing of the outer layer of a winter window with thin double insulating glazing	2,4	1,23	no change	minor outside	complete	no	low	€€
2A4d	Replace the single glazing of the inner layer in a box type window with double glazing	2,4	1,15	increases consid.	minor inside	complete	no	mediu m	€€
3A4d	Replace the single glazing of the outer layer of a box-type window with double insulating glazing	2,4	1,15	increases consid.	minor outside	complete	no	mediu m	€€
3A5d	Replace the single glazing of the outer layer of a winter window with double insulating glazing	2,4	1,15	minimal change	minor outside	partial	no	mediu m	€€
2A4h	Replace the single glazing of the inner layer in a box type window with vacuum glazing	2,4	1,07	minimal change	minor inside	partial	no	mediu m	€€
3A4h	Replace the single glazing of the outer layer of a box-type window with vacuum glazing	2,4	1,07	minimal change	minor outside	partial	no	mediu m	€€
3A5h	Replace the single glazing of the outer layer of a winter window with vacuum glazing	2,4	1,07	minimal change	minor outside	partial	no	mediu m	€€
3C4m	Replace the outer sashes of a box-type window with a new wooden double insulating glazing window	2,4	1,07	minimal change	minor outside	partial	no	rather high	€€
3C5m	Replace the outer sashes of a winter window with a new wooden double insulating glazing window	2,4	1,07	minimal change	minor outside	partial	no	rather high	€€
4A4s	Substitute the existing box type window with a replica wooden box-type window with double insulating glazing	2,4	1,05	minimal change	minor both	partial	no	very high	€€€€
4B4n	Substitute the existing box-type window with a new window with triple glazing	2,4	1,02	no change	both sides	complete	no	high	€€
4B5n	Substitute the existing winter window with a new window with triple glazing	2,4	1,02	minimal change	both sides		no	high	€€
2A4g	Replace the single glazing of the inner layer in a box type window with thin triple glazing	2,4	0,99	minimal change	minor inside		no	mediu m	€€
3A4g	Replace the single glazing of the outer layer of a box-type window with thin triple glazing	2,4	0,99	minimal change	minor outside		no	mediu m	€€
3A5g	Replace the single glazing of the outer layer of a winter window with thin triple glazing	2,4	0,99	minimal change	minor outside		no	mediu m	€€

[1]	[2]	[10]	[11]	[19]	[22]	[23]	[28]	[25]	[29]
2E4m	Replace the inner sashes of a box-type window with a new wooden double insulating glazing window	2,4	0,87	minimal change	minor inside		no	rather high	€€
3C4n	Replace the outer sashes of a box-type window with a new wooden triple glazing window	2,4	0,84	minimal change	minor outside		no	high	€€
3C5n	Replace the outer sashes of a winter window with a new wooden triple glazing window	2,4	0,84	minimal change	minor outside		no	high	€€
2E4n	Replace the inner sashes of a box-type window with a new wooden triple glazing window	2,4	0,72	minimal change	minor inside		no	high	€€
4A4u	Substitute the existing box type window with a replica wooden box-type window with thin triple glazing	2,4	0,70	minimal change	minor both		no	very high	€€€€

4. Potential applications and limitations of solutions

The solutions collected in this task were subsequently evaluated against the typologies defined in Task 1.2. These typologies represent key historic residential and public building types from the respective countries. They are shown in Table 10.

*Table 10. Labels used to describe each typology in Table 15 -Table 23**Error! Reference source not found.**.*

Nr	Country	Name	Label
1	Spain	*Casa de pisos* — terraced tenement building (1600–1920)	ES 1
2	Spain	*Patio de vecinos* — terraced courtyard tenement building (1600–1920)	ES 2
3	Poland	*Kamienica* — terraced tenement building (1750–1945)	PL 1
4	Poland	*Willa miejska* — garden-city/urban villa (1900–1945)	PL 2
5	Sweden	*Monumentalbyggnad* — monumental public building (1850–1920)	SE 1
6	Sweden	*Flerbostadshus funktionalism* — functionalist multi-family housing block (1920–1945)	SE 2
7	Scotland	*Georgian cottage* — detached cottage (1750–1850)	SC 1
8	Scotland	*Georgian tenement* — terraced tenement building (1750–1850)	SC 2
9	Scotland	*Victorian terraced house* — terraced house (1850–1920)	SC 3

To gather detailed information on each typology, workshops were conducted both online and during the 4th project meeting held in Krakow, Poland. Participants included typology experts, local specialists, and other Futurist partners involved with the demonstration cases from these countries.

A questionnaire covering insulation systems, windows, and active systems was used to collect data. The questions were tailored based on parameters gathered in earlier steps and were presented in a multiple-choice format, with mandatory comments required if any options were rejected. The part of questionnaire regarding passive systems is included in Table 11 (insulation solutions) and in Table 12 (window retrofit).

Answers and accompanying notes explaining the rationale for each selection were collected and subsequently applied as filters to the comprehensive list of solutions. This process allowed assessment of the applicability of each solution to a given typology, categorizing them as 'possible, 'impossible, or 'depends'. A compilation of the notes gathered for each country and the full assessment of all passive solutions are provided below.

Table 11. Questions regarding insulation solutions in typology.

Nr	Checkpoint	Question	Options
1	**Envelope element**	What part of the building envelope can the insulation be applied to (walls, roof, floor)?	☐ *Walls from outside* ☐ *Walls from inside* ☐ *Cavity walls* ☐ *Basement ceiling (from below)* ☐ *Ground floor / floor above basement* ☐ *Above existing roof structure (e.g., over rafters or roof deck)* ☐ *Below or between roof structure (e.g., under or between rafters)* ☐ *Attic ceiling or floor*
2	**System thickness**	What is the maximum possible thickness of the insulation system? If the maximum thickness varies depending on the type of building element (e.g., wall, roof, or floor), please indicate this under potential limitations.	☐ *Less than 5 cm* ☐ *5 - 10 cm* ☐ *10 - 20 cm* ☐ *More than 20 cm*
3	**Insulation material**	Which of the following insulation material types are suitable for use in an insulation system?	☐ *Mineral wool based (e.g., rock/stone wool, glass wool)* ☐ *Mineral board based (e.g., calcium silicate, perlite, Multipor)* ☐ *Oil-based polymers (e.g., EPS, XPS, PUR, PIR)* ☐ *Biobased (e.g., wood fibre, hemp fibre, cellulose, sheep wool, cork)* ☐ *Insulation plasters* ☐ *Other (e.g., Vacuum Insulation Panels, aerogel, foam glass)*
4	**U-value**	What is the expected U-value for the insulation system based on the selected material and thickness? Does the system need to meet different thermal performance requirements for various building elements (e.g., walls, roof, floors)? If so, please	☐ *Less than 0.10 W/m²·K* ☐ *0.10–0.20 W/m²·K* ☐ *0.20–0.30 W/m²·K* ☐ *More than 0.30 W/m²·K*

		specify the variations.	
5	**Thermal conductivity**	What is the expected thermal conductivity (λ-value) for the insulation system based on the selected material and thickness? Does the system need to meet different thermal performance requirements for various building elements (e.g., walls, roof, floors)? If so, please specify the variations.	☐ *Less than 0.020 W/m·K* ☐ *0.020–0.035 W/m·K* ☐ *0.035–0.050 W/m·K* ☐ *More than 0.050 W/m·K*
6	**Fire protection**	What fire protection class should the insulation system or material meet according to EN 15301? Please specify the required fire class (e.g., A1, B, C) based on relevant building codes or safety regulations.	☐ *Class A1 (Non-combustible)* ☐ *Class A2 (Limited combustibility)* ☐ *Class B (Combustible with low flammability)* ☐ *Class C (Combustible with moderate flammability)* ☐ *Class D (Combustible with high flammability)* ☐ *Class E (Flammable)* ☐ *Class F (Not classified)*
7	**Vapour-tightness**	Should the insulation material prevent moisture movement (i.e., should it be vapour-tight), or is a vapour-open system preferred?	☐ *Vapour-tight* ☐ *Vapour-open*
8	**Recyclability**	Should the insulation system be recyclable at the end of its life cycle?	☐ *Yes, fully recyclable* ☐ *Yes, partially recyclable* ☐ *No*
9	**Reversibility**	Should the insulation system allow for disassembly without damaging the existing building structure?	☐ *Yes* ☐ *No* ☐ *Partially (e.g., reversible under specific conditions)*
10	**Embodied energy**	What should be the embodied energy of the insulation system (energy required for extraction, manufacturing, and transport)?	☐ *Low* ☐ *Medium* ☐ *High*
11	**Average lifetime**	What is the expected average lifetime of the insulation system?	☐ *Less than 25 years* ☐ *25 - 50 years* ☐ *More than 50 years*
12	**Price**	What is the approximate price range of the new insulation system? If there are different ranges for different parts of envelope, please add it in comments.	☐ *Low cost (e.g., budget-friendly options)* ☐ *Mid-range cost (e.g., standard market pricing)* ☐ *High cost (e.g., premium or specialized systems)*
13	**Supplier**	Are there any limitations regarding the supplier of the insulation system (e.g., local availability, limited options)?	☐ *Yes (please specify limitations)* ☐ *No limitations* ☐ *Limited to specific regions* ☐ *Limited to specific suppliers or brands*
14	**Installation**	What should the installation process be for this insulation system?	☐ *Spray-applied (e.g., spray foam)* ☐ *Board/Panel installation (e.g., rigid foam or mineral wool boards)* ☐ *Loose-fill or blown-in (e.g.,*

			cellulose, fiberglass) ☐ *Batt or roll installation (e.g., fiberglass, mineral wool)* ☐ *Fitting within frames/ cavities (e.g., insulation installed within wall or ceiling frames)* ☐ *Cladding or external systems (e.g., external wall insulation with finishing layers)* ☐ *Insulated plasterboard (e.g., plasterboard with integrated insulation)* ☐ *Plaster* ☐ *Other (please specify)*
15	**Prefabrication**	Should the insulation system be available in prefabricated panels or modules?	☐ *Yes* ☐ *No* ☐ *Partially (e.g., components are prefabricated)*

Table 12. Questions regarding window retrofit solutions in typology.

Nr	Checkpoint	Question	Options
1	**Existing windows**	What kind of windows are there?	☐ *single window with single glazing* ☐ *single window with double glazing* ☐ *coupled window* ☐ *box type window* ☐ *winter window* ☐ *single sash* ☐ *two sashes* ☐ *additional upper sash* ☐ *sliding sashes* ☐ *fixed windows*
2	**Priority**	Is there a need to improve the energy performance of windows?	☐ *yes* ☐ *no*
3	**Parts to be preserved**	Are there parts original? Should the frame be kept? Should the glazing be kept?	☐ *no* ☐ *frame original and should be kept* ☐ *glazing original and should be kept*
4	**Space**	Is there space for an additional window layer inside or outside? Think also about positive co-benefits: With interior insulation adding a window layer inside e.g., would avoid window reveal insulation.	☐ *no* ☐ *there is space outside* ☐ *there is space inside*
5	**Shading**	Is there a shading system in place? Would a shading system be needed?	☐ *there is an exterior shading* ☐ *there is an interior shading* ☐ *shading would be needed* ☐ *no*
6	**Visibility**	Can the solution be visible? Are there limits for a potential aesthetic impact?	☐ *no visibility/aesthetic impact acceptable* ☐ *minor from the inside acceptable* ☐ *from the inside acceptable* ☐ *minor from the outside acceptable*

			☐ *from the outside acceptable* ☐ *from both sides acceptable*
7	**Reversibility**	Is reversibility important? If yes, on which parts?	☐ *yes* ☐ *yes, partly* ☐ *no*
8	**Sustainability**	Does the project have a focus on sustainability and embodied energy/carbon?	☐ *yes* ☐ *no*
9	**Cost**	Is the project very limited in terms of cost?	☐ *yes, the financial frame is very tight* ☐ *focus is on long term optimal solution* ☐ *investment in carbon reduction measures is fine*
10	**Installation**	Are local craftsmen available?	☐ *yes, with restoration competences* ☐ *yes, they can produce replica* ☐ *no, but in future hopefully yes* ☐ *no*
11	**Ventilation**	How is the building ventilated?	☐ *opening windows* ☐ *trickle vents* ☐ *exhaust ventilation* ☐ *ventilation with heat recovery*

4.1. Potential limitations on results regarding building typology

In order to better understand the applicability of insulation systems and window retrofit solutions across different European contexts, a typology-based assessment was conducted in four countries: Spain (ES), Poland (PL), Sweden (SE), and Scotland (SC). The analysis for each country is presented in two summary tables (Table 13 and Table 14).

Table 13 addresses the feasibility of applying insulation systems with respect to envelope element, system thickness, material type and technical performance (e.g., U-value and thermal conductivity), as well as aspects related to reversibility, embodied energy and installation. Table 14 covers national observations and constraints for window retrofits, including typology-specific conditions, preservation of original elements, technical feasibility, shading options, visual impact, reversibility, sustainability, cost and the availability of local craftsmen.

The collected information highlights the influence of building typology, protection level, and national or regional regulations on the selection, design, and implementation of energy retrofit interventions. It also reveals variability in technical possibilities and decision-making priorities between countries.

Table 13. Notes on insulation system questions and typology assessments for each country.

Nr	Question	Spain (ES)	Poland (PL)	Sweden (SE)	Scotland (SC)
1	**Envelope element** What part of the building envelope can the insulation be applied to (walls, roof, floor)?	External insulation is only possible when the volume can be increased (walls and roof) and if there are not decorative façade elements to be preserved. Cavity walls are not present in these typologies. Basement is not a common element in these typologies. If present, insulation can be applied; however, if the floor finishing is to be preserved it may be difficult to apply. Insulation below the roof structure is only possible if the minimum space height is preserved and if the original appearance can be modified. Attic floor can be insulated only if the attic is not inhabited.	In heritage-sensitive contexts, no change of volume is possible. Therefore, it is not acceptable to insulate external walls and roof from the outside. In *Typology 1*, walls can be insulated from the outside only on the back facade or the side facade (if there is no other building or decorative details there). In *Typology 2*, there's no possibility of adding external insulation to any wall. Walls can be insulated from the inside, but there might be some restrictions, such as moulding or frescos (the latter not very common). There are no other restrictions in insulating from the inside (walls, ceilings, floors, roof). There are no cavity walls in both typologies.	*Typology 1* is a building generally under highest heritage protection level. For this reason, external insulation in all envelope parts (wall, roof, ground floor) is in general not possible. Exceptions can be negotiated eventually for specific buildings. *Typology 2* is more common and less protected but possibility of external insulation should also be checked case by case. For both typologies, internal insulation is feasible, but this must be checked, and no cavity wall insulation can be considered as a lack of cavity wall is characteristic of *Typology 2*. Some solutions can also be considered for basement insulation in *Typology 2*. Insulation of the roof (above, below, between the structural elements) must be considered case by case and no "a priori" exclusions should be made.	Cavity wall insulation (i.e., insulation between the stone wall and lath and plaster) would be the preferred option in both typologies. It may need disclosure and should be considered together with finding a solution for the wooden cladded window reveals. Exterior insulation is usually not an option. Interior insulation is probably not possible in listed buildings but might be in conservation areas and should always be considered together with window reveals. In very specific cases replacing lath and plaster can be considered. As regards the floor, in quite some cases in both typologies there will be a suspended floor which is "crawlable" and can thus be insulated "from below". In the other cases the flooring will have to be lifted. As regards the roof, in both building typologies, insulating the attic ceiling floor would be preferred upon insulating the roof below or between rafters - and will actually often be possible since attics are often not used as living spaces.

					Insulation above the existing roof might be considered in *Typology 1*, under the condition that the Scottish slate is preserved and the added layer is thin enough not to influence the detailing.
2	**System thickness** What is the maximum possible thickness of the insulation system?	The most compatible thickness for insulation is up to 5 cm for any element. Thicker insulation can be applied if regulation and space available allow it (could be easier to increase the thickness in back facades).	Thickness of insulation system is restricted only on outside walls, to keep the details, volume, and size of window openings. The system thickness shouldn't exceed 10 cm.	For both typologies there are not clear limitations in terms of insulation thickness. However, the final assessment must be done for the specific case considering eventual limitations and condensation risk for internal insulation. Moreover, for internal insulation, the thickness of the insulation layer should account also for eventual limitations associated with characteristics and usage of the building.	For walls and cavity insulation the available space is usually less than 5 cm, idem for "on roof" insulation. For the very specific cases, where interior insulation is replacing lath and plaster, up to 10 cm are possible. More than 20 cm would be possible for the option "attic floor insulation" and when insulating the suspended floor.
3	**Insulation material** Which of the following insulation material types are suitable for use in an insulation system?	All materials are suitable if the finish is compatible with the heritage requirements and if the material is compliant with fire safety regulation.	Oil-based polymers are usually not accepted by authorities in listed buildings and by existing wooden structures (walls, roof). Biobased solutions are only accepted if they have local or European certification.	The group does not have the necessary expertise to answer this question. In general, there is a preference for natural materials but it is only a preference.	Mineral wool based systems not for wall but yes for roof insulation. Mineral board based systems are thinkable when replacing lath and plaster is possible, the not flat cut stones being a challenge. Oil-based systems are not per se excluded, typically suitable for the floor directly on the ground or as EPS beads blown in cavities. Biobased systems as wood fibre are thinkable for roof insulation, providing additional inertia. Insulation plasters are suitable

					inside instead of lath and plaster and potentially on the back façade (if possible with sharp edges).
4	**U-value** What is the expected U-value for the insulation system based on the selected material and thickness?	If building (or element) is not listed, CTE (Spanish legal targets) must be met, including maximum U-values for envelope elements by climate zone.	No specific requirements.	The group does not have the necessary expertise to answer this question. However, the intervention must consider eventual specific limitations in terms of U-value after renovation from National regulation.	According building standards.
5	**Thermal conductivity** What is the expected thermal conductivity (λ-value) for the insulation system based on the selected material and thickness?	No specific requirements.	No specific requirements.	The group has not the necessary expertise to answer this question. However, the intervention must consider eventual specific limitations in terms of Thermal conductivity after renovation from National regulation.	No specific requirements.
6	**Fire protection** What fire protection class should the insulation system or material meet according to EN 15301?	External maximum accepted is C s3 d0; internal insulation has to have a minimum fire protection class C s2 d0.	Suggested fire class A1 or A2. Fire protection has high priority. Flammable materials (Class E) are usually not allowed. Local regulations describe the minimum time of stopping and not spreading fire.	The fire protection level depends in general on a series of parameters as the specific building usage. In general non-flammable materials seem better but there is no general mandate at typology level.	Suggested fire class A1 or A2. Fire protection has high priority.

7	**Vapour-tightness** Should the insulation material prevent moisture movement (i.e., should it be vapour-tight), or is a vapour-open system preferred?	No restrictions.	No regulations, but preferred vapour-open systems.	No "a priori" answer and no known regulation. The choice of vapour-open/tight material, however, should be done as part of the design process accounting in general for the physical characteristics and behaviour of the insulation material and of the wall stratigraphy.	Vapour tight systems are usually discouraged. Vapour open systems which are also capillary active are preferable.
8	**Recyclability** Should the insulation system be recyclable at the end of its life cycle?	Recyclability is desirable.	No specific requirements.	No specific requirements as of today. However, regulations with specific requirements about recyclability are expected in the near future.	Recyclability is desirable, but it is not a cut-out criterion.
9	**Reversibility** Should the insulation system allow for disassembly without damaging the existing building structure?	Reversibility is preferred.	No regulations, but reversible systems are preferred. Non-reversible systems are possible only for a lower class of listed buildings (of local significance).	In general, the solution should be reversible. However, as reported above, there are cases, especially for *Typology 1* that, being under the maximum level of protection, simply do not allow interventions, also if reversible.	In listed buildings a clear yes. Overall, it is desirable. It depends however also on the building element: the insulation of the basement will often not be reversable, but this is acceptable.
10	**Embodied energy** What should be the embodied energy of the insulation system (energy required for extraction, manufacturing, and transport)?	Low embodied energy is desirable.	No specific requirements.	The group has not the necessary expertise to answer this question.	Focus on carbon rather than embodied energy and on overall life cycle – embodied part being part of the story.
11	**Average lifetime** What is the expected	The longest possible lifetime is desirable.	No specific requirements.	This parameter does not depend on the typology but on the	No systems below 25 years. It should be good practice to use

	average lifetime of the insulation system?			characteristic of the insulation system. There are specific tables and regulations about these aspects. In general, not less than 25 years. More in the range of 50 years.	long lasting systems.
12	**Price** What is the approximate price range of the new insulation system?	No range, but the largest investment would generally be for the walls because they have the greatest impact.	No range. More expensive options (premium or specialised systems) are possible if they meet other requirements.	This aspect is related not only on the typology but on the specific building context (usage, users, founds availability, objective and limits of the renovation):	Question for the owners.
13	**Supplier** Are there any limitations regarding the supplier of the insulation system (e.g., local availability, limited options)?	For public buildings the supplier should be in Spain.	Only certified products and suppliers are approved. Possible certifications: CE, Polska Norma, Aprobata Techniczna.	No general indications about this point.	Limitations might be on installers e.g., for hemp.
14	**Installation** What should the installation process be for this insulation system?	Spray-application is excluded.	No specific requirements.	No "a priori" answer. It depends on the specific case.	Spray-on, external cladding and in-sulated plasterboard are excluded. Board/panel insulation is suitable if the surface is flat enough. Batt or roll typically for floor and roof.
15	**Prefabrication** Should the insulation system be available in prefabricated panels or modules?	Prefabricated elements are favoured as reducing the installation process is important for inhabited residential buildings:	No specific requirements.	No specific requirements.	Reduction of disturbance time for residents is preferable.

Table 14. Notes on window retrofit questions and typology assessments for each country.

Nr	Checkpoint	Spain (ES)	Poland (PL)	Sweden (SE)	Scotland (SC)
1	**Existing windows** What kind of windows are there?	Most common windows are double sash; sometimes single sash can be found (sliding sashes and fixed windows can be found in service spaces). When original windows are in place, they are single window with single glazing; if they have been replaced, they are single window with double glazing.	Most buildings originally had box type windows, but in many cases, they have been replaced with single windows with double glazing. Single windows with single glazing exist if they were not modernised in the last 60 years. There are also buildings with original or modernised box type windows. Nowadays, new windows should have triple glazing. In *Typology 1*, fixed windows are also possible.	Both typologies present coupled windows with two sashes. This kind of configuration (couple windows with two sashes) is, by far, the most common.	In both typologies windows with sliding sashes are in place, usually with single glazing. In *Typology 1*, some might already have been fitted with slim double glazing.
2	**Priority** Is there a need to improve the energy performance of windows?	Yes.	Yes, windows are often the first element of a building to improve.	In general, yes, windows need renovations in both typologies.	Yes, seen the size of windows this is a major priority.
3	**Parts to be preserved** Are there parts original? Should the frame be kept? Should the glazing be kept?	If original frame is present, it should be preserved. The original glazing should be preserved only if it is decorated.	Windows are usually not original anymore. Existing windows can be replaced with new wooden ones, just like the original. Plastic ones are not allowed. The frame is required to be kept only in listed buildings, but there is often not enough craftsmanship to preserve the frame. Original glazing must be maintained only if it is special (e.g., rolled or stained glass).	No "a priori" indications. In general, it depends on the specific building considered.	This would depend on the building status (listed, conservation area) and the building component. Original frame should be kept, original glazing too – but in practice this has been lost more often (at the *Typology 1*, 40% of glazing are original)

4	**Space** Is there space for an additional window layer inside or outside?	There is space outside because usually in Andalusia the windows are on the interior edge of wall; however, the addition of a window outer side is regulated by heritage authorities.	If an original box type window has been replaced with a single window, a space for an additional window layer can usually be found inside.	Usually, there is no space for an additional window as coupled windows are already present.	There is no space outside. Inside solutions would be difficult – compatible with shutters in the reveals would have to be found, still resulting in very large sashes. Sliding doors could be helpful.
5	**Shading** Is there a shading system in place? Would a shading system be needed?	Usually there are "Persianas" outside, sometimes shutters. Shutter can also be found inside sometimes.	There is no shading system. There is almost no possibility of adding any shading, as it changes the external appearance. The only option is to add a thin shading in the layer of external insulation if applied.	Shadings are generally not present. They will be probably more and more needed in the future. The possibility to put external or internal shading will depend on the specific condition (listed/non listed/other limitations) of the specific building considered. No "a priori" limitations.	Internal shutters and curtains are usually there.
6	**Visibility** Can the solution be visible? Are there limits for a potential aesthetic impact?	Preserving outer appearance is more important for both typologies: changing only the glazing is the most compatible option.	There are usually no limits regarding visibility from the inside. From the outside, only minor changes are acceptable. New windows should be like the old ones.	Not clear limits at typology level but eventual limits must be checked case by case. As reported also in other parts, *Typology 1* is in the highest protection level, therefore possible interventions on outside are limited and should be discussed/negotiated case by case. *Typology 2* generally present a lower level of protection.	From the outside only minor visibility would be acceptable. There is more flexibility inside.
7	**Reversibility** Is reversibility important? If yes, on which parts?	Yes, it is important, with no specifications on the parts.	No specific requirements.	In general, reversibility is welcome but with no clear regulation on specific aspects about windows recyclability.	Depends on the protection status. Generally, “yes”. If the window has already been changed, reversibility might not be first priority, but still good practice.

8	**Sustainability** Does the project have a focus on sustainability and embodied energy/carbon?	Sustainability and low carbon solutions are desirable.	No specific requirements.	No specific requirements.	Sustainability and low carbon solutions are desirable, but it is not cut-out criterion.
9	**Cost** Is the project very limited in terms of cost?	The largest investment would generally be for the walls because they have the greatest impact.	In social housing, the financial frame is tight. In private buildings, the focus is on long-term optimisation.	No "a priori" answers. In general, it depends on the specific building considered.	Question for the owner.
10	**Installation** Are local craftsmen available?	Very few local specialists could be able to produce replicas, hopefully there will be more in the future.	Local craftsmen are available. The ones with conservation competencies are preferable. If conservation is not possible, craftsmen can produce a replica.	The group has not enough expertise to assess this point. In general, local installers are present. Not clear and to be checked is the level of knowledge in specific fields of windows restoration.	Yes, there are craftsmen available – both for restoration and production of replica. They might not be trained on innovative energy solutions.
11	**Ventilation** How is the building ventilated?	Through windows and exhaust ventilation (the latter is not original).	All *Typology 1* and *2* buildings have stack ventilation, drawing cooler air in through windows' leaks or vents and expelling warmer air out through chimneys. Additionally, buildings are ventilated by opening windows. Mechanical ventilation with heat recovery is not common.	Mechanical Ventilation System is present only if the building undergone a renovation in the last years.	Opening windows and trickle vents are the most common ventilation strategies.

4.2. Review of limitations of solutions

Review of all passive solutions regarding their limitations in each typology is shown in tables below (Table 15 to Table 23). Solutions are marked possible ✓, impossible X or possible with some restrictions ?. The number in brackets relates to the question in *Section 4.1. Potential limitations on results regarding building typology*.

This cross-referenced approach allows designers and decision-makers to quickly identify which solutions may be applicable to a given building type and which limitations must be taken into account. The goal is to support informed choices during the planning of energy retrofits, especially in heritage-sensitive contexts.

Table 15. Assessment of internal insulation systems for each typology.

Nr	Solution	ES 1	ES 2	PL 1	PL 2	SE 1	SE 2	SC 1	SC 2	SC 3
1	Aerogel blanket/matt	? (6)	? (6)	✓	✓	? (3)	? (3)	? (6)	? (1,6)	? (1,6)
2	Aerogel board	? (6,10)	? (6,10)	? (10)	? (10)	? (3,10)	? (3,10)	? (6)	? (1,6,14)	? (1,6,14)
3	Aerogel insulating plaster	? (6)	? (6)	✓	✓	? (3,8,10)	? (3,8,10)	✓	? (1)	? (1)
4	Autoclaved cellular concrete (AAC)	✓	✓	✓	✓	? (3,8)	? (3,8)	✓	? (1,14)	? (1,14)
5	Calcium silicate boards	✓	✓	✓	✓	✓	✓	✓	? (1,14)	? (1,14)
6	Calcium silicate board with core made of high-performance insulation material (PU, foam glass, VIP)	? (6)	? (6)	✓	✓	? (3)	? (3)	✓	? (1,14)	? (1,14)
7	Cellulose (loose/blown-in/dry application)	✓	✓	? (3,6,7)	? (3,6,7)	? (3)	? (3)	X (6)	? (1,6)	? (1,6)
8	Cellulose (wet application)	✓	✓	? (3,6)	? (3,6)	? (3)	? (3)	? (6)	? (1,3,6)	? (1,3,6)
9	Cellulose batts or rolls	X (6)	X (6)	? (3,6,7,10)	? (3,6,7,10)	? (3,10)	? (3,10)	X (6)	X (6)	X (6)
10	Clay cork insulation	X (6)	X (6)	? (3,6,10)	? (3,6,10)	? (8,10)	? (8,10)	X (6)	X (6)	X (6)
11	Cork insulation	X (6)	X (6)	? (3,6,10)	? (3,6,10)	? (8,10)	? (8,10)	X (6)	X (6)	X (6)
12	Flax insulation	X (6)	X (6)	? (3,6,7)	? (3,6,7)	? (3,8)	? (3,8)	X (6)	X (6)	X (6)
13	Foam glass	✓	✓	? (7)	? (7)	? (3,8)	? (3,8)	X (7)	X (7)	X (7)
14	Hemp fibre	X (6)	X (6)	? (3,6,7)	? (3,6,7)	? (3)	? (3)	X (6,7)	X (6,7)	X (6,7)
15	Hemp+lime insulation	✓	✓	? (3,10)	? (3,10)	? (10)	? (10)	? (6)	? (1,6)	? (1,6)
16	Mineral wool	✓	✓	? (7,10)	? (7,10)	? (3,8)	? (3,8)	X (7)	X (3,7)	X (3,7)
17	Perlite insulation board	✓	✓	✓	✓	? (3)	? (3)	✓	? (1,14)	? (1,14)
18	Phenolic foam boards	? (6,10)	? (6,10)	? (3,6,7,10)	? (3,6,7,10)	? (3,10)	? (3,10)	X (6,7)	X (6,7)	X (6,7)

Nr	Solution	ES 1	ES 2	PL 1	PL 2	SE 1	SE 2	SC 1	SC 2	SC 3
19	Polystyrene/EPS/XPS	? (6,10)	? (6,10)	? (3,6,7,10)	? (3,6,7,10)	? (3,8,10)	? (3,8,10)	X (6,7)	X (6,7)	X (6,7)
20	Polyurethane insulation (PIR/PUR)	? (6,10)	? (6,10)	? (3,6,7,10)	? (3,6,7,10)	? (3,8,10)	? (3,8,10)	X (6,7)	X (6,7)	X (6,7)
21	PU-foam with calcium silicate channels	? (2)	? (2)	? (3,6)	? (3,6)	? (3,8)	? (3,8)	? (6)	? (1,6,14)	? (1,6,14)
22	Recycled textile	? (6)	? (6)	? (6)	? (6)	? (3)	? (3)	? (6)	? (1,6)	? (1,6)
23	Reed insulation	X (6)	X (6)	? (3,6,10)	? (3,6,10)	✓	✓	? (6,7)	X (6,7)	X (6,7)
24	Sheep wool	? (6)	? (6)	? (3,6,7)	? (3,6,7)	? (6)	? (6)	? (6,7)	X (6,7)	X (6,7)
25	Thermal insulation glazing	? (2)	? (2)	? (7)	? (7)	? (1)	? (1)	X (7)	X (7)	X (7)
26	Thermal insulation plaster	✓	✓	✓	✓	? (8)	? (8)	✓	? (1)	? (1)
27	Thermoreflective insulation	? (6)	? (6)	? (6,7)	? (6,7)	? (3)	? (3)	X (7)	X (6,7)	X (6,7)
28	Vacuum Insulation Panel (VIP)	X (6)	X (6)	? (6,7)	? (6,7)	? (13)	? (13)	X (7)	X (6,7)	X (6,7)
29	Ventilated interior insulation (RetroWall)	? (2)	? (2)	? (7)	? (7)	? (3)	? (3)	X (7)	X (7)	X (7)
30	Wood fibre board	X (6)	X (6)	? (3,6,10)	? (3,6,10)	? (10)	? (10)	? (6)	? (1,6)	? (1,6)
31	Wood fibre board with vapour control layer	X (6)	X (6)	? (3,6,10)	? (3,6,10)	? (3,10)	? (3,10)	? (6)	? (1,6)	? (1,6)

Table 16. Assessment of external insulation systems for each typology.

Nr	Solution	ES 1	ES 2	PL 1	PL 2	SE 1	SE 2	SC 1	SC 2	SC 3
1	Aerogel insulating plaster	? (1,2)	? (1,2)	? (1, 2)	X (1)	X (1)	? (1,3,8)	? (1)	? (3)	? (3)
2	Cavity wall insulation with insulation granulate	? (1,2)	? (1,2)	X (1)	X (1)	X (1)	X (1)	? (1)	X (1)	X (1)
3	Cellulose in timber frame	? (1,2)	? (1,2)	? (1,2,3)	X (1)	X (1)	X (1)	? (1,6)	X (1)	X (1)
4	Foam glass	? (1,2)	? (1,2)	? (1,2)	X (1)	X (1)	? (3,8)	? (1)	X (1)	X (1)
5	Hemp insulation board	? (1,2)	? (1,2)	? (1,2,3)	X (1)	X (1)	? (3)	? (1,6)	X (1)	X (1)
6	Insulation cork boards	? (1,2)	? (1,2)	? (1,2,3)	X (1)	X (1)	? (12)	? (1)	X (1)	X (1)
7	Mineral insulation boards	? (1,2)	? (1,2)	? (1,2)	X (1)	X (1)	? (3,8)	? (1,6)	X (1)	X (1)
8	Mineral wool insulation	? (1,2,10)	? (1,2,10)	? (1,2,10)	X (1)	X (1)	? (3,8,10)	? (1)	X (1)	X (1)
9	Phenolic foam boards	X (6)	X (6)	? (1,2,3,6,10)	X (1)	X (1)	? (3,8,10)	X (1,6)	X (1)	X (1)
10	Polystyrene insulation (EPS/XPS)	X (6)	X (6)	? (1,2,3,6,10)	X (1)	X (1)	? (3,8,10)	X (1,6)	X (1)	X (1)
11	Polyurethane insulation (PIR/PUR)	? (1,2,6,10)	? (1,2,6,10)	? (1,2,3,6,10)	X (1)	X (1)	? (3,8,10)	X (1,6)	X (1)	X (1)
12	Prefabricated modules with cellulose	? (1,2)	? (1,2)	X (2)	X (1)	X (1)	? (3)	? (1,6)	X (1)	X (1)
13	Reed insulation	X (6)	X (6)	? (1,2,3,6)	X (1)	X (1)	✓	X (1,6)	X (1)	X (1)
14	Thermal insulating plaster	? (1,2)	? (1,2)	? (1,2)	X (1)	X (1)	? (3,8)	? (1)	? (3)	? (3)
15	Vacuum Insulation Panels (VIP)	X (6)	X (6)	? (1,2,6)	X (1)	X (1)	X (13)	X (1,6)	X (1)	X (1)
16	Wood fibre/wood wool insulation	X (6)	X (6)	? (1,2,3,6)	X (1)	X (1)	? (1,8)	X (1,6)	X (1)	X (1)

Table 17. Assessment of roof insulation systems for each typology.

Nr	Solution	ES 1	ES 2	PL 1	PL 2	SE 1	SE 2	SC 1	SC 2	SC 3
1	Blown-in cellulose in attic	? (1,2)	? (1,2)	? (3)	? (3)	? (3)	? (3)	? (6)	? (6)	? (6)
2	Clay boards	? (1,2)	? (1,2)	? (3)	? (3)	✓	✓	✓	✓	✓
3	Construction wood + cellulose	? (1,2)	? (1,2)	? (3)	? (3)	? (3)	? (3)	? (6)	X (6)	? (6)
4	Construction wood + mineral wool/glass wool/rock wool	? (1,2)	? (1,2)	✓	✓	? (3)	? (3)	✓	✓	✓
5	Construction wood + plant fiber insulation	X (6)	X (6)	? (3,6)	? (3,6)	? (3)	? (3)	✓	X (6)	X (6)
6	Construction wood + sheep wool	X (6)	X (6)	? (3,6)	? (3,6)	✓	✓	X (6)	X (6)	X (6)
7	Construction wood + wood fibre	X (6)	X (6)	? (3,6)	? (3,6)	✓	✓	X (6)	X (6)	X (6)
8	Flat roof insulation with polystyrene (EPS/XPS)	X (6)	X (6)	X (1)	X (1)	X (1)	X (1)	X (3,6)	X (6)	X (6)
9	Foam glass	? (1,2,10)	? (1,2,10)	? (1,10)	? (1,10)	? (1,3,10)	? (1,3,10)	? (1)	? (1)	X (1)
10	Insulation panels with Polystyrene/Polyurethan	X (6)	X (6)	? (1,3,6,10)	? (1,3,6,10)	? (1,3,10)	? (1,3,10)	X (3,6)	X (6)	X (6)
11	Mineral wool/glass wool/rock wool (inside)	? (1,2)	? (1,2)	✓	✓	? (3)	? (3)	✓	✓	✓
12	Mineral wool/glass wool/rock wool (loose/blown-in)	? (1,2)	? (1,2)	? (1)	? (1)	X (1)	? (1,3)	✓	✓	✓
13	Mineral wool/glass wool/rock wool (outside)	? (1,2)	? (1,2)	? (1)	? (1)	X (1)	? (1,3)	? (1)	? (1)	X (1)
14	Mineralised fir wood wool bound with Portland cement	? (1,2,10)	? (1,2,10)	? (1,3,10)	? (1,3,10)	X (1)	? (1,10)	X (6)	? (1,6)	X (1)
15	Wood fibre (outside)	X (6)	X (6)	? (1,3,6)	? (1,3,6)	X (1)	? (1,3)	✓	? (1,6)	X (1)
16	Wood fibre/wood wool (inside)	X (6)	X (6)	? (3,6)	? (3,6)	? (3)	? (3)	✓	✓	✓

Table 18. Assessment of basement and foundation insulation systems for each typology.

Nr	Solution	ES 1	ES 2	PL 1	PL 2	SE 1	SE 2	SC 1	SC 2	SC 3
1	Aerogel composite panel on the floor	? (1,2)	? (1,2)	✓	✓	? (3)	? (3)	✓	✓	✓
2	Blown-in cellulose	? (1,2)	? (1,2)	? (3)	? (3)	X (1)	X (1)	? (6)	? (6)	? (6)
3	External insulation on foundation: EPS/XPS	? (1,2,10)	? (1,2,10)	? (1,2,3,6,10)	X (1)	X (1)	? (1,3,10)	n.a.	n.a.	n.a.
4	External insulation on foundation: foam glass	? (1,2)	? (1,2)	? (1,2)	X (1)	X (1)	? (1,3,8)	n.a.	n.a.	n.a.
5	External insulation on foundation: mineral boards	? (1,2)	? (1,2)	? (1,2)	X (1)	X (1)	? (1,3,8)	n.a.	n.a.	n.a.
6	External insulation on foundation: Vacuum Insulation Panels (VIP)	? (1,2,10)	? (1,2,10)	? (1,2,10)	X (1)	X (1)	X (13)	n.a.	n.a.	n.a.
7	Foam glass on the floor	? (1,2)	? (1,2)	✓	✓	? (3,8)	? (3,8)	✓	✓	✓
8	Lightweight expanded clay insulation on the floor	? (1,2)	? (1,2)	✓	✓	? (2)	? (2)	✓	✓	✓
9	Lightweight insulating concrete on the floor	? (1,2,10)	? (1,2,10)	? (10)	? (10)	? (2,3,8)	? (3,8)	? (9)	? (9)	? (9)
10	Lime-hemp concrete on the floor	? (1,2,10)	? (1,2,10)	? (3,10)	? (3,10)	? (10)	? (10)	? (6,9)	? (6,9)	? (6,9)
11	Mineral wool between beams/joists	? (1,2)	? (1,2)	✓	✓	? (3)	? (3)	? (3)	✓	✓
12	Mineral wool on the floor	? (1,2)	? (1,2)	✓	✓	? (3)	? (3)	? (3)	✓	✓
13	Mineral wool under the ceiling	? (1,2)	? (1,2)	✓	✓	? (3)	? (3)	? (3)	✓	✓
14	Polystyrene/EPS/XPS on the floor	X (6)	X (6)	? (3,6,10)	? (3,6,10)	? (3,10)	? (3,10)	? (6)	? (6)	? (6)
15	Polystyrene/EPS/XPS under the ceiling	X (6)	X (6)	? (3,6,10)	? (3,6,10)	? (3,10)	? (3,10)	? (6)	? (6)	? (6)
16	Polyurethane/PUR/PIR on the floor	X (6)	X (6)	? (3,6,10)	? (3,6,10)	? (3,10)	? (3,10)	? (6)	? (6)	? (6)
17	Wood wool insulation on the floor	X (6)	X (6)	? (3,6)	? (3,6)	? (6)	? (6)	? (6)	? (6)	? (6)

Table 19. Assessment of window retrofit solutions for the ***Polish*** *typologies, where a* ***box-type window is still in place****: (pre-filter: solutions for box-type windows (1).*

Nr	Solution	$U_{w,before}$ (2)	$U_{w,after}$ (2)	Aesthetic impact (6)	Material impact (3)	Cost (9)	PL 1	PL 2
1A0v	Repair window	n.a.	n.a.	no	no	€	? (2)	? (2)
1B4a	Add sealing to the inner layer of a box type window	2,4	2,4	no	minor	€	? (2)	? (2)
1C4b	Add soft coating to box type window	2,4	2,00	minor inside	no	€	? (2)	? (2)
2A4d	Replace the single glazing of the inner layer in a box type window with double glazing	2,4	1,15	minor inside	partial	€€	✓	✓
2A4e	Replace the single glazing of the inner layer in a box type window with thin double glazing	2,4	1,23	minor inside	partial	€€	✓	✓
2A4g	Replace the single glazing of the inner layer in a box type window with thin triple glazing	2,4	0,99	minor inside	partial	€€	✓	✓
2A4h	Replace the single glazing of the inner layer in a box type window with vacuum glazing	2,4	1,07	minor inside	partial	€€	✓	✓
2C4i	Add a low-e glazing with minimised frame to the inner layer of a box-type window	2,4	1,81	minor inside	no	€	? (2)	? (2)
2E4m	Replace the inner sashes of a box-type window with a new wooden double ins. glazing window	2,4	0,87	minor inside	partial	€€	? (3)	? (3)
2E4n	Replace the inner sashes of a box-type window with a new wooden triple glazing window	2,4	0,72	minor inside	partial	€€	? (3)	? (3)
3A4c	Replace the single glazing of the outer layer of a box-type window with low-e glazing	2,4	1,99	minor outside	partial	€€	? (2)	? (2)
3A4d	Replace the single glazing of the outer layer of a box-type window with double ins. glazing	2,4	1,15	minor outside	partial	€€	✓	✓
3A4e	Replace the single glazing of the outer layer of a box-type window with thin double ins.glazing	2,4	1,23	minor outside	partial	€€	✓	✓
3A4g	Replace the single glazing of the outer layer of a box-type window with thin triple glazing	2,4	0,99	minor outside	partial	€€	✓	✓
3A4h	Replace the single glazing of the outer layer of a box-type window with thin vacuum glazing	2,4	1,07	minor outside	partial	€€	✓	✓
3C4m	Replace the outer sashes of a box-type window with a new wooden double ins. glazing window	2,4	1,07	minor outside	partial	€€	? (3)	? (3)
3C4n	Replace the outer sashes of a box-type window with a new wooden triple glazing window	2,4	0,84	minor outside	partial	€€	? (3)	? (3)
4A4s	Substitute the box type window with a replica wooden box-type window with double ins. glazing	2,4	1,05	minor both	complete	€€€€	X (1)	X (1)
4A4u	Substitute the box type window with a replica wooden box-type window with thin triple glazing	2,4	0,7	both sides	complete	€€€€	? (3,6,9)	? (3,6,9)
4B4m	Substitute the existing box-type window with a new window with double insulating glazing	2,4	1,37	both sides	complete	€€	X (1)	X (1)
4B4n	Substitute the existing box-type window with a new window with triple glazing	2,4	1,02	both sides	complete	€€	? (3)	? (3)

*Table 20. Assessment of window retrofit solutions for the **Polish** typologies, where the **original single glazing** window is still in place – assuming these are all **listed** buildings: (pre-filter: solutions for single window with single glazing (1).*

Nr	Solution	$U_{w,before}$ (2)	$U_{w,after}$ (2)	Aesthetic impact (6)	Material impact (3)	Cost (9)	PL 1	PL 2
1A0v	Repair window	n.a.	n.a.	no	no	€	? (2)	? (2)
1B1a	Add sealing to a single glazed window	4,8	4,8	no	minor	€	? (2)	? (2)
1C1b	Add soft coating to window with single glazing	4,8	3,41	minor inside	no	€	? (2)	? (2)
2C1i	Add a low-e glazing with minimised frame to a single window with single glazing	4,8	2,47	minor inside	no	€	? (2)	? (2)
2C1d	Add a double insulating glazing to upgrade the existing single to a coupled window	4,8	1,27	inside	no	€€	✓	✓
2C1j	Add a vacuum glazing with minimised frame to a single window with single glazing	4,8	1,25	minor inside	no	€€	✓	✓
2D1m	Upgrade a single window to box-type window with an addit. window with double glazing inside	4,8	1,07	inside	no	€€	✓	✓
2D1n	Upgrade a single window to box-type window with an addit. window with triple glazing inside	4,8	0,84	inside	no	€€	✓	✓
3A1c	Replace the single glazing with low-e glazing	4,8	3,40	minor both	partial	€€	? (2)	? (2)
3A1d	Replace the single glazing with double insulating glazing	4,8	1,52	minor both	partial	€€	? (2)	? (2)
3A1e	Replace the single glazing with thin double insulating glazing	4,8	1,66	minor both	partial	€€	? (2)	? (2)
3A1g	Replace the single glazing with thin triple glazing	4,8	1,24	minor both	partial	€€	✓	✓
3A1h	Replace the single glazing with thin vacuum glazing	4,8	1,38	minor both	partial	€€	✓	✓
3B1k	Add a window with single glazing on the outside	4,8	2,36	outside	no	€€	X (6)	X (6)
3B1l	Add a window with low-e glazing on the outside	4,8	1,94	outside	no	€€	X (6)	X (6)
3B1m	Add a window with double insulating glazing on the outside	4,8	1,07	outside	no	€€	X (6)	X (6)
3B1n	Add a window with triple insulating glazing on the outside	4,8	0,847	outside	no	€€	X (6)	X (6)
4A1m	Substitute the existing single window with a replica wooden window with double glazing	4,8	1,37	minor both	complete	€€€	X (1)	X (1)
4A1n	Substitute the existing single window with a replica wooden window with triple glazing	4,8	1,02	minor both	complete	€€€	X (3)	X (3)
4A1o	Substitute the existing single window with a replica wooden window with thin double glazing	4,8	1,51	minor both	complete	€€€	X (3)	X (3)
4A1p	Substitute the existing single window with a replica wooden window with thin triple glazing	4,8	1,09	minor both	complete	€€€	X (3)	X (3)
4A1q	Substitute the existing single window with a replica wooden window with vacuum glazing	4,8	1,23	minor both	complete	€€€	X (3)	X (3)
4B1m	Substitute the single window with single glazing with a new window with double insul. glazing	4,8	1,37	both sides	complete	€€	X (1)	X (1)
4B1n	Substitute the existing single window with single glazing with a new window with triple glazing	4,8	1,02	both sides	complete	€€	X (3)	X (3)

*Table 21. Assessment of window retrofit solutions for the **Polish** typologies, where the windows have been **changed to single windows with double glazing**:(pre-filter: solutions for single window with double glazing (1).*

Nr	Solution	$U_{w,before}$ (2)	$U_{w,after}$ (2)	Aesthetic impact (6)	Material impact (3)	Cost (9)	PL 1	PL 2
2C2i	Add a low-e glazing with minimised frame to a single window with double glazing	2,8	1,97	minor inside	no	€	X (2)	X (2)
2D2m	Upgrade a single window with double glazing to box-type window with an additional wooden window with double insulating glazing on the inside	2,8	0,92	inside	no	€€	✓	✓
4B2m	Substitute the existing single window with double glazing with a new window with double insulating glazing	2,8	1,37	both sides	complete	€€	X (1)	X (1)
4B2n	Substitute the existing single window with double glazing with a new window with triple glazing	2,8	1,02	both sides	complete	€€	✓	✓

*Table 22. Assessment of window retrofit solutions for the **Swedish** typologies:(pre-filter: solutions for coupled windows (1).*

Nr	Solution	$U_{w,before}$ (2)	$U_{w,after}$ (2)	Aesthetic impact (6)	Material imp. (3)	Revers. (7)	SE 1	SE 2
1B3a	Add sealing to a coupled window	2,6	2,60	no	minor	no	X (2)	X (2)
2A3h	Replace the single glazing of the inner layer in a coupled window with vacuum glazing	2,6	1,11	minor inside	partial	no	✓	✓
2C3i	Add a low-e glazing with minimised frame (kind duplo duplex or Krampp) to the inner layer of a coupled window	2,6	1,89	minor inside	no	yes	? (2)	? (2)
2D3m	Upgrade a coupled window to box-type window with an additional wooden window with double insulating glazing on the inside	2,6	0,90	inside	no	yes	✓	✓
3A3f	Replace the two glasses of a coupled window with triple glazing	2,6	0,97	minor outside	partial	no	? (6)	✓
3A3f	Replace the two glasses of a coupled window with insulating double glazing	2,6	0,97	minor outside	partial	no	? (6)	✓
4A3r	Substitute the existing coupled window with a replica wooden coupled window with double insulating glazing	2,6	1,05	minor both	complete	no	? (3)	? (3)
4A3t	Substitute the existing coupled window with a replica wooden coupled window with thin triple glazing	2,6	0,70	minor both	complete	no	? (3)	? (3)
4B3m	Substitute the existing coupled window with a new window with double ins. glazing	2,6	1,37	both sides	complete	no	? (2,3,6)	? (2,3,6)
4B3n	Substitute the existing coupled window with a new window with triple glazing	2,6	1,02	both sides	complete	no	? (3,6)	? (3,6)
1A0v	Repair window	n.a.	n.a.	no	no	yes		

Table 23. Assessment of window retrofit solutions for the ***Spanish and Scottish*** *typologies: pre-filter single window with single (or double) glazing.*

Nr	Solution	$U_{w,after}$ (2)	Material loss (3)	Aesthetic impact (6)	Rever-sibility (7)	Sustain-ability (8)	ES 1	ES 2	SC 1	SK 2	SC 3
1A0v	Repair window	n.a.	no	no	yes	very low	? (2)	? (2)	? (2)	? (2)	? (2)
1B1a	Add sealing to a single glazed window	4,8	minor	no	no	very low	? (2)	? (2)	? (2)	? (2)	? (2)
1C1b	Add soft coating to window with single glazing	3,4	no	minor inside	no	very low	? (2)	? (2)	? (2)	? (2)	? (2)
2C1d	Add a double insulating glazing to upgrade the existing single to a coupled window	1,3	no	inside	yes	medium	✓	✓	X (1)	X (1)	X (1)
2C1i	Add a low-e glazing with minimised frame to a single window with single glazing	2,5	no	minor inside	yes	very low	✓	✓	✓	✓	✓
2C1j	Add a vacuum glazing with minimised frame to a single window with single glazing	1,3	no	minor inside	yes	medium	✓	✓	✓	✓	✓
2C2i	Add a low-e glazing with minimised frame to a single window with double glazing	2,0	no	minor inside	yes	very low	✓	✓	✓	✓	✓
2D1m	Upgrade a single window with single glazing to box-type window with an additional wooden window with double glazing on the inside	1,1	no	inside	yes	rather high	? (4)	? (4)	? (4)	? (4)	? (4)
2D1n	Upgrade single window with single glazing to box-type window with add. triple glazing window inside	0,8	no	inside	yes	high	? (4)	? (4)	? (4)	? (4)	? (4)
2D2m	Upgrade single window with double glazing to box-type window with add. double glazing window inside	0,9	no	inside	yes	rather high	? (4)	? (4)	? (4)	? (4)	? (4)
3A1c	Replace the single glazing with low-e glazing	3,4	partial	minor both	no	very low	? (2)	? (2)	? (2)	? (2)	? (2)
3A1d	Replace the single glazing with double glazing	1,5	partial	minor both	no	medium	✓	✓	?	?	?
3A1e	Replace the single glazing with thin double glazing	1,7	partial	minor both	no	low	✓	✓	✓	✓	✓
3A1g	Replace the single glazing with thin triple glazing	1,2	partial	minor both	no	medium	✓	✓	X	X	X
3A1h	Replace the single glazing with thin vacuum glazing	1,4	partial	minor both	no	medium	✓	✓	✓	✓	✓
3B1k	Add a window with single glazing on the outside	2,4	no	outside	yes	medium	? (4,6)	? (4,6)	X (1)	X (1)	X (1)
3B1l	Add a window with low-e glazing on the outside	1,9	no	outside	yes	medium	? (4,6)	? (4,6)	X (1)	X (1)	X (1)
3B1m	Add a window with double glazing on the outside	1,1	no	outside	yes	rather	? (4,6)	? (4,6)	X (1)	X (1)	X (1)

						high					
3B1n	Add a window with triple glazing on the outside	0,8	no	outside	yes	high	? (4,6)	? (4,6)	X (1)	X (1)	X (1)
4A1m	Substitute the existing single window with a replica wooden window with double glazing	1,4	complete	minor both	no	rather high	? (3)	? (3)	? (3)	? (3)	? (3)
4A1n	Substitute the existing single window with a replica wooden window with triple glazing	1,0	complete	minor both	no	high	? (3)	? (3)	X	X	X
4A1o	Substitute the existing single window with a replica wooden window with thin double glazing	1,5	complete	minor both	no	medium	? (3)	? (3)	? (3)	? (3)	? (3)
4A1p	Substitute the existing single window with a replica wooden window with thin triple glazing	1,1	complete	minor both	no	rather high	? (3)	? (3)	? (3)	? (3)	? (3)
4A1q	Substitute the existing single window with a replica wooden window with vacuum glazing	1,2	complete	minor both	no	rather high	? (3)	? (3)	? (3)	? (3)	? (3)
4B1m	Substitute the existing single window with single glazing with a new window with double glazing	1,4	complete	both sides	no	rather high	X (3,6)	X (3,6)	X (3,6)	X (3,6)	X (3,6)
4B1n	Substitute the existing single window with single glazing with a new window with triple glazing	1,0	complete	both sides	no	high	? (3,6)	? (3,6)	X (3,6)	X (3,6)	X (3,6)
4B2m	Substitute the existing single window with double glazing with a new window with double glazing	1,4	complete	both sides	no	rather high	X (3,6)	X (3,6)	X (3,6)	X (3,6)	X (3,6)
4B3n	Substitute the existing single window with double glazing with a new window with triple glazing	1,0	complete	both sides	no	high	X (3,6)	X (3,6)	X (3,6)	X (3,6)	X (3,6)

5. Conclusions and Outlook

The goal of the report was to gather passive solutions used in the retrofitting of historic buildings, with a particular focus on systems currently in use and linked to existing case studies. The intention was to parametrise these solutions in a generalised manner in order to enable comparison between different systems.

During the course of the task, it was decided to divide the work into two parts: insulation systems and window retrofitting, as each require a different approach. The insulation systems were further categorised into four groups based on the building envelope element they address: internal wall insulation, external wall insulation, roof insulation, and basement/foundation insulation. In total, 170 solutions were identified — 80 related to insulation systems and 76 to window retrofitting. All solutions, along with their parameters, are presented in tabular form in this report.

The collected insulation system solutions reflect a variety of retrofit approaches suitable for different scenarios—such as vapour-open or vapour-tight systems, applications for flat or pitched roofs, and installations on basement ceilings or ground floors. Each solution was parametrised based on general characteristics, technical specifications, and sustainability and lifecycle aspects. The majority of solutions were identified for internal wall insulation, as this application presents higher moisture risks and thus requires more specialised approaches. Solutions were categorised according to the primary insulation material. While the category of biobased materials proved to be the most diverse, it was not the most widely used. The highest number of case studies were found for systems using autoclaved aerated concrete, calcium silicate boards, mineral wool, polystyrene, cellulose, and wood fibre.

The window retrofitting solutions were described on two levels: solutions and products, as some products can be implemented across multiple solution types. They were parametrised according to general information, technical specifications, and sustainability and lifecycle aspects. Parameters included e.g., the types of existing windows the solution is compatible with, the expected aesthetic impact on the building, and the availability of existing examples of use. Relevant technical values were also documented.

After collecting the possible passive solutions, their potential applications and limitations were discussed during a workshop in FuturHist. The aim was to identify solutions suitable for the building typologies defined in Task 1.2, considering both the characteristics of the buildings and relevant local regulations and restrictions. Some solutions were found to be unsuitable for certain typologies, while others could only be applied under specific conditions. A final assessment of each passive system must still be conducted on a case-by-case basis for individual buildings.

The results from this task will be integrated into the tools and toolbox developed within Work Package 4 (WP4), while further development and refinement of the described solutions will continue in the subsequent tasks of Work Package 2 (WP2). As FuturHist progresses—and even beyond its duration—new examples may be added, contributing to the continuous expansion and enrichment of the database.

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7. Annex

Annex 1. Review of passive solutions and their parameters.

Annex 1. Review of passive solutions and their parameters

A1.1. Internal wall insulation

Table 24. Solution IWI-1: Aerogel blanket/matt.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Aerogel blanket/matt*
	2	Category	*Other*
	3	Example of application	• *Wee Causeway, Culross* • *Article 1* • *Article 2* • *Article 3* • *Article 4* • *Article 5* • *Article 6* • *Article 7* • *Article 8*
	4	Possible supplier	• *Aspen Aerogels* • *BASF (SLENTEX)* • *Cabot* • *Evergel* • *Thermablok Aerogels Ltd*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Aerogel blanket/insulation matt*
	6	System thickness	*5-50 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.013-0.025 W/mK*
	9	Fire protection class	• *A2-s1,d0* • *C-s1, d0*
	10	System type	*vapour open (high diff. resistance)*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*> 50 MJ/kg*
	14	Average lifetime	*50 years*
	15	Recyclability	*yes, can be mechanically recycled into its main component parts*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Fixed to battens with timber studs, or directly to masonry/existing finish using expanded steel mesh with thermally decoupled fasteners or 8–10 mm glue mortar. Requires protective gear. Material is flexible and cuttable.*
	19	Cost	*High (€€€)*

Table 25. Solution IWI-2: Aerogel board.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Aerogel board*
	2	Category	*Other*
	3	Example of application	• *Villa Castelli* • *Article 1* • *Article 2*
	4	Possible supplier	• *AEROPAN* • *Sto* • *Thermablok Aerogels Ltd*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Aerogel board OR carrier board with aerogel blanket* • *Glue & surface render*
	6	System thickness	*10-80 mm + finish*
	7	Av. thermal conductivity	*0.025 W/mK*
	8	Thermal conductivity of ins. layer	*0.0131-0.028 W/mK*
	9	Fire protection class	• *A2-s1,d0* • *C-s1,d0* • *D-s1,d0*
	10	System type	*vapour open (capillary active)*
	11	Capillary active	*yes*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*> 50 MJ/kg*
	14	Average lifetime	*50 years*
	15	Recyclability	*yes*
	16	Prefabricated solution	*partially*
	17	Reversible system	*depends on installation*
	18	Installation	*Surface must be flat, clean, and dry. Glued directly to prepared masonry substrate or mechanically fixed without framing or ventilation cavity—ideal for maximum space saving.*
	19	Cost	*High (€€€)*

Table 26. Solution IWI-3: Aerogel insulating plaster.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Aerogel insulating plaster*
	2	Category	*Insulation plasters*
	3	Example of application	*none*
	4	Possible supplier	• *Fixit* • *Röfix*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Aerogel insulating plaster* • *Render*
	6	System thickness	*30-150 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.028 W/mK*
	9	Fire protection class	*A2-s1,d0*
	10	System type	*vapour open (high diff. resistance)*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*> 50 MJ/kg*
	14	Average lifetime	*40+ years*
	15	Recyclability	*no*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Applied to clean, dry surfaces (brickwork, sand-lime bricks, natural stone, quarry stone, raw concrete). No modification to original wall structure needed. Curves and recesses are accurately reproduced, and uneven surfaces can be filled with millimetre precision. For strongly absorbent surfaces, pre-treatment with roughcast is required. Applied using a machine designed for insulating plaster.*
	19	Cost	*Medium (€€)*

Table 27. Solution IWI-4: Autoclaved cellular concrete (AAC)

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Autoclaved cellular concrete (AAC)*
	2	Category	*Mineral board based*
	3	Example of application	• *Farm house Huber* • *Klostergebäude Kaiserstrasse* • *Magasinet i Varvsstaden, Malmö* • *Musikschule Velden* • *Article 1* • *Article 2* • *Article 3* • *Article 4* • *Article 5* • *Article 6* • *Article 7* • *Article 8* • *Article 9* • *Article 10* • *Article 11* • *Article 12* • *Article 13* • *Article 14*
	4	Possible supplier	• *Sto* • *Tarmac* • *Xella* • *Ytong*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Mineral foam insulation board* • *Glue/adhesive mortar*
	6	System thickness	*50-300 mm + finish*
	7	Av. thermal conductivity	*0.046-0.181 W/mK*
	8	Thermal conductivity of ins. layer	*0.042-0.05 W/mK*
	9	Fire protection class	*A1*
	10	System type	*vapour open (capillary active)*
	11	Capillary active	*yes (highly)*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*< 25 MJ/kg*
	14	Average lifetime	*50+ years*
	15	Recyclability	*no*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Requires a flat, clean, and dry surface. Glued with adhesive and reinforcing mortar, or glued and screwed (surface can be uneven, up to 2 cm/m). Wide range of insulation thicknesses available. Cut with band saws or carbide saws. Attached with lightweight mineral mortar or dowels. Can be plastered, painted, or finished with building boards.*
	19	Cost	*Low (€)*

Table 28. Solution IWI-5: Calcium silicate boards.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Calcium silicate boards*
	2	Category	*Mineral board based*
	3	Example of application	• *Gemeindeamt Zwischenwasser* • *Kasperhof* • *Villa Capodivacca* • *Wee Causeway, Culross* • *Article 1* • *Article 2* • *Article 3* • *Article 4* • *Article 5* • *Article 6* • *Article 7* • *Article 8* • *Article 9* • *Article 10* • *Article 11* • *Article 12* • *Article 13* • *Article 14* • *Article 15*
	4	Possible supplier	• *Akurit* • *ALLIGATOR* • *Calsitherm* • *Caparol* • *CASIPLUS* • *Epasit* • *Getifix* • *HASIT* • *HECK WALL* • *Isotec* • *KEIM* • *Pavatex* • *Promat* • *Redstone* • *Remmers* • *Röfix* • *Saint-Gobain* • *Skamowall* • *Xella* • *ZERO-LACK*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish (diffusion open)* • *Calcium silicate boards* • *Adhesive*
	6	System thickness	*15-500 mm + finish*
	7	Av. thermal conductivity	*0.055-0.061 W/mK*
	8	Thermal conductivity of ins. layer	*0.04-0.07 W/mK*
	9	Fire protection class	*A1*
	10	System type	*vapour open (capillary active)*
	11	Capillary active	*yes (highly)*
Susta inabi ...	12	Based on natural materials	*yes*
	13	Embodied energy	*< 25 MJ/kg*
	14	Average lifetime	*80 years*

	15	Recyclability	*depends on the product*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Perforation and cutting can be done on-site without affecting thermal properties. Requires a flat surface for application. High density. Bonded to masonry with adhesive and wet plaster, ensuring no air gaps between insulation and masonry.*
	19	Cost	*Medium (€€)*

Table 29. Solution IWI-6: Calciumsilicate board with core made of high-performance insulation material (PU, foam glass, VIP).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Calciumsilicate board with core made of high-performance insulation material (PU, foam glass, VIP)*
	2	Category	*Mineral board based*
	3	Example of application	*none*
	4	Possible supplier	• *Calsitherm*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Insulation board* • *Adhesive*
	6	System thickness	*50-80 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.031 W/mK*
	9	Fire protection class	*A1*
	10	System type	*vapour open (capillary active)*
	11	Capillary active	*yes (highly)*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*no data*
	14	Average lifetime	*no data*
	15	Recyclability	*no data*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Ensure wall is clean, dry, and undamaged. Cut panels to size, apply adhesive or use mechanical fixings to secure. Seal joints to prevent moisture infiltration, then finish with plaster or decoration.*
	19	Cost	*Medium (€€)*

Table 30. Solution IWI-7: Cellulose (loose/blown-in/dry application).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Cellulose (loose/blown-in/dry application)*
	2	Category	*Biobased*
	3	Example of application	• *Alte Schäfflerei, Kloster Benediktbeuern* • *Hof Neuhäusl* • *Holyrood Park Lodge* • *Farmhouse Straub* • *Primary School Hötting, Innsbruck* • *Oeconomy building Josef Weiss*
	4	Possible supplier	• *Ekovilla* • *Isocell* • *Isofloc* • *Thermofloc* • *Warmfiber*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Clay/gips panel/OSB board* • *Blown-in cellulose fibre*
	6	System thickness	*adaptable (e.g., 40-120 mm + finish)*
	7	Av. thermal conductivity	*0.046-0.107 W/mK*
	8	Thermal conductivity of ins. layer	*0.037-0.045 W/mK*
	9	Fire protection class	• *B-s2,d0* • *E*
	10	System type	*vapour tight (v. barrier)*
	11	Capillary active	*yes (moderately)*
Sustainability and Lifecycle	12	Based on natural materials	*partially*
	13	Embodied energy	*< 25 MJ/kg*
	14	Average lifetime	*50 years*
	15	Recyclability	*easily recyclable and reusable, these scenarios are not yet mainstreamed in Europe*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Cellulose fibre is blown into a cavity behind a panel (gypsum or clay) covered with internal plaster. The panel is fixed to the existing wall using a wooden frame, thermally decoupled by 2.8 cm soft wood fibre strips.*
	19	Cost	*Medium (€€)*

Table 31. Solution IWI-8: Cellulose (wet application).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Cellulose (wet application)*
	2	Category	*Biobased*
	3	Example of application	• *Kirkton of Coull, Aberdeenshire* • *Sword Street, Glasgow* • *Wartin, Brandenburg* • *Article 1* • *Article 2*
	4	Possible supplier	• *Climacell* • *Isofloc*
Technical Specifications	5	Composition (from inside to outside)	• *Internal lime or clay plaster/gypsum board* • *Cellulose fibre with glue*
	6	System thickness	*adaptable (e.g., 50-120 mm + finish)*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.039–0.045 W/mK*
	9	Fire protection class	• *B-s2,d0* • *E*
	10	System type	*vapour open (capillary active)*
	11	Capillary active	*yes*
Sustainability and Lifecycle	12	Based on natural materials	*partially*
	13	Embodied energy	*< 25 MJ/kg*
	14	Average lifetime	*50 years*
	15	Recyclability	*easily recyclable and reusable, these scenarios are not yet mainstreamed in Europe*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Bonded directly to masonry without separate adhesive. No air gap between insulation and masonry. Suitable for uneven surfaces and eliminates thermal bridges.*
	19	Cost	*Medium (€€)*

Table 32. Solution IWI-9: Cellulose batts or rolls.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Cellulose batts or rolls*
	2	Category	*Biobased*
	3	Example of application	• *Article 1* • *Article 2* • *Article 3* • *Article 4* • *Article 5* • *Article 6* • *Article 7* • *Article 8*
	4	Possible supplier	• *Ekovilla* • *iCell*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish with vapour retarder* • *Cellulose rolls +timber construction*
	6	System thickness	*30-200 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.036-0.039 W/mK*
	9	Fire protection class	*E*
	10	System type	*vapour tight (v. barrier)*
	11	Capillary active	*yes (moderately)*
Sustainability and Lifecycle	12	Based on natural materials	*partially*
	13	Embodied energy	*< 25 MJ/kg*
	14	Average lifetime	*50 years*
	15	Recyclability	*yes, recycled into loose cellulose insulation*
	16	Prefabricated solution	*no*
	17	Reversible system	*depends on installation*
	18	Installation	*Wide range of insulation thicknesses available. Requires a flat surface for application.*
	19	Cost	*Medium (€€)*

Table 33. Solution IWI-10: Clay cork insulation.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Clay cork insulation*
	2	Category	*Biobased*
	3	Example of application	*none*
	4	Possible supplier	• *Cellco*
Technical Specifications	5	Composition (from inside to outside)	• *Clay plaster* • *Loam cork board* • *Render + adhesive*
	6	System thickness	*40-60 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.05 W/mK*
	9	Fire protection class	*E*
	10	System type	*vapour open (capillary active)*
	11	Capillary active	*yes (moderately)*
Sustainability and Lifecycle	12	Based on natural materials	*yes*
	13	Embodied energy	*< 25 MJ/kg*
	14	Average lifetime	*no data*
	15	Recyclability	*recycling possible only if insulation doesn't contain synthetic additives*
	16	Prefabricated solution	*no*
	17	Reversible system	*no*
	18	Installation	*Glued and screwed to the surface. Requires a flat surface and use of render.*
	19	Cost	*High (€€€)*

Table 34. Solution IWI-11: Cork insulation.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Cork insulation*
	2	Category	*Biobased*
	3	Example of application	• *Article 1* • *Article 2* • *Article 3*
	4	Possible supplier	• *Cellco* • *Thermacork*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Cork insulation* • *Adhesive*
	6	System thickness	*12-300 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.036-0.04 W/mK*
	9	Fire protection class	*E*
	10	System type	*vapour open (high diff. resistance)*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*yes*
	13	Embodied energy	*> 50 MJ/kg*
	14	Average lifetime	*25-50 years*
	15	Recyclability	*partially, recycled (grinded) into expanded cork granulates*
	16	Prefabricated solution	*no*
	17	Reversible system	*depends on installation*
	18	Installation	*Perforation and cutting can be done on-site without affecting the thermal properties of the material.*
	19	Cost	*High (€€€)*

Table 35. Solution IWI-12: Flax insulation.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Flax insulation*
	2	Category	*Biobased*
	3	Example of application	*none*
	4	Possible supplier	• *Isolina* • *Isovlas*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish with vapour retarder* • *Flax insulation (linen)*
	6	System thickness	*30-150 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.038-0.045 W/mK*
	9	Fire protection class	*E*
	10	System type	*vapour tight (v. barrier)*
	11	Capillary active	*yes (moderately)*
Sustainability and Lifecycle	12	Based on natural materials	*partially*
	13	Embodied energy	*> 25, < 50 MJ/kg*
	14	Average lifetime	*75 years*
	15	Recyclability	*no, but can be reused*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Available in roll or plate form, cut on-site and glued.*
	19	Cost	*Medium (€€)*

Table 36. Solution IWI-13: Foam glass.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Foam glass*
	2	Category	*Other*
	3	Example of application	• *Article 1*
	4	Possible supplier	• *ERFURT* • *Foamglas*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Foam glass insulation* • *Render & bonding*
	6	System thickness	*40-200 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.036-0.042 W/mK*
	9	Fire protection class	*A1*
	10	System type	*vapour tight ins. material*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*partially*
	13	Embodied energy	*> 25, < 50 MJ/kg*
	14	Average lifetime	*100 years*
	15	Recyclability	*partially (50-60%), re-used as additives in the manufacture of new foam glass*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Glued to the surface. Requires a flat surface.*
	19	Cost	*Medium (€€)*

Table 37. Solution IWI-14: Hemp fibre.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Hemp fibre*
	2	Category	*Biobased*
	3	Example of application	• *Sword Street, Glasgow* • *Timber-framed barn in the north of France* • *Article 1* • *Article 2* • *Article 3* • *Article 4* • *Article 5*
	4	Possible supplier	• *Hempitecture* • *Thermo Hanf* • *von Hanf*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish with vapour retarder* • *Hemp insulation +timber construction*
	6	System thickness	*30-220 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.043 W/mK*
	9	Fire protection class	*E*
	10	System type	*vapour tight (v. barrier)*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*partially*
	13	Embodied energy	*> 25, < 50 MJ/kg*
	14	Average lifetime	*50 years*
	15	Recyclability	*yes*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Cut on-site to required size and mounted between timber construction.*
	19	Cost	*Medium (€€)*

Table 38. Solution IWI-15: Hemp+lime insulation.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Hemp+lime insulation*
	2	Category	*Biobased*
	3	Example of application	• *Rebecco Farm* • *Réhabilitation Ecuries de Versailles - Aile de Sceaux* • *Timber-framed house in Alsace, France* • *Article 1* • *Article 2*
	4	Possible supplier	• *dade design GmbH* • *Hempblock* • *Hempitecture* • *Schönthaler* • *UK Hempcrete*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Hemp blocks & bricks OR hempcrete (lime-hemp concrete)*
	6	System thickness	*adaptable*
	7	Av. thermal conductivity	*0.08-0.1 W/mK*
	8	Thermal conductivity of ins. layer	*0.053-0.07 W/mK*
	9	Fire protection class	• *A1* • *B-s1,d0*
	10	System type	*vapour open (capillary active)*
	11	Capillary active	*yes (moderately)*
Sustainability and Lifecycle	12	Based on natural materials	*yes*
	13	Embodied energy	*< 25 MJ/kg*
	14	Average lifetime	*100 years*
	15	Recyclability	*yes, can be chopped up and recast into hemp bricks / hemp stones*
	16	Prefabricated solution	*no*
	17	Reversible system	*depends on installation*
	18	Installation	*Available as prefabricated blocks or mixed and formed on-site in temporary forms. Hempcrete is applied directly to the wall, suitable for uneven surfaces.*
	19	Cost	*Medium (€€)*

Table 39. Solution IWI-16: Mineral wool.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Mineral wool*
	2	Category	*Mineral wool based*
	3	Example of application	• *Ansitz Kofler* • *Colbert Post Office - Marseille* • *Elementary School in Mulhouse, France* • *Halle Bouchayer Viallet* • *PalaCinema Locarno - Locarno, Switzerland* • *Réhabilitation - 116 Réaumur* • *Article 1* • *Article 2* • *Article 3* • *Article 4* • *Article 5* • *Article 6* • *Article 7* • *Article 8* • *Article 9* • *Article 10* • *Article 11* • *Article 12* • *Article 13*
	4	Possible supplier	• *Brillux* • *Caparol* • *FLUMROC* • *Isover* • *Knauf* • *PAROC* • *Rockwool* • *Sto*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish with vapour retarder* • *Mineral wool (with or without air cavity between existing wall and insulation system)*
	6	System thickness	*20-300 mm + finish*
	7	Av. thermal conductivity	*0.042-0.056 W/mK*
	8	Thermal conductivity of ins. layer	*0.034-0.045 W/mK*
	9	Fire protection class	*A1*
	10	System type	*vapour tight (v. barrier)*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*> 25, < 50 MJ/kg*
	14	Average lifetime	*50 years*
	15	Recyclability	*partly recycled at their end-of-life, but no established collection system*
	16	Prefabricated solution	*no*
	17	Reversible system	*depends on installation*
	18	Installation	*Glued or glued and screwed; requires a flat surface for application. Wide range of insulation thicknesses available. Perforation and cutting can be done on-site without affecting thermal properties. Easy to customize on-site.*
	19	Cost	*Low (€)*

Table 40. Solution IWI-17: Perlite insulation board.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Perlite insulation board*
	2	Category	*Mineral board based*
	3	Example of application	• *Haus Moroder* • *Villa Castelli* • *Article 1* • *Article 2*
	4	Possible supplier	• *Knauf* • *Schlagmann Poroton* • *Sto*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Perlite insulation board* • *Glue*
	6	System thickness	*25-200 mm + finish*
	7	Av. thermal conductivity	*0.052-0.055 W/mK*
	8	Thermal conductivity of ins. layer	*0.045 W/mK*
	9	Fire protection class	*A1*
	10	System type	*vapour open (capillary active)*
	11	Capillary active	*yes*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*< 25 MJ/kg*
	14	Average lifetime	*50 years*
	15	Recyclability	*yes*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Requires a flat, clean, and dry surface; glued.*
	19	Cost	*Medium (€€)*

Table 41. Solution IWI-18: Phenolic foam boards.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Phenolic foam boards*
	2	Category	*Oil-based polymers*
	3	Example of application	• *Article 1* • *Article 2* • *Article 3* • *Article 4* • *Article 5* • *Article 6* • *Article 7*
	4	Possible supplier	• *Austrotherm* • *Caparol* • *Kingspan* • *Knauf* • *Sto* • *Unilin insulation*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Phenolic foam board* • *Adhesive*
	6	System thickness	*20-200 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.021-0.045 W/mK*
	9	Fire protection class	• *B-s1,d0* • *C-s1,d0 (ins. material)* • *C-s2,d0 (ins. material)* • *D-s1,d0 (ins. material)* • *E (ins. material)"*
	10	System type	*vapour tight ins. material*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*> 50 MJ/kg*
	14	Average lifetime	*50 years*
	15	Recyclability	*yes*
	16	Prefabricated solution	*no*
	17	Reversible system	*depends on installation*
	18	Installation	*Airtightness achieved with a metal foil vapour barrier between insulation and gypsum board, sealed with silicone at junctions. Mechanically fixed to battens with timber studs, or glued and screwed. Surface can be uneven (up to 2 cm/m). Wide range of insulation thicknesses available.*
	19	Cost	*Low (€)*

Table 42. Solution IWI-19: Polystyrene/EPS/XPS.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Polystyrene/EPS/XPS*
	2	Category	*Oil-based polymers*
	3	Example of application	• *Idrija mercury smelting plant* • *Résidence Services Sénior* • *Wiesbaden - Lehrstraße 2* • *Article 1* • *Article 2* • *Article 3* • *Article 4* • *Article 5* • *Article 6* • *Article 7* • *Article 8* • *Article 9* • *Article 10*
	4	Possible supplier	• *Austrotherm* • *BEWI* • *Brillux* • *Caparol* • *Danogips* • *Fassa Bartolo* • *Glutolin* • *JACKON Insulation* • *JUB* • *Knauf* • *Ravago* • *Saint-Gobain* • *Sto* • *Styrodur* • *Swisspor* • *Tenapors* • *Wedi*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Insulation board* • *Adhesive*
	6	System thickness	*10-400 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.031-0.040 W/mK*
	9	Fire protection class	• *B* • *C* • *E (ins. material)*
	10	System type	*vapour tight ins. material*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*> 50 MJ/kg*
	14	Average lifetime	*40-50+ years*
	15	Recyclability	*yes, but only in special places*
	16	Prefabricated solution	*no*
	17	Reversible system	*depends on installation*
	18	Installation	*Glued or glued and screwed; requires a flat surface for application. Screw-mounted using incorporated wood*

			battens. Perforation and cutting can be done on-site without losing thermal properties. Easy to customize on-site. Low density. Wide range of insulation thicknesses available.
	19	Cost	*Low (€)*

Table 43. Solution IWI-Polyurethane insulation (PIR/PUR).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Polyurethane insulation (PIR/PUR)*
	2	Category	*Oil-based polymers*
	3	Example of application	• *Article 1* • *Article 2* • *Article 3* • *Article 4* • *Article 5* • *Article 6* • *Article 7* • *Article 8* • *Article 9*
	4	Possible supplier	• *Brillux* • *Caparol* • *Linzmeier* • *Recticel* • *Sto* • *Swisspor* • *Tenapors*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *PIR/PUR boards* • *Adhesive*
	6	System thickness	*20-300 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.024-0.045 W/mK*
	9	Fire protection class	• *B-s1,d0* • *B-s2,d0* • *C* • *D-s2,d0* • *E* • *F*
	10	System type	*vapour tight ins. material*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*> 50 MJ/kg*
	14	Average lifetime	*50 years*
	15	Recyclability	*usually no, but possible*
	16	Prefabricated solution	*no*
	17	Reversible system	*depends on installation*
	18	Installation	*Perforation and cutting can be done on-site without losing thermal properties. Easy to customize on-site. Low density. Wide range of insulation thicknesses available. Requires a flat surface for application.*
	19	Cost	*Low (€)*

Table 44. Solution IWI-21: PU-foam with calciumsilicate channels.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*PU-foam with calciumsilicate channels*
	2	Category	*Oil-based polymers*
	3	Example of application	• *Primary School Hötting, Innsbruck* • *Article 1* • *Article 2* • *Article 3* • *Article 4* • *Article 5* • *Article 6* • *Article 7* • *Article 8* • *Article 9*
	4	Possible supplier	• *Remmers*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Insulation board* • *Adhesive*
	6	System thickness	*30-120 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.031 W/mK*
	9	Fire protection class	• *B-s1,d0* • *E (ins. material)*
	10	System type	*vapour open (capillary active)*
	11	Capillary active	*yes (moderately)*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*no data*
	14	Average lifetime	*no data*
	15	Recyclability	*no data*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Mortar is applied to the wall, then blocks are glued and finished with suitable plaster. Requires a flat, clean, and dry surface. Can be cut on-site.*
	19	Cost	*Medium (€€)*

Table 45. Solution IWI-22: Recycled textile.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Recycled textile*
	2	Category	*Other*
	3	Example of application	• *Article 1* • *Article 2*
	4	Possible supplier	• *Bonded Logic*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Insulation board made out of recycled textile*
	6	System thickness	*89-220 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	• *0.039-0.044 W/mK (recycled cotton),* • *0.036-0.038 W/mK (recycled denim),* • *0.041-0.053 W/mK (recycled synthetic textile)*
	9	Fire protection class	• *B-s1,d0* • *E (cotton)*
	10	System type	*vapour open (high diff. resistance)*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*partially*
	13	Embodied energy	*< 25 MJ/kg*
	14	Average lifetime	*no data*
	15	Recyclability	*yes*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*no data*
	19	Cost	*no data*

Table 46. Solution IWI-24: Reed insulation.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Reed insulation*
	2	Category	*Biobased*
	3	Example of application	• *Ackerbürgerhäuschen* • *Rebecco Farm* • *Article 1* • *Article 2*
	4	Possible supplier	• *ClayTec* • *Hiss Reet*
Technical Specifications	5	Composition (from inside to outside)	• *Render* • *Reed insulation* • *External plaster*
	6	System thickness	*20-120 mm + finish*
	7	Av. thermal conductivity	*0.064 W/mK*
	8	Thermal conductivity of ins. layer	*0.055-0.065 W/mK*
	9	Fire protection class	*E*
	10	System type	*vapour open (high diff. resistance)*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*yes*
	13	Embodied energy	*< 25 MJ/kg*
	14	Average lifetime	*30-50 years*
	15	Recyclability	*yes, possible reuse or recycling*
	16	Prefabricated solution	*no*
	17	Reversible system	*depends on installation*
	18	Installation	*Surface must be clean, dry, and flat (use of render). Mounted to the existing wall and covered with grout.*
	19	Cost	*Low (€)*

Table 47. Solution IWI-25: Sheep wool.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Sheep wool*
	2	Category	*Biobased*
	3	Example of application	• *Giatla Haus* • *Article 1* • *Article 2* • *Article 3*
	4	Possible supplier	• *Havelock* • *Isolena* • *thermafleece*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish with vapour retarder* • *Sheep wool insulation felt + timber frame*
	6	System thickness	*up to 60 mm*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.033-0.054 W/mK*
	9	Fire protection class	• *B-s1,d0* • *B-s3,d0* • *D-s2,d0* • *C-s2,d0* • *E*
	10	System type	*vapour tight (v. barrier)*
	11	Capillary active	*yes (moderately)*
Sustainability and Lifecycle	12	Based on natural materials	*yes*
	13	Embodied energy	*> 25, < 50 MJ/kg*
	14	Average lifetime	*50-60 years*
	15	Recyclability	*yes*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Cut and fitted between the rafters; can be stapled.*
	19	Cost	*High (€€€)*

Table 48. Solution IWI-26: Thermal insulation glazing.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Thermal insulation glazing*
	2	Category	*Other*
	3	Example of application	• *Alte Schäfflerei, Kloster Benediktbeuern* • *Osramhuset (The Osram Building)*
	4	Possible supplier	• *Saint-Gobain*
Technical Specifications	5	Composition (from inside to outside)	• *Thermally insulated glazing* • *Aluminium facade with ventilated air gap*
	6	System thickness	*adaptable (e.g., 129-149 mm)*
	7	Av. thermal conductivity	*0.154 W/mK*
	8	Thermal conductivity of ins. layer	*depends on the glazing*
	9	Fire protection class	*no data*
	10	System type	*vapour tight ins. material*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*no data*
	14	Average lifetime	*no data*
	15	Recyclability	*no data*
	16	Prefabricated solution	*yes*
	17	Reversible system	*yes*
	18	Installation	*no data*
	19	Cost	*no data*

Table 49. Solution IWI-27: Thermal insulation plaster.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Thermal insulation plaster*
	2	Category	*Insulation plasters*
	3	Example of application	• *Ancien presbytère en logements* • *Ancien presbytère en Mairie* • *Ansitz Mairhof* • *Downie's Cottage* • *Ecuries de Versailles - Aile de Sceaux* • *Rainhof* • *Rathaus Bergrheinfeld* • *Ruckenzaunerhof* • *Article 1* • *Article 2* • *Article 3* • *Article 4*
	4	Possible supplier	• *Baumit* • *ClayTec* • *Diasen* • *Getifix* • *Grigolin* • *Haacke* • *HECK WALL* • *Redstone* • *Röfix* • *Scankalk* • *Sto*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Thermal insulation plaster*
	6	System thickness	*20-120 mm*
	7	Av. thermal conductivity	*0.045-0.241 W/mK*
	8	Thermal conductivity of ins. layer	*0.037 W/mK*
	9	Fire protection class	*A1*
	10	System type	*vapour open (capillary active)*
	11	Capillary active	*yes*
Sustainability and Lifecycle	12	Based on natural materials	*partially*
	13	Embodied energy	*< 25 MJ/kg*
	14	Average lifetime	*40-100 years*
	15	Recyclability	*no*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Thermal plaster adapts to the irregularities of internal walls, following bends between walls and ceilings. Suitable for walls affected by capillary rising damp due to its high water vapour diffusion coefficient. Surface must be clean and dry.*
	19	Cost	*High (€€€)*

Table 50. Solution IWI-28: Thermoreflective insulation.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Thermoreflective insulation*
	2	Category	*Other*
	3	Example of application	*none*
	4	Possible supplier	• *Foilboard* • *SuperFOIL*
Technical Specifications	5	Composition (from inside to outside)	*e.g., bubble film covered with aluminium foil or many layers of metalized foil, wadding, reflective inserts, and/or foams*
	6	System thickness	*non-thickness dependent*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*no inherent R-value & no thermal conductivity coefficient*
	9	Fire protection class	*B-s1,0, E*
	10	System type	*vapour tight ins. material*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*no data*
	14	Average lifetime	*no data*
	15	Recyclability	*no data*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Installation depends on climatic conditions and moisture sources. Ensure all joints and seams are butted or overlapped and taped to reduce moisture condensation in the cavity and improve performance.*
	19	Cost	*High (€€€)*

Table 51. Solution IWI-29: Vacuum Insulation Panel (VIP).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Vacuum Insulation Panel (VIP)*
	2	Category	*Other*
	3	Example of application	• *Article 1* • *Article 2* • *Article 3* • *Article 4* • *Article 5* • *Article 6*
	4	Possible supplier	• *Etex* • *Isover* • *Kingspan* • *Muevo* • *Recticel* • *Vaku-Isotherm* • *Variotec*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish* • *Air cavity* • *Mineral wool* • *Vacuum Insulation Panel (VIP)* • *PE-foil*
	6	System thickness	*60-130 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.004-0.008 W/mK*
	9	Fire protection class	*E*
	10	System type	*vapour tight ins. material*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*> 50 MJ/kg*
	14	Average lifetime	*60 years*
	15	Recyclability	*partly possible, but not common*
	16	Prefabricated solution	*partially*
	17	Reversible system	*yes*
	18	Installation	*Adding VIP to internal surfaces of historic brick walls can increase relative humidity in wooden beam ends and reduce drying capacity. Relative humidity increases when exposed to wind-driven rain. Suitable for areas with limited insulation thickness. Requires a flat surface for application. Cannot be customized on-site. Small range of insulation thicknesses available.*
	19	Cost	*High (€€€)*

Table 52 Solution IWI-30: Ventilated interior insulation (RetroWall).

Type	Nr	Parameter	Parameter Assessment
General Informatio	1	Solution name	*Ventilated interior insulation (RetroWall)*
	2	Category	*Mineral wool based*
	3	Example of application	• *Article 1*
	4	Possible supplier	• *Isover*
Technical Specifications	5	Composition (from inside to outside)	• *Metal spacers / Air gap (25 mm)* • *Glass wool (50 mm)* • *Gypsum board (13 mm)* • *Vapor barrier* • *Gypsum board (13 mm)*
	6	System thickness	*100 mm*
	7	Av. thermal conductivity	*0.03 W/mK*
	8	Thermal conductivity of ins. layer	*no data*
	9	Fire protection class	*A2-s1, d0*
	10	System type	*vapour tight (v. barrier)*
	11	Capillary active	*no*
Sustainability and Lifecycle	12	Based on natural materials	*no*
	13	Embodied energy	*no data*
	14	Average lifetime	*no data*
	15	Recyclability	*no data*
	16	Prefabricated solution	*no*
	17	Reversible system	*yes*
	18	Installation	*Metal spacers and an air duct system are installed on the existing wall. Mineral wool is placed between spacers, with two layers of gypsum board installed, including a vapour barrier in between. A small dehumidifier unit is connected to maintain low relative humidity in the air cavity between the existing wall and the insulation system.*
	19	Cost	*no data*

Table 53. Solution IWI-31: Wood fibre board.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Wood fibre board*
	2	Category	*Biobased*
	3	Example of application	• *Sword Street, Glasgow* • *Wartin, Brandenburg* • *Article 1* • *Article 2* • *Article 3* • *Article 4* • *Article 5* • *Article 6*
	4	Possible supplier	• *BetonWood* • *ClayTec* • *Conluto* • *DAW SE* • *Gutex* • *Isover* • *Pavatex* • *SCHOMBURG* • *Steico* • *UNGER DIFFUTHERM*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish with/without vapour retarder* • *Wood fibre board*
	6	System thickness	*40-240 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.032-0.04 W/mK*
	9	Fire protection class	*E*
	10	System type	*vapour open (capillary active)*
	11	Capillary active	*yes (moderately)*
Sustainability and Lifecycle	12	Based on natural materials	*yes*
	13	Embodied energy	*< 25 MJ/kg*
	14	Average lifetime	*50 years*
	15	Recyclability	*Can be recycled in production process or thermally e.g., for combustion as biomass or in waste incineration plants.*
	16	Prefabricated solution	*no*
	17	Reversible system	*no*
	18	Installation	*Wide range of insulation thicknesses available. Requires a flat surface for application. Can be stapled and screwed (timber wall) or glued and screwed.*
	19	Cost	*Medium (€€)*

Table 54. Solution IWI-32: Wood fibre board with vapour control layer.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Wood fibre board with vapour control layer*
	2	Category	*Biobased*
	3	Example of application	• *Article 1* • *Article 2* • *Article 3*
	4	Possible supplier	• *Knauf* • *Pavatex*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish (vapour open)* • *Insulation board*
	6	System thickness	*40-250 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.035-0.045 W/mK*
	9	Fire protection class	• *A2-s1,d0* • *E*
	10	System type	*vapour open (capillary active)*
	11	Capillary active	*yes (moderately)*
Sustainability and Lifecycle	12	Based on natural materials	*partially*
	13	Embodied energy	*> 25, < 50 MJ/kg*
	14	Average lifetime	*50 years*
	15	Recyclability	*no data*
	16	Prefabricated solution	*partially*
	17	Reversible system	*no*
	18	Installation	*Wide range of insulation thicknesses available. Screwed; requires a flat surface for application.*
	19	Cost	*Medium (€€)*

A1.2. External wall insulation

Table 55. Solution EWI-1: Aerogel insulating plaster.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Aerogel insulating plaster*
	2	Category	*Insulation plasters*
	3	Example of application	• *Alte Schäfflerei, Kloster Benediktbeuern* • *Mariahilferstrasse* • *Residential building Pierre de Coubertin*
	4	Possible supplier	• *Fixit* • *Röfix*
Technical Specifications	5	Composition (from inside to outside)	• *Render* • *Aerogel insulating plaster* • *External finish*
	6	System thickness	*45-55 mm + finish*
	7	Av. thermal conductivity	*0.023-0.05 W/mK*
	8	Thermal conductivity of ins. layer	*0.028-0.044 W/mK*
	9	Fire protection class	*A2-s1,d0*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*> 50 MJ/kg*
	18	Average lifetime	*40+ years*
	19	Recyclability	*no*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Applied on clean, dry surfaces when wet. No modification to original wall structure is needed. Curves and recesses are reproduced accurately, and uneven surfaces can be filled with millimetre precision. Suitable for brickwork, sand-lime bricks, natural stone, quarry stone, and raw concrete. Surface must be of adequate load-bearing capacity. Strongly absorbent surfaces require pre-treatment with roughcast. Aerogel is applied using a machine designed for insulating plaster.*
	23	Cost	*High (€€€)*

Table 56. Solution EWI-2: Cavity wall insulation with insulation granulate.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Cavity wall insulation with insulation granulate*
	2	Category	*Mineral wool based*
	3	Example of application	*none*
	4	Possible supplier	• *Isover* • *Knauf* • *Rockwool*
Technical Specifications	5	Composition (from inside to outside)	• *Internal wall* • *Loose fill insulation* • *External wall*
	6	System thickness	*adaptable, min. 80 mm*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.034-0.042 W/mK*
	9	Fire protection class	*A1*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*Partly recycled at the end of life, but no established collection system.*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Blown into the prepared wooden frame for fast and uniform installation. Provides good airtightness.*
	23	Cost	*no data*

Table 57. Solution EWI-3: Cellulose in timber frame.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Cellulose in timber frame*
	2	Category	*Biobased*
	3	Example of application	• *Ackerbürgerhäuschen* • *Farmhouse Straub* • *Kelchalm - Bochumer Hütte* • *Ritterhof*
	4	Possible supplier	• *Isocell* • *Thermofloc*
Technical Specifications	5	Composition (from inside to outside)	• *Adhesive* • *Cellulose + timber framework;* • *External finish*
	6	System thickness	*adaptable*
	7	Av. thermal conductivity	*0.052-0.117 W/mK*
	8	Thermal conductivity of ins. layer	*0.037-0.038 W/mK*
	9	Fire protection class	*B-s2,d0*
Sustainability and Lifecycle	16	Based on natural materials	*partially*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*15-100 years*
	19	Recyclability	*Can be reused as insulation or burned in a refuse incineration plant.*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Blown into the prepared wooden frame for fast and uniform installation. Ensures good airtightness.*
	23	Cost	*Low (€)*

Table 58. Solution EWI-4: Foam glass.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Foam glass*
	2	Category	*Other*
	3	Example of application	*none*
	4	Possible supplier	• *Foamglas*
Technical Specifications	5	Composition (from inside to outside)	• *Bonding;* • *Foam glass insulation;* • *External finish*
	6	System thickness	*40-200 mm +finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.036-0.042 W/mK*
	9	Fire protection class	*A1*
Sustainability and Lifecycle	16	Based on natural materials	*partially*
	17	Embodied energy	*> 25, < 50 MJ/kg*
	18	Average lifetime	*100 years*
	19	Recyclability	*Partially re-used as additives in the manufacture of new foam glass.*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Glued to the surface. Requires a flat surface.*
	23	Cost	*High (€€€)*

Table 59. Solution EWI-5: Hemp insulation board.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Hemp insulation board*
	2	Category	*Biobased*
	3	Example of application	• *Kelchalm - Bochumer Hütte*
	4	Possible supplier	• *Capatect* • *Ekolution*
Technical Specifications	5	Composition (from inside to outside)	• *Adhesive* • *Hemp insulation board;* • *Reinforcement layer;* • *Finishing render*
	6	System thickness	*20-240 mm + finish*
	7	Av. thermal conductivity	*0.044 W/mK*
	8	Thermal conductivity of ins. layer	*0.023-0.044 W/mK*
	9	Fire protection class	*B-s1,d0*
Sustainability and Lifecycle	16	Based on natural materials	*partially*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*50-75 years*
	19	Recyclability	*Possible reuse or recycle (e.g. re-admission to the production process).*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Glued to brick walls. Requires a clean, dry, and flat surface for application.*
	23	Cost	*Low (€)*

Table 60. Solution EWI-6: Insulation cork boards.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Insulation cork boards*
	2	Category	*Biobased*
	3	Example of application	*none*
	4	Possible supplier	• *Röfix* • *Thermacork*
Technical Specifications	5	Composition (from inside to outside)	• *Adhesive* • *Cork insulation* • *Reinforcement layer;* • *Finishing render*
	6	System thickness	*10-300 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.040-0.045 W/mK*
	9	Fire protection class	*B-s1,d0*
Sustainability and Lifecycle	16	Based on natural materials	*yes*
	17	Embodied energy	*> 50 MJ/kg*
	18	Average lifetime	*25-50 years*
	19	Recyclability	*Partially recycled (grinded) into expanded cork granulates.*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Requires a flat, clean, and dry surface for application. Glued and can be cut into any shape.*
	23	Cost	*High (€€€)*

Table 61. Solution EWI-7: Mineral insulation boards.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Mineral insulation boards*
	2	Category	*Mineral board based*
	3	Example of application	• *Frühwerk Sep Ruf* • *Kindergarten and apartments - Chur, Switzerland* • *Prescriptions techniques*
	4	Possible supplier	• *Caparol* • *Röfix* • *Sto* • *Xella* • *Ytong*
Technical Specifications	5	Composition (from inside to outside)	• *Adhesive;* • *Mineral board;* • *External finish*
	6	System thickness	*20-300 mm +finish*
	7	Av. thermal conductivity	*0.046-0.056 W/mK*
	8	Thermal conductivity of ins. layer	*0.042-0.050 W/mK*
	9	Fire protection class	• *A1-s1,d0* • *A2-s1,d0*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*50+ years*
	19	Recyclability	*no*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Glued and screwed; surface can be uneven (up to 2 cm/m). Wide range of insulation thicknesses available. Mineral insulation boards are hand-processed and cut with band saws or carbide saws, generating mostly coarse dust. Attached to the substrate with lightweight mineral mortar (approx. 3.5 kg/m²) or dowels. Can be plastered, painted, or finished with building boards.*
	23	Cost	*Medium (€€)*

Table 62. Solution EWI-8: Mineral wool insulation.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Mineral wool insulation*
	2	Category	*Mineral wool based*
	3	Example of application	• *Ansitz Kofler* • *Apartment building Magnusstrasse - Zürich* • *Baur Residence, Lustenau* • *Gasthof Adler Langenegg* • *Haus Pernter* • *Notarjeva vila* • *Osramhuset (The Osram Building)* • *Residential and commercial building Feldbergstrasse - Basel* • *Single Family House - Gstaad, Switzerland* • *Solar silo in Gundeldinger Feld - Basel*
	4	Possible supplier	• *Brillux* • *Caparol* • *FLUMROC* • *Knauf* • *Sto*
Technical Specifications	5	Composition (from inside to outside)	• *Adhesive;* • *Vapour rearder;* • *Mineral wool, with or without timber frame;* • *External finish*
	6	System thickness	*20-300 mm +finish*
	7	Av. thermal conductivity	*0.036-0.074 W/mK*
	8	Thermal conductivity of ins. layer	*0.034-0.045 W/mK*
	9	Fire protection class	• *A1* • *A2*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*> 25, < 50 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*Partly recycled at their end-of-life, but no established collection system.*
	20	Prefabricated solution	*no*
	21	Reversible system	*depends on installation*
	22	Installation	*Glued or glued and screwed; requires a flat surface for application. Wide range of insulation thicknesses available.*
	23	Cost	*Medium (€€)*

Table 63. Solution EWI-9: Phenolic foam boards.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Phenolic foam boards*
	2	Category	*Oil-based polymers*
	3	Example of application	*none*
	4	Possible supplier	• *Caparol* • *Kingspan* • *Knauf* • *Sto*
Technical Specifications	5	Composition (from inside to outside)	• *Adhesive;* • *Phenolic foam board;* • *External finish*
	6	System thickness	*20-200 mm +finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.021-0.045 W/mK*
	9	Fire protection class	• *C-s1,d0* • *C-s2, d0* • *E*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*> 50 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*no*
	20	Prefabricated solution	*no*
	21	Reversible system	*no*
	22	Installation	*Glued and screwed; surface can be uneven (up to 2 cm/m). Wide range of insulation thicknesses available.*
	23	Cost	*Medium (€€)*

Table 64. Solution EWI-10: Polystyrene insulation (EPS/XPS).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Polystyrene insulation (EPS/XPS)*
	2	Category	*Oil-based polymers*
	3	Example of application	• *Casa Rossa Chemnitz* • *Maison Rubens* • *Rheintalhaus Irgang*
	4	Possible supplier	• *Austrotherm* • *Brillux* • *Caparol* • *JACKON Insulation* • *JUB* • *Knauf* • *Ravago* • *Sto* • *Styrodur*
Technical Specifications	5	Composition (from inside to outside)	• *Adhesive;* • *Polystyrene board (EPS/XPS);* • *Reinforcement layer;* • *Finishing render*
	6	System thickness	*10-400 mm +finish*
	7	Av. thermal conductivity	*0.035-0.041 W/mK*
	8	Thermal conductivity of ins. layer	*0.031-0.040 W/mK*
	9	Fire protection class	• *B* • *C* • *E (ins. material)*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*> 50 MJ/kg*
	18	Average lifetime	*40-50+ years*
	19	Recyclability	*Partly recycled at their end-of-life, but only in special places and no established collection system.*
	20	Prefabricated solution	*no*
	21	Reversible system	*depends on installation*
	22	Installation	*Glued or glued and screwed; requires a flat surface for application. Wide range of insulation thicknesses available.*
	23	Cost	*Low (€)*

Table 65. Solution EWI-11: Polyurethane insulation (PIR/PUR).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Polyurethane insulation (PIR/PUR)*
	2	Category	*Oil-based polymers*
	3	Example of application	*none*
	4	Possible supplier	• *Brillux* • *Caparol* • *Linzmeier* • *Sto*
Technical Specifications	5	Composition (from inside to outside)	• *Adhesive;* • *Polyurethane board;* • *External finish*
	6	System thickness	*20-300 mm +finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.024-0.045 W/mK*
	9	Fire protection class	• *B-s1,d0* • *B-s2,d0* • *C* • *D-s2,d0* • *E* • *F*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*> 50 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*Usually no, but possible in certain cases.*
	20	Prefabricated solution	*no*
	21	Reversible system	*no*
	22	Installation	*Glued and screwed; requires a flat surface for application. Wide range of insulation thicknesses available.*
	23	Cost	*Medium (€€)*

Table 66. Solution EWI-12: Prefabricated modules with cellulose.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Prefabricated modules with cellulose*
	2	Category	*Biobased*
	3	Example of application	• *Bauernhof Trins*
	4	Possible supplier	*none*
Technical Specifications	5	Composition (from inside to outside)	• *Facade connector system;* • *Prefabricated modules consisting of timber frame, blown-in cellulose, external finish and windows*
	6	System thickness	*adaptable - on order, example - 410 mm*
	7	Av. thermal conductivity	*0.052 W/mK*
	8	Thermal conductivity of ins. layer	*0.037-0.038 W/mK*
	9	Fire protection class	*B-s2,d0*
Sustainability and Lifecycle	16	Based on natural materials	*partially*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*15-100 years*
	19	Recyclability	*Can be reused as insulation or burnt in a refuse incineration plant.*
	20	Prefabricated solution	*yes*
	21	Reversible system	*yes*
	22	Installation	*Prefabrication of facade elements in the factory, including window installation, blowing in cellulose, and assembly of the facade connector system. Transport of prefabricated panels and careful hanging on the connector system.*
	23	Cost	*High (€€€)*

Table 67. Solution EWI-13: Reed insulation.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Reed insulation*
	2	Category	*Biobased*
	3	Example of application	• *Kohlerhaus*
	4	Possible supplier	• *ClayTec* • *Hiss Reet*
Technical Specifications	5	Composition (from inside to outside)	• *Render;* • *Reed insulation;* • *External plaster*
	6	System thickness	*20-120 mm +finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.055 W/mK*
	9	Fire protection class	*E*
Sustainability and Lifecycle	16	Based on natural materials	*yes*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*30-50 years*
	19	Recyclability	*Yes, possible reuse or recycle.*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Surface must be clean, dry, and flat (use of render). Mounted to the existing wall and covered with grout.*
	23	Cost	*Low (€)*

Table 68. Solution EWI-14: Thermal insulating plaster.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Thermal insulating plaster*
	2	Category	*Insulation plasters*
	3	Example of application	• *Platzbon* • *Sankt Christoph*
	4	Possible supplier	• *Röfix*
Technical Specifications	5	Composition (from inside to outside)	*Insulating plaster on the outside*
	6	System thickness	*max. 120 mm*
	7	Av. thermal conductivity	*0.077 W/mK*
	8	Thermal conductivity of ins. layer	*0.02-0.067 W/mK*
	9	Fire protection class	• *A1* • *A2-s1,d0*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*40+ years*
	19	Recyclability	*no*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Surface must be clean and dry. Applied wet, usually with a special machine, prepared on-site.*
	23	Cost	*High (€€€)*

Table 69. Solution EWI-15: Vacuum Insulation Panels (VIP).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Vacuum Insulation Panels (VIP)*
	2	Category	*Other*
	3	Example of application	• *Swedish building* • *Article 1*
	4	Possible supplier	• *Etex* • *Kingspan* • *Vaku-Isotherm*
Technical Specifications	5	Composition (from inside to outside)	• *Bonding,* • *VIP panels + glass wool / VIP panels with Polystyrene layers* • *Air space* • *Exterior finishing*
	6	System thickness	*60-130 mm +finish*
	7	Av. thermal conductivity	*0.02 W/mK*
	8	Thermal conductivity of ins. layer	*0.004-0.008 W/mK*
	9	Fire protection class	*E*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*> 50 MJ/kg*
	18	Average lifetime	*60 years*
	19	Recyclability	*Possible, but not common.*
	20	Prefabricated solution	*partially*
	21	Reversible system	*yes*
	22	Installation	*Available in standard sizes, but different sizes can be prepared if needed. Glued to the surface and finished with plaster.*
	23	Cost	*High (€€€)*

Table 70. Solution EWI-16: Wood fibre/wood wool insulation.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Wood fibre/wood wool insulation*
	2	Category	*Biobased*
	3	Example of application	• *Half-timberframed house in Alken, Belgium* • *Hof 6, Schwarzenberg, Vorarlberg, Austria* • *House Maurer, Wolfurt*
	4	Possible supplier	• *BetonWood* • *Caparol* • *Isover* • *Knauf* • *Steico* • *Sto*
Technical Specifications	5	Composition (from inside to outside)	• *Adhesive* • *Wood fibre insulation;* • *Reinforcement layer;* • *Finishing render*
	6	System thickness	*25-240 mm +finish*
	7	Av. thermal conductivity	*0.113 W/mK*
	8	Thermal conductivity of ins. layer	*0.032-0.049 W/mK*
	9	Fire protection class	• *B* • *E (ins. material)*
Sustainability and Lifecycle	16	Based on natural materials	*yes*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*Can be recycled in the production process or thermally, e.g., for combustion as biomass or in waste incineration plants.*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Stapled and screwed (timber wall) or glued and screwed. Requires a flat surface for application. Wide range of insulation thicknesses available.*
	23	Cost	*Medium (€€)*

A1.3. Roof insulation

Table 71. Solution RI-1: Blown-in cellulose in attic.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Blown-in cellulose in attic*
	2	Category	*Biobased*
	3	Example of application	• *Réhabilitation du Clos Jouve - Bâtiment 3* • *Réhabilitation Ecuries de Versailles - Aile de Sceaux*
	4	Possible supplier	• *AUSTROZELL* • *clima-super* • *Isocell* • *Isofloc* • *Isover* • *Thermofloc*
Technical Specifications	5	Composition (from inside to outside)	• *Existing construction;* • *Blown-in cellulose*
	6	System thickness	*adaptable*
	7	Av. thermal conductivity	*0.04-0.05 W/mK*
	8	Thermal conductivity of ins. layer	*0.037-0.041 W/mK*
	9	Fire protection class	*B-s2,d0*
	11	System type	*attic space*
	13	Application	*Above existing construction*
	15	Roof type	*attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*partially*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*15-100 years*
	19	Recyclability	*Can be reused as insulation or burned in a refuse incineration plant.*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Blown into the prepared wooden frame for fast, uniform installation. Provides good airtightness.*
	23	Cost	*Low (€)*

Table 72. Solution RI-2: Clay boards.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Clay boards*
	2	Category	*Biobased*
	3	Example of application	• *Town Hall Bergrheinfeld*
	4	Possible supplier	• *ClayTec*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish;* • *Clay boards;* • *Existing construction*
	6	System thickness	*16-22 mm + finish, possible multiple layers*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.18-0.353 W/mK*
	9	Fire protection class	• *A1* • *A2-s1.d0*
	11	System type	*cold roof*
	13	Application	*Below existing construction*
	15	Roof type	*pitched roof*
Sustainability and Lifecycle	16	Based on natural materials	*yes*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*no data*
	19	Recyclability	*yes*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Cut to desired form and size, then screwed to the existing roof construction.*
	23	Cost	*Medium (€€)*

Table 73. Solution RI-3: Construction wood + cellulose.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Construction wood + cellulose*
	2	Category	*Biobased*
	3	Example of application	• *Ackerbürgerhäuschen* • *Casa Rossa Chemnitz* • *Community Hall Zwischenwasser* • *Farmhouse Straub* • *House Maurer, Wolfurt* • *Kindergarten and apartments - Chur, Switzerland* • *Musikschule Velden* • *Oeconomy building Josef Weiss* • *Single family House - Bern, Switzerland*
	4	Possible supplier	• *Isocell*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish with vapour retarder;* • *Construction wood/cellulose insulation;* • *External finish*
	6	System thickness	*50-400 mm +finish*
	7	Av. thermal conductivity	*0.050-0.089 W/mK*
	8	Thermal conductivity of ins. layer	*0.038-0.039 W/mK*
	9	Fire protection class	*B-s2,d0*
	11	System type	*cold roof*
	13	Application	*Between roof rafters*
	15	Roof type	• *flat roof* • *pitched roof*
Sustainability and Lifecycle	16	Based on natural materials	*partially*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*15-100 years*
	19	Recyclability	*Can be reused as insulation or burned in a refuse incineration plant.*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Space between construction wood is filled with blown-in cellulose or clamped rolls.*
	23	Cost	*Low (€)*

Table 74. Solution RI-4: Construction wood + mineral wool/glass wool/rock wool.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Construction wood + mineral wool/glass wool/rock wool*
	2	Category	*Mineral wool based*
	3	Example of application	• *Ansitz Kofler* • *Klostergebäude Kaiserstrasse* • *Notarjeva vila* • *Oberbergerhof* • *Rhine Valley House Irgang* • *Single Family House - Gstaad, Switzerland*
	4	Possible supplier	• *Isover* • *FLUMROC* • *Knauf* • *URSA*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish with vapour retarder;* • *Construction wood/mineral wool/glass wool/rock wool;* • *External finish*
	6	System thickness	*40-300 mm +finish*
	7	Av. thermal conductivity	*0.051-0.135 W/mK*
	8	Thermal conductivity of ins. layer	*0.031-0.032 W/mK*
	9	Fire protection class	*A1*
	11	System type	*warm roof*
	13	Application	*Between roof rafters*
	15	Roof type	• *pitched roof* • *attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*> 25, < 50 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*Partly recyclable at the end of life, but no established collection system.*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Insulation cut from roll with 10–15 mm extra width and clamped between rafters after measuring clear span.*
	23	Cost	*Medium (€€)*

Table 75. Solution RI-5: Construction wood + plant fiber insulation.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Construction wood + plant fiber insulation*
	2	Category	*Biobased*
	3	Example of application	• *Réhabilitation - Ancien presbytère en logements* • *Timber-framed barn in the north of France* • *Town Hall Bergrheinfeld*
	4	Possible supplier	• *Ekolution* • *Hempitecture* • *Thermo Hanf* • *Vicarius Canna*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish with vapour retarder;* • *Construction wood/plant fiber insulation/hemp wool/(recycled) cotton fibre etc.;* • *External finish*
	6	System thickness	*30-310 mm +finish*
	7	Av. thermal conductivity	*0.05-0.096 W/mK*
	8	Thermal conductivity of ins. layer	*0.039-0.040 W/mK* *cotton: 0.123-0.126 W/mK*
	9	Fire protection class	• *D-s1,d0* • *E*
	11	System type	*warm roof*
	13	Application	*Between roof rafters*
	15	Roof type	• *flat roof* • *pitched roof* • *attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*yes/partially (possible nonnatural bonding additions)*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*60 years*
	19	Recyclability	*When disassembled without damage, materials may be reused for the same application or in an alternative location. If not contaminated, the raw material can be easily recycled and recovered (e.g., re-admission to the production process).*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Cut in factory or on-site to slightly exceed rafter spacing. Placed between rafters, optionally finished with a second layer, vapour barrier, and internal finish.*
	23	Cost	*Low (€)*

Table 76. Solution RI-6: Construction wood + sheep wool.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Construction wood + sheep wool*
	2	Category	*Biobased*
	3	Example of application	• *Giatla house*
	4	Possible supplier	• *Havelock* • *Isolena* • *thermafleece*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish with vapour retarder;* • *Construction wood/sheep wool;* • *External finish*
	6	System thickness	*35-300 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.035-0.039 W/mK*
	9	Fire protection class	• *B-s1,d0* • *C-s2,d0* • *D-s2,d0* • *E*
	11	System type	*warm roof*
	13	Application	*Between roof rafters*
	15	Roof type	• *pitched roof* • *attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*yes*
	17	Embodied energy	*> 25, < 50 MJ/kg*
	18	Average lifetime	*50-60 years*
	19	Recyclability	*yes*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Cut and fitted between rafters; can be stapled in place.*
	23	Cost	*Low (€)*

Table 77. Solution RI-7: Construction wood + wood fibre.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Construction wood + wood fibre*
	2	Category	*Biobased*
	3	Example of application	• *Annat Road* • *Ansitz Mairhof* • *Downie's Cottage* • *Kohlerhaus* • *Half-timberframed house in Alken, Belgium* • *Maison Rubens* • *Rainhof* • *Ruckenzaunerhof* • *Sankt Christoph* • *Solar Villa* • *Timber-framed house in Alsace, France* • *Villa Castelli*
	4	Possible supplier	• *Gutex* • *Knauf* • *Pavatex* • *Steico*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish with vapour retarder;* • *Construction wood/wood fibre insulation;* • *External finish*
	6	System thickness	*100-240 mm + finish*
	7	Av. thermal conductivity	*0.042-0.137 W/mK*
	8	Thermal conductivity of ins. layer	*0.036-0.041 W/mK*
	9	Fire protection class	*E (ins. material)*
	11	System type	*warm roof*
	13	Application	*Between roof rafters*
	15	Roof type	• *flat roof* • *pitched roof* • *attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*yes*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*Can be recycled in the production process or thermally (e.g., for combustion as biomass or in waste incineration plants).*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Cut with standard wood-cutting machines, mounted between trusses, and can be screwed to trusses.*
	23	Cost	*Low (€)*

Table 78. Solution RI-8: Flat roof insulation with polystyrene (EPS/XPS).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Flat roof insulation with polystyrene (EPS/XPS)*
	2	Category	*Oil-based polymers*
	3	Example of application	*none*
	4	Possible supplier	• BMI Group • JACKON Insulation • JUB • Ravago • Styrodur
Technical Specifications	5	Composition (from inside to outside)	• *Existing load-bearing construction* • *Waterproofing membrane* • *Polystyrene / EPS / XPS* • *External finish*
	6	System thickness	*10-400 mm +finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.031-0.053 W/mK*
	9	Fire protection class	*E (ins. material)*
	11	System type	*warm roof*
	13	Application	*Above existing construction*
	15	Roof type	*flat roof*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*> 50 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*no*
	20	Prefabricated solution	*no*
	21	Reversible system	*no*
	22	Installation	*Depending on application, boards are glued, mechanically fastened, or laid freely.*
	23	Cost	*Low (€)*

Table 79. Solution RI-9: Foam glass.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Foam glass*
	2	Category	*Other*
	3	Example of application	*none*
	4	Possible supplier	• *Foamglas* • *Schlüsselbauer Geomaterials*
Technical Specifications	5	Composition (from inside to outside)	• *Existing construction;* • *Separation layer (bituminous);* • *Foam glass insulation;* • *External finish*
	6	System thickness	*40-200 mm +finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.036-0.042 W/mK*
	9	Fire protection class	*A1*
	11	System type	*warm roof*
	13	Application	*Above existing construction*
	15	Roof type	• *flat roof* • *pitched roof* • *attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*partially*
	17	Embodied energy	*> 25, < 50 MJ/kg*
	18	Average lifetime	*100 years*
	19	Recyclability	*Partially recyclable, reused as additives in the manufacture of new material.*
	20	Prefabricated solution	*no*
	21	Reversible system	*no*
	22	Installation	*Apply bituminous separation layer. Fully bond boards with hot bitumen, dip edges, press into place, and remove excess. Apply finish.*
	23	Cost	*High (€€€)*

Table 80. Solution RI-10: Insulation panels with Polystyrene/Polyurethan.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Insulation panels with Polystyrene/Polyurethan*
	2	Category	*Oil-based polymers*
	3	Example of application	• *Doragno Castle - Rovio, Ticino, Switzerland* • *Hof Neuhäusl*
	4	Possible supplier	• *BMI Group* • *Isotec* • *Linzmeier* • *Steinbacher* • *Thermochip*
Technical Specifications	5	Composition (from inside to outside)	• *Existing construction;* • *Insulation panel;* • *External finish*
	6	System thickness	*20-240 mm + finish*
	7	Av. thermal conductivity	*0.053 W/mK*
	8	Thermal conductivity of ins. layer	*0.022-0.023 W/mK*
	9	Fire protection class	*E (ins. material)*
	11	System type	*warm roof*
	13	Application	*Above existing construction*
	15	Roof type	• *flat roof* • *pitched roof* • *attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*> 50 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*Clean and undamaged polyurethane insulation boards can be reused and recycled as materials or raw materials.*
	20	Prefabricated solution	*partially*
	21	Reversible system	*no*
	22	Installation	*Can be cut, sawn, milled, or sanded. Fastening by mechanical fixing, loose laying, or bonding with adhesive.*
	23	Cost	*Medium (€€)*

Table 81. Solution RI-11: Mineral wool/glass wool/rock wool (inside).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Mineral wool/glass wool/rock wool (inside)*
	2	Category	*Mineral wool based*
	3	Example of application	• *Elementary School in Mulhouse, France*
	4	Possible supplier	• *Knauf*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish;* • *Mineral wool/glass wool/rock wool;* • *Existing construction*
	6	System thickness	*30-400 mm +finish*
	7	Av. thermal conductivity	*0.036 W/mK*
	8	Thermal conductivity of ins. layer	*0.031-0.04 W/mK*
	9	Fire protection class	*A1*
	11	System type	*cold roof*
	13	Application	*Below existing construction*
	15	Roof type	• *flat roof* • *pitched roof* • *attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*> 25, < 50 MJ/kg*
	18	Average lifetime	*60 years*
	19	Recyclability	*Partly recyclable at the end of life, but no established collection system.*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Installed between supporting structures. Retaining brackets recommended for insulation with thickness ≥ 30mm.*
	23	Cost	*Low (€)*

Table 82. Solution RI-12: Mineral wool/glass wool/rock wool (loose/blown-in).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Mineral wool/glass wool/rock wool (loose/blown-in)*
	2	Category	*Mineral wool based*
	3	Example of application	*none*
	4	Possible supplier	• *Knauf*
Technical Specifications	5	Composition (from inside to outside)	• *Existing construction;* • *Loose fill insulation*
	6	System thickness	*adaptable*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.033-0.04 W/mK*
	9	Fire protection class	*A1*
	11	System type	*warm roof*
	13	Application	*Above existing construction*
	15	Roof type	• *pitched roof* • *attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*> 25, < 50 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*Partly recyclable at the end of life, but no established collection system.*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Free shape allows easy filling of hollow spaces and access to narrow or irregular shapes.*
	23	Cost	*Medium (€€)*

Table 83. Solution RI-13: Mineral wool/glass wool/rock wool (outside).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Mineral wool/glass wool/rock wool (outside)*
	2	Category	*Mineral wool based*
	3	Example of application	• *Colbert Post Office - Marseille* • *Magasinet i Varvsstaden, Malmö*
	4	Possible supplier	• *Isover* • *Knauf*
Technical Specifications	5	Composition (from inside to outside)	• *Existing construction;* • *Mineral wool/glass wool/rock wool;* • *External finish*
	6	System thickness	*20-300 mm +finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.034-0.059 W/mK*
	9	Fire protection class	• *A1* • *A2-s1.d0*
	11	System type	*warm roof*
	13	Application	*Above existing construction*
	15	Roof type	• *flat roof* • *pitched roof* • *attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*no*
	17	Embodied energy	*> 25, < 50 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*Partly recyclable at the end of life, but no established collection system.*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Mounted on top of the existing construction.*
	23	Cost	*Low (€)*

Table 84. Solution RI-14: Mineralised fir wood wool bound with Portland cement.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Mineralised fir wood wool bound with Portland cement*
	2	Category	*Biobased*
	3	Example of application	• *Doragno Castle - Rovio, Ticino, Switzerland*
	4	Possible supplier	• *Celenit*
Technical Specifications	5	Composition (from inside to outside)	• *Existing construction;* • *Vapour barrier;* • *Wood wool panel;* *External finish*
	6	System thickness	*15-210 mm +finish*
	7	Av. thermal conductivity	*0.053 W/mK*
	8	Thermal conductivity of ins. layer	*0.04-0.065 W/mK*
	9	Fire protection class	*B-s1,d0*
	11	System type	*warm roof*
	13	Application	*Above existing construction*
	15	Roof type	• *flat roof* • *pitched roof* *attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*yes*
	17	Embodied energy	*> 25, < 50 MJ/kg*
	18	Average lifetime	*100+ years*
	19	Recyclability	*Potentially recyclable, depending on local recycling centres.*
	20	Prefabricated solution	*no*
	21	Reversible system	*no*
	22	Installation	*Cut on-site and mounted to the existing structure.*
	23	Cost	*Medium (€€)*

Table 85. Solution RI-15: Wood fibre (outside).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Wood fibre (outside)*
	2	Category	*Biobased*
	3	Example of application	• *Rebecco Farm* • *Solar Villa* • *Town Hall Burgkunstadt*
	4	Possible supplier	• *BetonWood* • *Steico*
Technical Specifications	5	Composition (from inside to outside)	• *Existing construction;* • *Waterproofing membrane* • *Wood fibre insulation;* • *External finish*
	6	System thickness	*22-240 mm +finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.048-0.050 W/mK*
	9	Fire protection class	• *A2-s1,d0* • *B-s1,d0* • *E*
	11	System type	*warm roof*
	13	Application	*Above existing construction*
	15	Roof type	• *flat roof* • *pitched roof* • *attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*partially*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*Can be recycled in the production process or thermally (e.g., for combustion as biomass or in waste incineration plants).*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Laid on the existing construction (usually roof trusses), fastened with screws or glued, then covered with roof underlay and external finish.*
	23	Cost	*Medium (€€)*

Table 86. Solution RI-16: Wood fibre/wood wool (inside).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Wood fibre/wood wool (inside)*
	2	Category	*Biobased*
	3	Example of application	• *Holyrood Park Lodge* • *Kasperhof*
	4	Possible supplier	• *BetonWood* • *Gutex* • *Knauf* • *Steico*
Technical Specifications	5	Composition (from inside to outside)	• *Internal finish with vapour retarder;* • *Wood fibre insulation;* • *Existing construction*
	6	System thickness	*15-240 mm +finish*
	7	Av. thermal conductivity	*0.049-0.056 W/mK*
	8	Thermal conductivity of ins. layer	*0.03-0.095 W/mK*
	9	Fire protection class	• *A2-s1,d0* • *B-s1,d0* • *E*
	11	System type	*cold roof*
	13	Application	*Below existing construction*
	15	Roof type	• *pitched roof* • *attic floor*
Sustainability and Lifecycle	16	Based on natural materials	*partially*
	17	Embodied energy	*< 25 MJ/kg*
	18	Average lifetime	*50 years*
	19	Recyclability	*Can be recycled in the production process or thermally (e.g., for combustion as biomass or in waste incineration plants).*
	20	Prefabricated solution	*no*
	21	Reversible system	*yes*
	22	Installation	*Fastened with screws or glued to the existing construction (roof trusses).*
	23	Cost	*Low (€)*

A1.4. Basement and foundation insulation

Table 87. Solution BFI-1: Aerogel composite panel on the floor.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Aerogel composite panel on the floor*
	2	Category	*Other*
	3	Example of application	*none*
	4	Possible supplier	• *CorePro Systems* • *Thermablok Aerogels Ltd*
Technical Specifications	5	Composition (from inside to outside)	• *Finish/flooring;* • *Aerogel panel;* • *Existing construction*
	6	System thickness	*13-33 mm + flooring*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.015-0.020 W/mK*
	9	Fire protection class	*A2, C-s1,d0*
	10	Application	*Floor on ground / floor above basement*
Sustainability and Lifecycle	11	Based on natural materials	*no*
	12	Embodied energy	*> 50 MJ/kg*
	13	Average lifetime	*60+ years*
	14	Recyclability	*yes*
	15	Prefabricated solution	*no*
	16	Reversible system	*yes*
	17	Installation	*Easily cut, shaped, and tape resealed on-site. Laid on a flat and prepared surface.*
	18	Cost	*High (€€€)*

Table 88. Solution BFI-2: Blown-in cellulose.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Blown-in cellulose*
	2	Category	*Biobased*
	3	Example of application	• *Maison Rubens*
	4	Possible supplier	• *AUSTROZELL* • *clima-super* • *Isocell* • *Isofloc* • *Thermofloc*
Technical Specifications	5	Composition (from inside to outside)	• *Existing ceiling;* • *Cellulose insulation + wooden structure;* • *Wooden boards with opt. finish* *OR* • *Finish/flooring;* • *Cellulose insulation + wooden structure;* • *Existing construction*
	6	System thickness	*adaptable*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.037-0.041 W/mK*
	9	Fire protection class	*B-s2,d0*
	10	Application	*Basement ceiling*
Sustainability and Lifecycle	11	Based on natural materials	*partially*
	12	Embodied energy	*< 25 MJ/kg*
	13	Average lifetime	*15-100 years*
	14	Recyclability	*can be reused as new insulation*
	15	Prefabricated solution	*no*
	16	Reversible system	*yes*
	17	Installation	*Blown into the prepared wooden frame for fast, uniform installation. Provides good airtightness.*
	18	Cost	*Medium (€€)*

Table 89. Solution BFI-3: External insulation on foundation: EPS/XPS.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*External insulation on foundation: EPS/XPS*
	2	Category	*Oil-based polymers*
	3	Example of application	*none*
	4	Possible supplier	• *Austrotherm* • *Brillux* • *JACKON Insulation* • *JUB* • *Knauf* • *Ravago* • *Styrodur*
Technical Specifications	5	Composition (from inside to outside)	• *Basement wall;* • *Insulation board;* • *External finish*
	6	System thickness	*10-400 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.027-0.043 W/mK*
	9	Fire protection class	*E*
	10	Application	*External wall insulation*
Sustainability and Lifecycle	11	Based on natural materials	*no*
	12	Embodied energy	*> 50 MJ/kg*
	13	Average lifetime	*30-50 years*
	14	Recyclability	*yes*
	15	Prefabricated solution	*no*
	16	Reversible system	*depends on installation*
	17	Installation	*Insulation boards require solid support at the base to prevent slipping. Bonded with solvent-free cold bitumen adhesive, ensuring proper sealing to prevent water infiltration. The choice of insulation material depends on the water content in the earth surrounding the foundation.*
	18	Cost	*Low (€)*

Table 90. Solution BFI-4: External insulation on foundation: foam glass.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*External insulation on foundation: foam glass*
	2	Category	*Other*
	3	Example of application	*none*
	4	Possible supplier	• *Foamglas* • *Schlüsselbauer Geomaterials*
Technical Specifications	5	Composition (from inside to outside)	• *Basement wall;* • *Render & waterproof membrane;* • *Foam glass insulation;* • *External finish*
	6	System thickness	*40-200 mm +finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.036-0.042 W/mK*
	9	Fire protection class	*A1*
	10	Application	*External wall insulation*
Sustainability and Lifecycle	11	Based on natural materials	*partially*
	12	Embodied energy	*> 25, < 50 MJ/kg*
	13	Average lifetime	*100 years*
	14	Recyclability	*partially, re-used as additives in the manufacture of new foam glass*
	15	Prefabricated solution	*no*
	16	Reversible system	*yes*
	17	Installation	*Glued to the surface. Requires a flat surface.*
	18	Cost	*High (€€€)*

Table 91. Solution BFI-5: External insulation on foundation: mineral boards.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*External insulation on foundation: mineral boards*
	2	Category	*Mineral board based*
	3	Example of application	*none*
	4	Possible supplier	• *Caparol* • *Röfix* • *Sto* • *Xella* • *Ytong*
Technical Specifications	5	Composition (from inside to outside)	• *Adhesive;* • *Mineral board;* • *External finish*
	6	System thickness	*20-300 mm +finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.042-0.050 W/mK*
	9	Fire protection class	• *A1-s1,d0* • *A2-s1,d0*
	10	Application	*External wall insulation*
Sustainability and Lifecycle	11	Based on natural materials	*no*
	12	Embodied energy	*< 25 MJ/kg*
	13	Average lifetime	*50+ years*
	14	Recyclability	*no*
	15	Prefabricated solution	*no*
	16	Reversible system	*yes*
	17	Installation	*Glued and screwed; surface may be uneven (≤ 2 cm/m). Wide range of insulation thicknesses available. Mineral insulation boards are processed by hand, cut with band saws or carbide saws (producing coarse dust). Attached to the substrate with lightweight mineral mortar (average 3.5 kg/m²) or dowels. Can be plastered, painted, or finished with building boards.*
	18	Cost	*Medium (€€)*

Table 92. Solution BFI-6: External insulation on foundation: Vacuum Insulation Panels (VIP).

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*External insulation on foundation: Vacuum Insulation Panels (VIP)*
	2	Category	*Other*
	3	Example of application	*none*
	4	Possible supplier	• *Etex* • *Kingspan* • *Vaku-Isotherm*
Technical Specifications	5	Composition (from inside to outside)	• *Bonding;* • *VIP panels + glass wool / VIP panels with polystyrene layers;* • *Air space;* • *Exterior finishing*
	6	System thickness	*18-100 mm + finish*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.004-0.008 W/mK*
	9	Fire protection class	*A1*
	10	Application	*External wall insulation*
Sustainability and Lifecycle	11	Based on natural materials	*no*
	12	Embodied energy	*> 50 MJ/kg*
	13	Average lifetime	*60 years*
	14	Recyclability	*possible but not common*
	15	Prefabricated solution	*partially*
	16	Reversible system	*no*
	17	Installation	*Available in standard sizes, but different sizes can be prepared if needed. Glued to the surface and finished with plaster. Cannot be punctured; if destroyed, insulation properties are lost.*
	18	Cost	*High (€€€)*

Table 93. Solution BFI-7: Foam glass on the floor.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Foam glass on the floor*
	2	Category	*Other*
	3	Example of application	• *Kindergarten and apartments - Chur, Switzerland* • *Kohlerhaus*
	4	Possible supplier	• *Foamglas* • *Schlüsselbauer Geomaterials*
Technical Specifications	5	Composition (from inside to outside)	• *Finish/flooring;* • *Foam glass;* • *Existing construction*
	6	System thickness	• *panels: 40-200 mm + flooring* • *loose: adaptable*
	7	Av. thermal conductivity	*0.087-0.157 W/mK*
	8	Thermal conductivity of ins. layer	*0.036-0.042 W/mK*
	9	Fire protection class	*A1*
	10	Application	• *Floor on ground* • *Floor above basement*
Sustainability and Lifecycle	11	Based on natural materials	*partially*
	12	Embodied energy	*> 25, < 50 MJ/kg*
	13	Average lifetime	*100 years*
	14	Recyclability	*partially, re-used as additives in the manufacture of new foam glas*
	15	Prefabricated solution	*no*
	16	Reversible system	*yes*
	17	Installation	*Can be in form of a panel or loose.*
	18	Cost	*High (€€€)*

Table 94. Solution BFI-8: Lightweight expanded clay insulation on the floor.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Lightweight expanded clay insulation on the floor*
	2	Category	*Other*
	3	Example of application	• *Appleby-in-Westmoreland* • *Decent Homes refurbishment* • *Dudley, West Midlands* • *Leicester* • *Liverpool 3-bedroom Terrace House* • *Nottingham*
	4	Possible supplier	• *Laterlite* • *LECA by Saint-Gobain* • *Liapor*
Technical Specifications	5	Composition (from inside to outside)	• *Finish/flooring;* • *Screed;* • *Damp Proof Membrane;* • *Lightweight expanded clay aggregate;* • *Opt. Separation Layer;* • *Existing construction*
	6	System thickness	*adaptable, min. 15 mm*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.08-0.13 W/mK*
	9	Fire protection class	*A1*
	10	Application	• *Floor on ground* • *Floor above basement*
Sustainability and Lifecycle	11	Based on natural materials	*yes*
	12	Embodied energy	*< 25 MJ/kg*
	13	Average lifetime	*100+ years*
	14	Recyclability	*yes*
	15	Prefabricated solution	*no*
	16	Reversible system	*yes*
	17	Installation	*Simple and fast insulation. Can be installed in a bag directly in the foundation or poured into a prepared shape.*
	18	Cost	*Medium (€€)*

Table 95. Solution BFI-9: Lightweight insulating concrete on the floor.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Lightweight insulating concrete on the floor*
	2	Category	*Other*
	3	Example of application	• *London King's College Renovation and Extension*
	4	Possible supplier	• *Laterlite* • *LECA by Saint-Gobain*
Technical Specifications	5	Composition (from inside to outside)	• *Finish/flooring;* • *Lightweight concrete plate;* • *Existing construction*
	6	System thickness	*adaptable, min. 40 mm*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.134-0.32 W/mK*
	9	Fire protection class	*A1*
	10	Application	• *Floor on ground* • *Floor above basement*
Sustainability and Lifecycle	11	Based on natural materials	*yes*
	12	Embodied energy	*< 25 MJ/kg*
	13	Average lifetime	*no data*
	14	Recyclability	*no data*
	15	Prefabricated solution	*no*
	16	Reversible system	*no*
	17	Installation	*Concrete applied in a single layer.*
	18	Cost	*Low (€)*

Table 96. Solution BFI-10: Lime-hemp concrete on the floor.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Lime-hemp concrete on the floor*
	2	Category	*Biobased*
	3	Example of application	• *Timber-framed house in Alsace, France*
	4	Possible supplier	• *dade design GmbH* • *Hempitecture* • *Schönthaler* • *UK Hempcrete*
Technical Specifications	5	Composition (from inside to outside)	• *Finish/flooring;* • *Lime-hemp concrete (+ timber construction);* • *Barrier layer;* • *Existing construction/ground*
	6	System thickness	*adaptable*
	7	Av. thermal conductivity	*0.138 W/mK*
	8	Thermal conductivity of ins. layer	*0.06-0.5 W/mK*
	9	Fire protection class	*B1*
	10	Application	• *Floor on ground* • *Floor above basement*
Sustainability and Lifecycle	11	Based on natural materials	*yes*
	12	Embodied energy	*< 25 MJ/kg*
	13	Average lifetime	*100+ years*
	14	Recyclability	*yes, can be chopped up and recast into hemp bricks / hemp stones*
	15	Prefabricated solution	*no*
	16	Reversible system	*no*
	17	Installation	*Wear protective clothing, gloves, and eye protection to avoid injury when handling, mixing, and installing. Hempcrete is abrasive to skin and lungs due to the lime content in the binder.*
	18	Cost	*Medium (€€)*

Table 97. Solution BFI-11: Mineral wool between beams/joists.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Mineral wool between beams/joists*
	2	Category	*Mineral wool based*
	3	Example of application	• *Apartment building Magnusstrasse - Zürich* • *Gasthof Adler Langenegg*
	4	Possible supplier	• *Isover* • *Knauf*
Technical Specifications	5	Composition (from inside to outside)	• *Finish/flooring;* • *Mineral wool + timber construction;* • *Finish*
	6	System thickness	*40-250 mm + finish/flooring*
	7	Av. thermal conductivity	*0.053-0.059 W/mK*
	8	Thermal conductivity of ins. layer	*0.030-0.033 W/mK*
	9	Fire protection class	• *A1* • *A2-s1,d0*
	10	Application	*Basement ceiling*
Sustainability and Lifecycle	11	Based on natural materials	*no*
	12	Embodied energy	*> 25, < 50 MJ/kg*
	13	Average lifetime	• *55+ years (rock wool)* • *20-30 years (glass wool)*
	14	Recyclability	*yes*
	15	Prefabricated solution	*no*
	16	Reversible system	*yes*
	17	Installation	*Use the light push-in method (cutting insulation ~+2 cm wider than the spacing between rafters) for wool thickness ≥100 mm, no stringing required.*
	18	Cost	*Medium (€€)*

Table 98. Solution BFI-12: Mineral wool on the floor.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Mineral wool on the floor*
	2	Category	*Mineral wool based*
	3	Example of application	*none*
	4	Possible supplier	• *Isover* • *Knauf*
Technical Specifications	5	Composition (from inside to outside)	• *Finish/Flooring;* • *Mineral wool;* • *Existing construction*
	6	System thickness	*13-80 mm + finish/flooring*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.032-0.040 W/mK*
	9	Fire protection class	• *A1* • *A2-s1,d0*
	10	Application	• *Floor on ground* • *Floor above basement*
Sustainability and Lifecycle	11	Based on natural materials	*no*
	12	Embodied energy	*> 25, < 50 MJ/kg*
	13	Average lifetime	• *55+ years (rock wool)* • *20-30 years (glass wool)*
	14	Recyclability	*yes*
	15	Prefabricated solution	*no*
	16	Reversible system	*yes*
	17	Installation	*Requires a flat surface; can be cut into shapes and laid on the floor.*
	18	Cost	*Low (€)*

Table 99. Solution BFI-13: Mineral wool under the ceiling.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Mineral wool under the ceiling*
	2	Category	*Mineral wool based*
	3	Example of application	• *Bygningskultur og Klima* • *Single family House - Bern, Switzerland*
	4	Possible supplier	• *Knauf* • *Sto*
Technical Specifications	5	Composition (from inside to outside)	• *Existing construction;* • *Bonding;* • *Mineral wool;* • *Fastening and coating*
	6	System thickness	*adaptable, min. 50 mm*
	7	Av. thermal conductivity	*0.033 W/mK*
	8	Thermal conductivity of ins. layer	*0.033-0.038 W/mK*
	9	Fire protection class	*A1*
	10	Application	*Basement ceiling*
Sustainability and Lifecycle	11	Based on natural materials	*no*
	12	Embodied energy	*> 25, < 50 MJ/kg*
	13	Average lifetime	• *55+ years (rock wool)* • *20-30 years (glass wool)*
	14	Recyclability	*yes*
	15	Prefabricated solution	*no*
	16	Reversible system	*yes*
	17	Installation	*Surface must be flat, clean, and dry; glued with optional screws. Wide range of insulation thicknesses available.*
	18	Cost	*Medium (€€)*

Table 100. Solution BFI-14: Polystyrene/EPS/XPS on the floor.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Polystyrene/EPS/XPS on the floor*
	2	Category	*Oil-based polymers*
	3	Example of application	• *Ancien presbytère en Mairie* • *Ansitz Kofler* • *Community Hall Zwischenwasser* • *Farm house Huber* • *Musikschule Velden* • *Timber-framed barn in the north of France* • *Villa Castelli*
	4	Possible supplier	• *JACKON Insulation* • *JUB* • *Ravago* • *Steinbacher* • *Styrodur*
Technical Specifications	5	Composition (from inside to outside)	• *Finish/flooring;* • *Polystyrene insulation;* • *Existing construction*
	6	System thickness	*10-400 mm + flooring*
	7	Av. thermal conductivity	*0.039-0.11 W/mK*
	8	Thermal conductivity of ins. layer	*0.031-0.048 W/mK*
	9	Fire protection class	*E*
	10	Application	• *Floor on ground* • *Floor above basement*
Sustainability and Lifecycle	11	Based on natural materials	*no*
	12	Embodied energy	*> 50 MJ/kg*
	13	Average lifetime	*30-50 years*
	14	Recyclability	*yes*
	15	Prefabricated solution	*no*
	16	Reversible system	*depends on installation*
	17	Installation	*Thermal insulation boards are installed by gluing, mechanical fastening, or laid freely, depending on the purpose of use.*
	18	Cost	*Low (€)*

Table 101. Solution BFI-15: Polystyrene/EPS/XPS under the ceiling.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Polystyrene/EPS/XPS under the ceiling*
	2	Category	*Oil-based polymers*
	3	Example of application	• *Early work Sep Ruf* • *Oeconomy building Josef Weiss*
	4	Possible supplier	• *Austrotherm* • *Ravago* • *URSA*
Technical Specifications	5	Composition (from inside to outside)	• *Existing construction;* • *Polystyrene insulation;* • *Coating*
	6	System thickness	*30-400 mm + coating*
	7	Av. thermal conductivity	*0.035-0.088 W/mK*
	8	Thermal conductivity of ins. layer	*0.027-0.038 W/mK*
	9	Fire protection class	*E*
	10	Application	*Basement ceiling*
Sustainability and Lifecycle	11	Based on natural materials	*no*
	12	Embodied energy	*> 50 MJ/kg*
	13	Average lifetime	*30-50 years*
	14	Recyclability	*yes*
	15	Prefabricated solution	*no*
	16	Reversible system	*depends on installation*
	17	Installation	*Glued*
	18	Cost	*Low (€)*

Table 102. Solution BFI-16: Polyurethane/PUR/PIR on the floor.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Polyurethane/PUR/PIR on the floor*
	2	Category	*Oil-based polymers*
	3	Example of application	• *Elementary School in Mulhouse, France* • *Hof Neuhäusl* • *Notarjeva vila* • *Sankt Christoph* • *Town Hall Bergrheinfeld*
	4	Possible supplier	• *Isofloor* • *Kingspan* • *Linzmeier* • *Steinbacher*
Technical Specifications	5	Composition (from inside to outside)	• *Finish/flooring;* • *Polyurethan insulation;* • *Existing construction*
	6	System thickness	*20-220 mm + flooring*
	7	Av. thermal conductivity	*0.057-0.118 W/mK*
	8	Thermal conductivity of ins. layer	*0.022 W/mK*
	9	Fire protection class	*E*
	10	Application	• *Floor on ground* • *Floor above basement* • *Basement ceiling*
Sustainability and Lifecycle	11	Based on natural materials	*no*
	12	Embodied energy	*> 50 MJ/kg*
	13	Average lifetime	*50 years*
	14	Recyclability	*usually no, but possible*
	15	Prefabricated solution	*no*
	16	Reversible system	*depends on installation*
	17	Installation	• *Boards: Laid on a flat, prepared surface and can be cut into the desired shape.* • *Sprayed: Applied on a dry, clean surface, suitable for any surface shape, including pipes of underfloor heating.*
	18	Cost	*Low (€)*

Table 103. Solution BFI-17: Wood insulation on the floor.

Type	Nr	Parameter	Parameter Assessment
General Information	1	Solution name	*Wood insulation on the floor*
	2	Category	*Biobased*
	3	Example of application	• *Annat Road* • *Hof 6, Schwarzenberg, Voralberg, Austria* • *Holyrood Park Lodge* • *Ritterhof*
	4	Possible supplier	• *BetonWood* • *Knauf* • *Pavatex* • *Steico*
Technical Specifications	5	Composition (from inside to outside)	• *Finish/flooring;* • *Wood fibre boards/loose wood fibre/wood shavings/loose hemp fibers +timber construction;* • *Existing construction*
	6	System thickness	• *boards: 8-240 mm* • *loose: adaptable*
	7	Av. thermal conductivity	*no data*
	8	Thermal conductivity of ins. layer	*0.038-0.050 W/mK*
	9	Fire protection class	*E*
	10	Application	• *Floor on ground* • *Floor above basement* • *Basement ceiling*
Sustainability and Lifecycle	11	Based on natural materials	*yes*
	12	Embodied energy	*< 25 MJ/kg*
	13	Average lifetime	*50-70 years*
	14	Recyclability	*yes*
	15	Prefabricated solution	*no*
	16	Reversible system	*yes*
	17	Installation	• *Insulation boards: Require a flat, clean, and dry surface; can be easily cut into any shape.* • *Loose insulation: Blown-in or inflated between the wooden structure; adaptable to any surface shape.*
	18	Cost	*Low (€)*

A1.5. Windows

Solutions

Table 104: Solution 1A0v - Repair

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*1A0v*
	2	Solution Name	*Repair window*
	3	Documentation type	*solution*
	4	Category (solution type)	*Repairing window*
	5	Applicable to/ applied to	*all types*
	6	Category (product type)	*n.a.*
	7	Source	*IEA SHC Task59*
	8	Examples	*HIBERATLAS – Downies Cottage*
	9	Possible supplier	*Restorer, craftsmen*
Technical specifications	10	Uw before [W/m²K]	*n.a.*
	11	Uw after [W/m²K]	*n.a.*
	19	Ψ-value (installation) [W/mK]	*no change*
	20	g-value	*n.a.*
	21	Weight (kg/m²)	*n.a.*
Sustainability and Lifecycle	22	Aesthetic impact	*no*
	23	Material impact	*no*
	24	Spatial impact	*no*
	25	Embodied energy impact	*very low*
	26	Average lifetime [years]	*n.a.*
	27	Recyclability	*n.a.*
	28	Reversibility	*yes*
	29	Cost	*€*

Table 105: Solutions 1B1 - Add sealing

Type	Nr	Parameter	Parameter Assessment		
General information	1	Code	*1B1a*	*1B3a*	*1B4a*
	2	Solution Name	*Add sealing to a single glazed window*	*Add sealing to a coupled window*	*Add sealing to the inner layer of a box type window*
	3	Documentation type	*solution*		
	4	Category (solution type)	*Inserting a sealing strip*		
	5	Applicable to/ applied to	*single window with single glazing*	*coupled window*	*box type window*
	6	Category (product type)	*seal*		
	7	Source	*IEA SHC Task59*		
	8	Examples	*Planfenster – Dante Schule (summary in en)*		
	9	Possible supplier	*Restorer, craftsmen*		
Technical specifications	10	Uw before [W/m²K]	*4,8*	*2,6*	*2,4*
	11	Uw after [W/m²K]	*4,8*	*2,6*	*2,4*
	15	U-value frame [W/(m2K)]			
	16	Frame factor	*0,7*	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]			
	19	Ψ-value (installation) [W/mK]	*no change*	*no change*	*no change*
	20	g-value	*10*	*20*	*20*
	21	Weight (kg/m²)	*5*	*10*	*10*
Sustainability and Lifecycle	22	Aesthetic impact	*no*		
	23	Material impact	*minor loss of original material*		
	24	Spatial impact	*no*		
	25	Embodied energy impact	*very low*		
	26	Average lifetime [years]			
	27	Recyclability			
	28	Reversibility	*no*		
	29	Cost	*€*	*€*	*€*

Table 106: Add soft coating

Type	Nr	Parameter	Parameter Assessment	
General information	1	Code	*1C1b*	*1C4b*
	2	Solution Name	*Add soft coating to window with single glazing*	*Add soft coating to box type window*
	3	Documentation type	*solution*	
	4	Category (solution type)	*Adding foils/coating to the glass*	
	5	Applicable to/ applied to	*single window with single glazing*	*box type window*
	6	Category (product type)	*softcoating*	
	7	Source	*IEA SHC Task59, ukgbc.org*	
	8	Examples	*HIBERATLAS – Freihof Sulz*	
	9	Possible supplier	*Professional window film installer Examples for providers: ecolosynergy.com*	
Technical specifications	10	Uw before [W/m²K]	*4,8*	*2,4*
	11	Uw after [W/m²K]	*3,41*	*2,00*
	12b	Additional R glazing [m²K/W]	*0,09*	*0,09*
	15	U-value frame [W/(m2K)]		
	16	Frame factor	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]		
	19	Ψ-value (installation) [W/mK]	*no change*	*no change*
	20	g-value	*10*	*20*
	21	Weight (kg/m²)		
Sustainability and Lifecycle	22	Aesthetic impact	*minor inside*	
	23	Material impact	*no*	
	24	Spatial impact	*no*	
	25	Embodied energy impact	*very low*	
	26	Average lifetime [years]		
	27	Recyclability		
	28	Reversibility	*no*	
	29	Cost	*€*	*€*

Table 107: Replace inner layer of a coupled window with vacuum glazing

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*2A3h*
	2	Solution Name	*Replace the single glazing of the inner layer in a coupled window with vacuum glazing*
	3	Documentation type	*solution*
	4	Category (solution type)	*Replacing inner glazing*
	5	Applicable to/ applied to	*coupled window*
	6	Category (product type)	*vacuum glazing*
	7	Source	*IEA SHC Task59, product info & calculation based on EN 10077-1*
	8	Examples	
	9	Possible supplier	*Experienced craftsmen*
Technical specifications	10	Uw before [W/m²K]	*2,6*
	11	Uw after [W/m²K]	*1,11*
	12b	Additional R glazing [m²K/W]	*1,11*
	15	U-value frame [W/(m2K)]	
	16	Frame factor	*0,7*
	17	Frame materials	*wood*
	18	Ψ-value (glass edge) [W/mK]	
	19	Ψ-value (installation) [W/mK]	*no change*
	20	g-value	*30*
	21	Weight (kg/m²)	
Sustainability and Lifecycle	22	Aesthetic impact	*minor inside*
	23	Material impact	*partial loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*medium*
	26	Average lifetime [years]	
	27	Recyclability	
	28	Reversibility	*no*
	29	Kosten	*€€*

Table 108: Replace inner layer of a box type window

Type	Nr	Parameter	Parameter Assessment			
General information	1	Code	*2A4d*	*2A4e*	*2A4g*	*2A4h*
	2	Solution Name	*Replace the single glazing of the inner layer in a box type window with double glazing*	*Replace the single glazing of the inner layer in a box type window with thin double glazing*	*Replace the single glazing of the inner layer in a box type window with thin triple glazing*	*Replace the single glazing of the inner layer in a box type window with vacuum glazing*
	3	Documentation type	*solution*			
	4	Category (solution type)	*Replacing inner glazing*			
	5	Applicable to/ applied to	*box type window*			
	6	Category (product type)	*double glazing*	*thin double glazing*	*thin triple glazing*	*vacuum glazing*
	7	Source	*IEA SHC Task59 & calculation based on EN 10077-1*			
	8	Examples	*Planfenster – Knablhof (summary en) (2A4d)* *Planfenster - Eisenbahnerhaus (2A4d)* *HIBERATLAS - Trikåfakriken (2A4e)*			
	9	Possible supplier	*Experienced craftsmen*			
Technical specifications	10	Uw before [W/m²K]	*2,4*	*2,4*	*2,4*	*2,4*
	11	Uw after [W/m²K]	*1,15*	*1,23*	*0,99*	*1,07*
	12b	Additional R glazing [m²K/W]	*0,91*	*0,77*	*1,43*	*1,11*
	16	Frame factor	*0,7*	*0,7*	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]				
	19	Ψ-value (installation) [W/mK]	*minimal change*	*minimal change*	*minimal change*	*minimal change*
	20	g-value	*10+20*	*10+10*	*10+15*	*10+20*
	21	Weight (kg/m²)				
Sustainability and Lifecycle	22	Aesthetic impact	*minor inside*			
	23	Material impact	*partial loss of original material*			
	24	Spatial impact	*no*			
	25	Embodied energy impact	*medium*	*low*	*medium*	*medium*
	26	Average lifetime [years]				
	27	Recyclability				
	28	Reversibility	*no*			
	29	Cost	*€€*	*€€*	*€€*	*€€*

Table 109: Add a glazing layer to a single window with single glazing

Type	Nr	Parameter	Parameter Assessment		
General information	1	code	*2C1i*	*2C1d*	*2C1j*
	2	Solution Name	*Add a low-e glazing with minimised frame (kind duplo duplex or Krampp) to a single window with single glazing*	*Add a double insulating glazing to upgrade the existing single to a coupled window*	*Add a vacuum glazing with minimised frame (kind Krampp) to a single window with single glazing*
	3	Documentation type	*solution*		
	4	Category (solution type)	*Adding an additional glass layer on the inside*		
	5	Applicable to/ applied to	*single window with single glazing*		
	6	Category (product type)	*minimised window with single low-e glazing*	*double glazing*	*minimised window with single vacuum glazing*
	7	Source	*IEA SHC Task59, product information & calculation based on EN 10077-1*		
	8	Examples	*HIBERATLAS – Ryesgade* (2C1d)		
	9	Possible supplier	*Experienced craftsmen, Kramp&Kramp, Duplo-Doppelfenster*	*Experienced craftsmen*	*Experienced craftsmen, Kramp&Kramp, Duplo-Doppelfenster*
Technical specifications	10	Uw before [W/m²K]	*4,8*	*4,8*	*4,8*
	11	Uw after [W/m²K]	*2,47*	*1,27*	*1,25*
	12b	Additional R glazing [m²K/W]	*0,26*	*0,91*	*1,25*
	16	Frame factor	*0,7*	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]			
	19	Ψ-value (installat.) [W/mK]	*no change*	*no change*	*no change*
	20	g-value			
	21	Weight (kg/m²)	*20*	*30*	*20*
Sustainability and Lifecycle	22	Aesthetic impact	*minor inside*	*inside*	*minor inside*
	23	Material impact	*no*		
	24	Spatial impact	*no*		
	25	Embodied energy impact	*very low*	*medium*	*medium*
	26	Average lifetime [years]			
	27	Recyclability			
	28	Reversibility	*yes*		
	29	Kosten	*€*	*€€*	*€€*

Table 110: Adding minimised windows with single glazing to different window types

Type	Nr	Parameter	Parameter Assessment			
General information	1	Code	2C2i	2C3i	2C4i	2C5i
	2	Solution Name	Add a low-e glazing with minimised frame (kind duplo duplex or Krampp) to a single window with double glazing	Add a low-e glazing with minimised frame (kind duplo duplex or Krampp) to the inner layer of a coupled window	Add a low-e glazing with minimised frame (kind duplo duplex or Krampp) to the inner layer of a box-type window	Add a low-e glazing with minimised frame (kind duplo duplex or Krampp) to the inner layer of a winter window
	3	Documentation type	solution			
	4	Category (solution type)	single window with double glazing	coupled window	box type window	winter window
	5	Applicable to/ applied to	Adding an additional glass layer on the inside			
	6	Category (product type)	minimised window with single low-e glazing			
	7	Source	IEA SHC Task59, product information & calculation based on EN 10077-1			
	8	Examples				
	9	Possible supplier	Experienced craftsmen, Kramp&Kramp, Duplo-Doppelfenster			
Technical specifications	10	Uw before [W/m²K]	2,8	2,6	2,4	2,4
	11	Uw after [W/m²K]	1,97	1,89	1,81	1,81
	12b	Additional R glazing [m²K/W]	0,26	0,26	0,26	0,26
	15	U-value frame [W/m²K				
	16	Frame factor	0,7	0,7	0,7	0,7
	17	Frame materials	wood	wood	wood	wood
	18	Ψ-value (glass edge) [W/mK]				
	19	Ψ-value (install.[W/mK]	no change		minimal change	
	20	g-value	30	30	30	30
	21	Weight [kg/m²]	30	30	30	30
Sustainability and Lifecycle	22	Aesthetic impact	minor inside			
	23	Material impact	no			
	24	Spatial impact	no			
	25	Embodied energy impact	very low			
	26	Average lifetime [years]				
	27	Recyclability				
	28	Reversibility	yes			
	29	Cost	€	€	€	€

Table 111: Upgrade to box-type window with an additional window inside

Type	Nr	Parameter	Parameter Assessment			
General information	1	code	*2D1m*	*2D1n*	*2D2m*	*2D3m*
	2	Solution Name	*Upgrade a single window with single glazing to box-type window with an additional wooden window with double insulating glazing on the inside*	*Upgrade a single window with single glazing to box-type window with an additional wooden window with triple glazing on the inside*	*Upgrade a single window with double glazing to box-type window with an additional wooden window with double insulating glazing on the inside*	*Upgrade a coupled window to box-type window with an additional wooden window with double insulating glazing on the inside*
	3	Documentation type	*solution*			
	4	Category (solution type)	*Adding a new window on the inside*			
	5	Applicable to/ applied to	*single window with single glazing*		*single window with double glazing*	*coupled window*
	6	Category (product type)	*wooden window with double glazing*	*wooden window with triple glazing*	*wooden window with double glazing*	*wooden window with double glazing*
	7	Source	*IEA SHC Task59 & calculation based on EN 10077-1*			
	8	Examples	*HIBERATLAS - Giatla (2D1m)* *HIBERATLAS - Varvstaden (2D1m)*			
	9	Possible supplier	*Experienced craftsmen, window fitter*			
Technical specifications	10	Uw before [W/m²K]	*4,8*	*4,8*	*2,8*	*2,6*
	11	Uw after [W/m²K]	*1,07*	*0,84*	*0,92*	*0,90*
	12a	Addional R window layer [m²K/W]	*0,73*	*0,98*	*0,73*	*0,73*
	15	U-value frame [W/(m2K)]				
	16	Frame factor	*0,7*	*0,7*	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*	*wood*	*wood*
	18	Ψ-value (glass edg.) [W/mK]				
	19	Ψ-value (installat.) [W/mK]	*decreases considerably*			
	20	g-value				
	21	Weight (kg/m²)	*10+20*	*10+30*	*20+20*	*20+20*
Sustainability and Lifecycle	22	Aesthetic impact	*inside*			
	23	Material impact	*no*			
	24	Spatial impact	*yes*			
	25	Embodied energy impact	*rather high*	*high*	*rather high*	*rather high*
	26	Average lifetime [years]				
	27	Recyclability				
	28	Reversibility	*yes*			
	29	Kosten	*€€*	*€€*	*€€*	*€€*

Table 112: Replace the inner sashes of a box type window with a new window

Type	Nr	Parameter	Parameter Assessment	
General information	1	code	*2E4m*	*2E4n*
	2	Solution Name	*Replace the inner sashes of a box-type window with a new wooden double insulating glazing window*	*Replace the inner sashes of a box-type window with a new wooden triple glazing window*
	3	Documentation type	*solution*	
	4	Category (solution type)	*Replacing the window sashes on the inside*	
	5	Applicable to/ applied to	*box type window*	
	6	Category (product type)	*wooden window with double glazing*	*wooden window with triple glazing*
	7	Source	*IEA SHC Task59 & calculation based on EN 10077-1*	
	8	Examples	*HIBERATLAS - Kaiserstraße (2E4m)*	
	9	Possible supplier	*Experienced craftsmen, window fitter*	
Technical specifications	10	Uw before [W/m²K]	*2,4*	*2,4*
	11	Uw after [W/m²K]	*0,87*	*0,72*
	12a	Addional R window layer [m²K/W]	*0,73*	*0,98*
	15	U-value frame [W/(m2K)]		
	16	Frame factor	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]		
	19	Ψ-value (installation) [W/mK]	*minimal change*	
	20	g-value		
	21	Weight (kg/m²)	*10+20*	*10+30*
Sustainability and Lifecycle	22	Aesthetic impact	*minor inside*	
	23	Material impact	*partial loss of original material*	
	24	Spatial impact	*no*	
	25	Embodied energy impact	*rather high*	*high*
	26	Average lifetime [years]		
	27	Recyclability		
	28	Reversibility	*no*	
	29	Kosten	*€€*	*€€*

Table 113: Replace the glazing of a single window with a new glazing

Type	Nr	Parameter	Parameter Assessment				
General information	1	code	*3A1c*	*3A1d*	*3A1e*	*3A1g*	*3A1h*
	2	Solution Name	*Replace the single glazing with low-e glazing*	*Replace the single glazing with double insulating glazing*	*Replace the single glazing with thin double insulating glazing*	*Replace the single glazing with thin triple glazing*	*Replace the single glazing with thin vacuum glazing*
	3	Documentation type	*solution*				
	4	Category (solution type)	*Replacing (outer) glazing*				
	5	Applicable to/ applied to	*single window with single glazing*				
	6	Category (product type)	*low-e single glazing*	*double glazing*	*thin double glazing*	*thin triple glazing*	*vacuum glazing*
	7	Source	*IEA SHC Task59, product information & calculation based on EN 10077-1*				
	8	Examples	*HIBERATLAS – Holyrood Park Lodge (3A1e)* *HIBERATLAS – single family house Bern (3A1e)*				
	9	Possible supplier	*Experienced craftsmen*				
Technical specifications	10	Uw before [W/m²K]	*4,8*	*4,8*	*4,8*	*4,8*	*4,8*
	11	Uw after [W/m²K]	*3,40*	*1,52*	*1,66*	*1,24*	*1,38*
	12b	Additional R glazing [m²K/W]	*0,09*	*0,74*	*0,60*	*1,26*	*0,94*
	16	Frame factor	*0,7*	*0,7*	*0,7*	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*	*wood*	*wood*	*wood*
	18	Ψ-value (glass ed.) [W/mK]					
	19	Ψ-value (installat. [W/mK]	*no change*				
	20	g-value	*10*	*20*	*10*	*15*	*20*
	21	Weight (kg/m²)					
Sustainability and Lifecycle	22	Aesthetic impact	*minor from both sides*				
	23	Material impact	*partial loss of original material*				
	24	Spatial impact	*no*				
	25	Embodied energy impact	*very low*	*medium*	*low*	*medium*	*medium*
	26	Average lifetime [years]					
	27	Recyclability					
	28	Reversibility	*no*				
	29	Kosten	*€€*	*€€*	*€€*	*€€*	*€€*

Table 114: Replace the two glasses of a coupled window with a double/triple insulating glazing

Type	Nr	Parameter	Parameter Assessment	
General information	1	Code	*3A3f*	*3A3d*
	2	Solution Name	*Replace the two glasses of a coupled window with triple glazing*	*Replace the two glasses of a coupled window with insulating double glazing*
	3	Documentation type	*solution*	
	4	Category (solution type)	*Replacing (outer) glazing*	
	5	Applicable to/ applied to	*coupled window*	
	6	Category (product type)	*triple glazing*	*double glazing*
	7	Source	*IEA SHC Task59 & calculation based on EN 10077-1*	
	8	Examples		
	9	Possible supplier	*Experienced craftsmen*	
Technical specifications	10	Uw before [W/m²K]	*2,6*	*2,6*
	11	Uw after [W/m²K]	*0,97*	*0,97*
	12b	Additional R glazing [m²K/W]	*1,67*	*1,67*
	15	U-value frame [W/(m2K)]		
	16	Frame factor	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]		
	19	Ψ-value (installation) [W/mK]	*no change*	
	20	g-value		
	21	Weight (kg/m²)	*30*	*20*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the outside*	
	23	Material impact	*partial loss of original material*	
	24	Spatial impact	*no*	
	25	Embodied energy impact	*medium*	*medium*
	26	Average lifetime [years]		
	27	Recyclability		
	28	Reversibility	*no*	
	29	Cost	*€€*	*€€*

Table 115: Replace the glazing of the outer layer of box type window

Type	Nr	Parameter	Parameter Assessment				
General information	1	code	*3A1c*	*3A1d*	*3A1e*	*3A1g*	*3A1h*
	2	Solution Name	*Replace the single glazing with low-e glazing*	*Replace the single glazing with double insulating glazing*	*Replace the single glazing with thin double insulating glazing*	*Replace the single glazing with thin triple glazing*	*Replace the single glazing with thin vacuum glazing*
	3	Documentation type	*solution*				
	4	Category (solution type)	*Replacing (outer) glazing*				
	5	Applicable to/ applied to	*single window with single glazing*				
	6	Category (product type)	*low-e single glazing*	*double glazing*	*thin double glazing*	*thin triple glazing*	*vacuum glazing*
	7	Source	*IEA SHC Task59, product information & calculation based on EN 10077-1*				
	8	Examples	*HIBERATLAS – Holyrood Park Lodge (3A1e)* *HIBERATLAS – single family house Bern (3A1e)*				
	9	Possible supplier	*Experienced craftsmen*				
Technical specifications	10	Uw before [W/m²K]	*4,8*	*4,8*	*4,8*	*4,8*	*4,8*
	11	Uw after [W/m²K]	*3,40*	*1,52*	*1,66*	*1,24*	*1,38*
	12b	Additional R glazing [m²K/W]	*0,09*	*0,74*	*0,60*	*1,26*	*0,94*
	16	Frame factor	*0,7*	*0,7*	*0,7*	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*	*wood*	*wood*	*wood*
	18	Ψ-value (glass ed.) [W/mK]					
	19	Ψ-value (installat. [W/mK]	*no change*				
	20	g-value	*10*	*20*	*10*	*15*	*20*
	21	Weight (kg/m²)					
Sustainability and Lifecycle	22	Aesthetic impact	*minor from both sides*				
	23	Material impact	*partial loss of original material*				
	24	Spatial impact	*no*				
	25	Embodied energy impact	*very low*	*medium*	*low*	*medium*	*medium*
	26	Average lifetime [years]					
	27	Recyclability					
	28	Reversibility	*no*				
	29	Kosten	*€€*	*€€*	*€€*	*€€*	*€€*

Table 116: Replace the glazing of the outer layer of winter type window

Type	Nr	Parameter	Parameter Assessment				
General information	1	code	*3A5c*	*3A5d*	*3A5e*	*3A5g*	*3A5h*
	2	Solution Name	*Replace the single glazing of the outer layer of a winter window with low-e glazing*	*Replace the single glazing of the outer layer of a winter window with double insulating glazing*	*Replace the single glazing of the outer layer of a winter window with thin double insulating glazing*	*Replace the single glazing of the outer layer of a winter window with thin triple glazing*	*Replace the single glazing of the outer layer of a winter window with thin vacuum glazing*
	3	Documentation type	*solution*				
	4	Category (solution type)	*Replacing (outer) glazing*				
	5	Applicable to/ applied to	*winter window*				
	6	Category (product type)	*low-e single glazing*	*double glazing*	*thin double glazing*	*thin triple glazing*	*vacuum glazing*
	7	Source	*IEA SHC Task59, product information & calculation based on EN 10077-1*				
	8	Examples					
	9	Possible supplier	*Experienced craftsmen*				
Technical specifications	10	Uw before [W/m²K]	*2,4*	*2,4*	*2,4*	*2,4*	*2,4*
	11	Uw after [W/m²K]	*1,99*	*1,15*	*1,23*	*0,99*	*1,07*
	12b	Additional R glazing [m²K/W]	*0,26*	*0,91*	*0,77*	*1,43*	*1,11*
	15	U-value frame [W/(m2K)]					
	16	Frame factor	*0,7*	*0,7*	*0,7*	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*	*wood*	*wood*	*wood*
	18	Ψ-value (glass edg.) [W/mK]					
	19	Ψ-value (install.) [W/mK]	*minimal change*				
	20	g-value					
	21	Weight (kg/m²)	*10+10*	*20+10*	*10+10*	*15+10*	*20+10*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the outside*				
	23	Material impact	*partial loss of original material*				
	24	Spatial impact	*no*				
	25	Embodied energy impact	*very low*	*medium*	*low*	*medium*	*medium*
	26	Average lifetime [years]					
	27	Recyclability					
	28	Reversibility	*no*				
	29	Kosten	*€€*	*€€*	*€€*	*€€*	*€€*

Table 117: Add a window on the outside to a window with single glazing

Type	Nr	Parameter	Parameter Assessment			
General information	1	code	*3B1k*	*3B1l*	*3B1m*	*3B1n*
	2	Solution Name	*Add a window with single glazing on the outside*	*Add a window with low-e glazing on the outside*	*Add a window with double insulating glazing on the outside*	*Add a window with triple insulating glazing on the outside*
	3	Documentation type	*solution*			
	4	Category (solution type)	*Adding a new window on the outside*			
	5	Applicable to/ applied to	*single window with single glazing*			
	6	Category (product type)	*wooden window with single glazing*	*wooden window with single low-e glazing*	*wooden window with double glazing*	*wooden window with triple glazing*
	7	Source	*IEA SHC Task59, product information & calculation based on EN 10077-1*			
	8	Examples				
	9	Possible supplier	*Window fitter, exp. craftmen*	*Experienced craftsmen*	*Window fitter, experienced craftmen*	
Technical specifications	10	Uw before [W/m²K]	*4,8*	*4,8*	*4,8*	*4,8*
	11	Uw after [W/m²K]	*2,36*	*1,94*	*1,07*	*0,84*
	12a	Add. R window layer [m²K/W]	*0,21*	*0,31*	*0,73*	*0,98*
	12 b	Additional R glazing [m²K/W]				
	13	U-value glazing [W/(m2K)]				
	14	Composition of glazing (from inside to outside)				
	15	U-value frame [W/(m2K)]				
	16	Frame factor	*0,7*	*0,7*	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]				
	19	Ψ-value (installation) [W/mK]	*decreases considerably*			
	20	g-value				
	21	Weight (kg/m²)	*10+10*	*10+10*	*20+10*	*30+10*
Sustainability and Lifecycle	22	Aesthetic impact	*from the outside*			
	23	Material impact	*no*			
	24	Spatial impact	*yes*			
	25	Embodied energy impact	*medium*	*medium*	*rather high*	*high*
	26	Average lifetime [years]				
	27	Recyclability				
	28	Reversibility	*yes*			
	29	Kosten	*€€*	*€€*	*€€*	*€€*

Table 118: Replace the outer sashes of a box-type or winter window

Type	Nr	Parameter	Parameter Assessment			
General information	1	code	*3C4m*	*3C4n*	*3C5m*	*3C5n*
	2	Solution Name	*Replace the outer sashes of a box-type window with a new wooden double insulating glazing window*	*Replace the outer sashes of a box-type window with a new wooden triple glazing window*	*Replace the outer sashes of a winter window with a new wooden double insulating glazing window*	*Replace the outer sashes of a winter window with a new wooden triple glazing window*
	3	Documentation type	*solution*			
	4	Category (solution type)	*Replacing the window sashes on the outside*			
	5	Applicable to/ applied to	*box type window*		*winter window*	
	6	Category (product type)	*wooden*		*wooden*	
			window with double glazing	*wooden window with triple glazing*	*window with double glazing*	*wooden window with triple glazing*
	7	Source	*IEA SHC Task59 & calculation based on EN 10077-1*			
	8	Examples				
	9	Possible supplier	*Experienced craftsmen, window fitter*			
Technical specifications	10	Uw before [W/m²K]	*2,4*	*2,4*	*2,4*	*2,4*
	11	Uw after [W/m²K]	*1,07*	*0,84*	*1,07*	*0,84*
	12a	Addional R window layer [m²K/W]	*0,52*	*0,77*	*0,52*	*0,77*
	15	U-value frame [W/(m2K)]				
	16	Frame factor	*0,7*	*0,7*	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]				
	19	Ψ-value (installation) [W/mK]	*minimal change*			
	20	g-value				
	21	Weight (kg/m²)	*20+10*	*30+10*	*20+10*	*30+10*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the outside*			
	23	Material impact	*partial loss of original material*			
	24	Spatial impact	*no*			
	25	Embodied energy impact	*rather high*	*high*	*rather high*	*high*
	26	Average lifetime [years]				
	27	Recyclability				
	28	Reversibility	*no*			
	29	Kosten	*€€*	*€€*	*€€*	*€€*

Table 119: Substitute a single window with single glazing with a replica

Type	Nr	Parameter	Parameter Assessment				
General information	1	Code	*4A1m*	*4A1n*	*4A1o*	*4A1p*	*4A1q*
	2	Solution Name	*Substitute the existing single window with a replica wooden window with double glazing*	*Substitute the existing single window with a replica wooden window with triple glazing*	*Substitute the existing single window with a replica wooden window with thin double glazing*	*Substitute the existing single window with a replica wooden window with thin triple glazing*	*Substitute the existing single window with a replica wooden window with vacuum glazing*
	3	Documentation type	*solution*				
	4	Category (solution type)	*Substitute the window with a replica*				
	5	Applicable to/ applied to	*single window with single glazing*				
	6	Category (product type)	*wooden window with double glazing*	*wooden window with triple glazing*	*wooden window with thin double glazing*	*wooden window with thin triple glazing*	*wooden window with vacuum glazing*
	7	Source	*IEA SHC Task59 & EN 10077-1*	*IEA SHC Task59 & EN 10077-1*	*IEA SHC Task59, product info, EN 10077-1*	*IEA SHC Task59, 3encult & EN 10077-1*	*IEA SHC Task59, product info, EN 10077-1*
	8	Examples	*Planfenster - Villa Castelli (4A1n)* *HIBERATLAS – Timber-framed house in Alsace (4A1o)*				
	9	Possible supplier	*Experienced craftsmen*				
Technical specifications	10	Uw before [W/m²K]	*4,8*	*4,8*	*4,8*	*4,8*	*4,8*
	11	Uw after [W/m²K]	*1,37*	*1,02*	*1,51*	*1,09*	*1,23*
	12a	Add. R window layer [m²K/W]	*0,73*	*0,98*	*0,66*	*0,92*	*0,81*
	15	U-value frame [W/(m2K)]					
	16	Frame factor	*0,7*	*0,7*	*0,7*	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*	*wood*	*wood*	*wood*
	18	Ψ-value (glass edg.) [W/mK]					
	19	Ψ-value (install.) [W/mK]	*no change*				
	20	g-value					
	21	Weight (kg/m²)	*20*	*30*	*10*	*15*	*20*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from both sides*				
	23	Material impact	*complete loss of original material*				
	24	Spatial impact	*no*				
	25	Embodied energy impact	*rather high*	*high*	*medium*	*rather high*	*rather high*
	26	Average lifetime [years]					
	27	Recyclability					
	28	Reversibility	*no*				
	29	Cost	*€€€*	*€€€*	*€€€*	*€€€*	*€€€*

Table 120: Substitute a coupled or box-type window with a replica

Type	Nr	Parameter	Parameter Assessment			
General information	1	code	*4A3r*	*4A3t*	*4A4s*	*4A4u*
	2	Solution Name	*Substitute the existing coupled window with a replica wooden coupled window with double insulating glazing*	*Substitute the existing coupled window with a replica wooden coupled window with thin triple glazing*	*Substitute the existing box type window with a replica wooden box-type window with double insulating glazing*	*Substitute the existing box type window with a replica wooden box-type window with thin triple glazing*
	3	Documentation type	*solution*			
	4	Category (solution type)	*Substitute the window with a replica*			
	5	Applicable to/ applied to	*coupled window*		*box type window*	
	6	Category (product type)	*wooden coupled window with double insulating glazing*	*wooden coupled window with thin triple glazing*	*wooden box-type window with double insulating glazing*	*wooden box-type window with thin triple glazing*
	7	Source	*IEA SHC Task59 & EN 10077-1*	*IEA SHC Task59, product info & EN 10077-1*	*IEA SHC Task59 & EN 10077-1*	*IEA SHC Task59, product info & EN 10077-1*
	8	Examples				
	9	Possible supplier	*Experienced craftsmen*			
Technical specifications	10	Uw before [W/m²K]	*2,6*	*2,6*	*2,4*	*2,4*
	11	Uw after [W/m²K]	*1,05*	*0,70*	*1,05*	*0,70*
	12a	Add. R window layer [m²K/W]	*0,95*	*1,43*	*0,95*	*1,43*
	15	U-value frame [W/(m2K)]				
	16	Frame factor	*0,7*	*0,7*	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]				
	19	Ψ-value (installation) [W/mK]	*no change*			
	20	g-value				
	21	Weight (kg/m²)	*30*	*25*	*10+20*	*10+15*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from both sides*			
	23	Material impact	*complete loss of original material*			
	24	Spatial impact	*no*			
	25	Embodied energy impact	*high*	*high*	*very high*	*very high*
	26	Average lifetime [years]				
	27	Recyclability				
	28	Reversibility	*no*			
	29	Kosten	*€€€*	*€€€*	*€€€€*	*€€€€*

Table 121: Substitute a single window with single glazing with a new window

Type	Nr	Parameter	Parameter Assessment	
General information	1	code	*4B1m*	*4B1n*
	2	Solution Name	*Substitute the existing single window with single glazing with a new window with double insulating glazing*	*Substitute the existing single window with single glazing with a new window with triple glazing*
	3	Documentation type	*solution*	
	4	Category (solution type)	*Substitute the window*	
	5	Applicable to/ applied to	*single window with single glazing*	
	6	Category (product type)	*wooden window with double glazing*	*wooden window with triple glazing*
	7	Source	*IEA SHC Task59 & calculation based on EN 10077-1*	
	8	Examples	*HIBERATLAS - Ritterhof (aB1m+n)* *HIBERATLAS - Kindergarten Chur (4B1n)*	
	9	Possible supplier	*Window fitter, craftsmen*	
Technical specifications	10	Uw before [W/m²K]	*4,8*	*4,8*
	11	Uw after [W/m²K]	*1,37*	*1,02*
	12a	Add. R window layer [m²K/W]	*0,73*	*0,98*
	15	U-value frame [W/(m2K)]		
	16	Frame factor	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]		
	19	Ψ-value (installation) [W/mK]	*small change*	
	20	g-value		
	21	Weight (kg/m²)	*20*	*30*
Sustainability and Lifecycle	22	Aesthetic impact	*from both sides*	
	23	Material impact	*complete loss of original material*	
	24	Spatial impact	*no*	
	25	Embodied energy impact	*rather high*	*high*
	26	Average lifetime [years]		
	27	Recyclability		
	28	Reversibility	*no*	
	29	Kosten	*€€*	*€€*

Table 122: Substitute a single window with double glazing with a new window

Type	Nr	Parameter	Parameter Assessment	
General information	1	Code	*4B2m*	*4B2n*
	2	Solution Name	*Substitute the existing single window with double glazing with a new window with double insulating glazing*	*Substitute the existing single window with double glazing with a new window with triple glazing*
	3	Documentation type	*solution*	
	4	Category (solution type)	*Substitute the window*	
	5	Applicable to/ applied to	*single window with double glazing*	
	6	Category (product type)	*wooden window with double glazing*	*wooden window with triple glazing*
	7	Source	*IEA SHC Task59 & calculation based on EN 10077-1*	
	8	Examples	*HIBERATLAS - Villa Capodivacca*	
	9	Possible supplier	*Window fitter, craftsmen*	
Technical specifications	10	Uw before [W/m²K]	*2,8*	*2,8*
	11	Uw after [W/m²K]	*1,37*	*1,02*
	12a	Add. R window layer [m²K/W]	*0,73*	*0,98*
	15	U-value frame [W/(m2K)]		
	16	Frame factor	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]		
	19	Ψ-value (installation) [W/mK]	*small change*	
	20	g-value		
	21	Weight (kg/m²)	*20*	*30*
Sustainability and Lifecycle	22	Aesthetic impact	*from both sides*	
	23	Material impact	*complete loss of original material*	
	24	Spatial impact	*no*	
	25	Embodied energy impact	*rather high*	*high*
	26	Average lifetime [years]		
	27	Recyclability		
	28	Reversibility	*no*	
	29	Cost	*€€*	*€€*

Table 123: Substitute a coupled window with a new window

Type	Nr	Parameter	Parameter Assessment	
General information	1	code	*4B3m*	*4B3n*
	2	Solution Name	*Substitute the existing coupled window with a new window with double insulating glazing*	*Substitute the existing coupled window with a new window with triple glazing*
	3	Documentation type	*solution*	
	4	Category (solution type)	*Substitute the window*	
	5	Applicable to/ applied to	*coupled window*	
	6	Category (product type)	*wooden window with double glazing*	*wooden window with triple glazing*
	7	Source	*IEA SHC Task59 & calculation based on EN 10077-1*	
	8	Examples		
	9	Possible supplier	*Window fitter, craftsmen*	
Technical specifications	10	Uw before [W/m²K]	*2,6*	*2,6*
	11	Uw after [W/m²K]	*1,37*	*1,02*
	12a	Add. R window layer [m²K/W]	*0,73*	*0,98*
	15	U-value frame [W/(m2K)]		
	16	Frame factor	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]		
	19	Ψ-value (installation) [W/mK]	*small change*	
	20	g-value		
	21	Weight (kg/m²)	*20*	*30*
Sustainability and Lifecycle	22	Aesthetic impact	*from both sides*	
	23	Material impact	*complete loss of original material*	
	24	Spatial impact	*no*	
	25	Embodied energy impact	*rather high*	*high*
	26	Average lifetime [years]		
	27	Recyclability		
	28	Reversibility	*no*	
	29	Kosten	*€€*	*€€*

Table 124: Substitute a box-type or winter window with a new window

Type	Nr	Parameter	Parameter Assessment	
General information	1	code	*4B3m*	*4B3n*
	2	Solution Name	*Substitute the existing coupled window with a new window with double insulating glazing*	*Substitute the existing coupled window with a new window with triple glazing*
	3	Documentation type	*solution*	
	4	Category (solution type)	*Substitute the window*	
	5	Applicable to/ applied to	*coupled window*	
	6	Category (product type)	*wooden window with double glazing*	*wooden window with triple glazing*
	7	Source	*IEA SHC Task59 & calculation based on EN 10077-1*	
	8	Examples		
	9	Possible supplier	*Window fitter, craftsmen*	
Technical specifications	10	Uw before [W/m²K]	*2,6*	*2,6*
	11	Uw after [W/m²K]	*1,37*	*1,02*
	12a	Add. R window layer [m²K/W]	*0,73*	*0,98*
	15	U-value frame [W/(m2K)]		
	16	Frame factor	*0,7*	*0,7*
	17	Frame materials	*wood*	*wood*
	18	Ψ-value (glass edge) [W/mK]		
	19	Ψ-value (installation) [W/mK]	*small change*	
	20	g-value		
	21	Weight (kg/m²)	*20*	*30*
Sustainability and Lifecycle	22	Aesthetic impact	*from both sides*	
	23	Material impact	*complete loss of original material*	
	24	Spatial impact	*no*	
	25	Embodied energy impact	*rather high*	*high*
	26	Average lifetime [years]		
	27	Recyclability		
	28	Reversibility	*no*	
	29	Kosten	*€€*	*€€*

Table 125: REVETRO® HM-SIG

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*UG1c*
	2	Solution Name	*REVETRO HM-SIG*
	3	Documentation type	*solution*
	4	Category (solution type)	*Upgrade of existing glazing (inside or outside?)*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*low-e single glazing*
	7	Source	*www.holzmanufaktur-rottweil.de*
	8	Examples	*no data*
	9	Possible supplier	*Holzmanufaktur Rottweil*
Technical specifications	10	Uw before [W/m²K]	*4,8*
	11	Uw after [W/m²K]	*1,9*
	12b	Additional R glazing [m²K/W]	*0,32*
	13	U-value glazing [W/(m2K)]	*1,9*
	14	Composition of glazing (from inside to outside)	*3e-3-3*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*15*
Sustainability and Lifecycle	22	Aesthetic impact	*seal*
	23	Material impact	*minor loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*very low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no*
	29	Kosten	*no data*

Table 126: REVETRO® HM-VIG

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*UG1h*
	2	Solution Name	*REVETRO HM-VIG*
	3	Documentation type	*solution*
	4	Category (solution type)	*Upgrade of existing glazing (inside or outside?)*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*vacuum glazing*
	7	Source	*www.holzmanufaktur-rottweil.de*
	8	Examples	*no data*
	9	Possible supplier	*Holzmanufaktur Rottweil*
Technical specifications	10	Uw before [W/m²K]	*4,8*
	11	Uw after [W/m²K]	*0,6*
	12b	Additional R glazing [m²K/W]	*1,46*
	13	U-value glazing [W/(m2K)]	*0,6*
	14	Composition of glazing (from inside to outside)	*10,2e-10-3*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*33*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the inside*
	23	Material impact	*minor loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*medium*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no*
	29	Kosten	*no data*

Table 127: REVETRO® HM--3fachSIG

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*UG1e*
	2	Solution Name	*REVETRO HM-3fachSIG*
	3	Documentation type	*solution*
	4	Category (solution type)	*Upgrade of existing glazing (inside or outside?)*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*thin double glazing*
	7	Source	*www.holzmanufaktur-rottweil.de*
	8	Examples	*no data*
	9	Possible supplier	*Holzmanufaktur Rottweil*
Technical specifications	10	Uw before [W/m²K]	*4,8*
	11	Uw after [W/m²K]	*0,5*
	12b	Additional R glazing [m²K/W]	*1,79*
	13	U-value glazing [W/(m2K)]	*0,5*
	14	Composition of glazing (from inside to outside)	*3e-10-4e-10-3*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	21	Weight (kg/m²)	*25*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the inside*
	23	Material impact	*minor loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*medium*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no*
	29	Kosten	*no data*

Table 128: REVETRO® THERMUR® HM

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*UG1c_&foil*
	2	Solution Name	*REVETRO THERMUR HM*
	3	Documentation type	*solution*
	4	Category (solution type)	*Upgrade of existing glazing (inside or outside?)*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*low-e single glazing*
	7	Source	*www.holzmanufaktur-rottweil.de*
	8	Examples	*no data*
	9	Possible supplier	*Holzmanufaktur Rottweil*
Technical specifications	10	Uw before [W/m²K]	*4,8*
	11	Uw after [W/m²K]	*0,6*
	12b	Additional R glazing [m²K/W]	*1,46*
	13	U-value glazing [W/(m2K)]	*0,6*
	14	Composition of glazing (from inside to outside)	*3e-9-0.1-9-3*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*15*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the inside*
	23	Material impact	*minor loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*medium*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no*
	29	Kosten	*no data*

Table 129: RETHERMO® HM 3fach-SIG

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*UG2c*
	2	Solution Name	*RETHERMO HM 3fach-SIG*
	3	Documentation type	*solution*
	4	Category (solution type)	*Upgrade of existing glazing (inside or outside?)*
	5	Applicable to/ applied to	*single window with double glazing*
	6	Category (product type)	*low-e single glazing*
	7	Source	*www.holzmanufaktur-rottweil.de*
	8	Examples	*no data*
	9	Possible supplier	*Holzmanufaktur Rottweil*
Technical specifications	10	Uw before [W/m²K]	*2,8*
	11	Uw after [W/m²K]	*0,8*
	12b	Additional R glazing [m²K/W]	*0,89*
	13	U-value glazing [W/(m2K)]	*0,8*
	14	Composition of glazing (from inside to outside)	*3e-10-[4-12-4]*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*27,5*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the inside*
	23	Material impact	*minor loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*very low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no*
	29	Kosten	*no data*

Table 130: RETHERMO® HM 3fach-VIG

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*UG2h*
	2	Solution Name	*RETHERMO HM 3fach-VIG*
	3	Documentation type	*solution*
	4	Category (solution type)	*Upgrade of existing glazing (inside or outside?)*
	5	Applicable to/ applied to	*single window with double glazing*
	6	Category (product type)	*vacuum glazing*
	7	Source	*www.holzmanufaktur-rottweil.de*
	8	Examples	*no data*
	9	Possible supplier	*Holzmanufaktur Rottweil*
Technical specifications	10	Uw before [W/m²K]	*2,8*
	11	Uw after [W/m²K]	*0,6*
	12b	Additional R glazing [m²K/W]	*1,31*
	13	U-value glazing [W/(m2K)]	*0,8*
	14	Composition of glazing (from inside to outside)	*6,2-10-[4-12-4]*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*35,5*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the inside*
	23	Material impact	*minor loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no*
	29	Kosten	*no data*

Table 131: RETHERMO® HM 3fach-SIG (middle)

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*UG2c_middle*
	2	Solution Name	*REVETRO HM-3fach-SIG*
	3	Documentation type	*solution*
	4	Category (solution type)	*Upgrade of existing glazing (inside or outside?)*
	5	Applicable to/ applied to	*single window with double glazing*
	6	Category (product type)	*low-e single glazing*
	7	Source	*www.holzmanufaktur-rottweil.de*
	8	Examples	*no data*
	9	Possible supplier	*Holzmanufaktur Rottweil*
Technical specifications	10	Uw before [W/m²K]	*2,8*
	11	Uw after [W/m²K]	*0,8*
	12b	Additional R glazing [m²K/W]	*0,89*
	13	U-value glazing [W/(m2K)]	*0,8*
	14	Composition of glazing (from inside to outside)	*4-10-3e-10-4*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*27,5*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the inside*
	23	Material impact	*minor loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*medium*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no*
	29	Kosten	*no data*

Table 132: RETHERMO® HM 3fach-VIG (foil)

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*UG2v_&foil*
	2	Solution Name	*RETHERMO HM 3fach-SIG*
	3	Documentation type	*solution*
	4	Category (solution type)	*Upgrade of existing glazing (inside or outside?)*
	5	Applicable to/ applied to	*single window with double glazing*
	6	Category (product type)	*n.a.*
	7	Source	*www.holzmanufaktur-rottweil.de*
	8	Examples	*no data*
	9	Possible supplier	*Holzmanufaktur Rottweil*
Technical specifications	10	Uw before [W/m²K]	*2,8*
	11	Uw after [W/m²K]	*0,9*
	12b	Additional R glazing [m²K/W]	*0,75*
	13	U-value glazing [W/(m2K)]	*0,9*
	14	Composition of glazing (from inside to outside)	*4-10-0,1-10-4*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*20*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the inside*
	23	Material impact	*minor loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*very low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no*
	29	Kosten	*no data*

Examples

Table 133 Example Downie's Cottage

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*1A1v_E01*
	2	Solution Name	*Example Downie's Cottage*
	3	Documentation type	*example*
	4	Category (solution type)	*Repairing window*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*n.a.*
	7	Source	*no data*
	8	Examples	*no data*
Technical specifications	10	Uw before [W/m²K]	*no data*
	11	Uw after [W/m²K]	*no data*
	13	U-value glazing [W/(m²K)]	*no data*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*no data*
	16	Frame factor	*0,48*
	17	Frame materials	*wood*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*no*
	23	Material impact	*no*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 134 Example Dante School

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*Example Dante School*
	2	Solution Name	*example*
	3	Documentation type	*Inserting a sealing strip*
	4	Category (solution type)	*coupled window*
	5	Applicable to/ applied to	*seal*
	6	Category (product type)	*no data*
	7	Source	*no data*
	8	Examples	*2,55*
Technical specifications	10	Uw before [W/m²K]	*2,55*
	11	Uw after [W/m²K]	*2,79*
	13	U-value glazing [W/(m²K)]	*3 - 21 - 2* *3 - 21 - 4*
	14	Composition of glazing (from inside to outside)	*1,9*
	15	U-value frame [W/(m²K)]	*0,65*
	16	Frame factor	*wood*
	17	Frame materials	*0,024*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*no*
Sustainability and Lifecycle	22	Aesthetic impact	*no*
	23	Material impact	*no*
	24	Spatial impact	*Example Dante School*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 135 Example Freihof Sulz

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*1C4b_E01*
	2	Solution Name	*Example Freiholz Sulz*
	3	Documentation type	*example*
	4	Category (solution type)	*Adding foils/coating to the glass*
	5	Applicable to/ applied to	*box type window*
	6	Category (product type)	*softcoating*
	7	Source	*HIBERATLAS – Freihof Sulz*
	8	Examples	*https://hiberatlas.eurac.edu/en/freihof-sulz--2-172.html#section3&gid=null&pid=image1*
Technical specifications	10	Uw before [W/m²K]	*2-2,2*
	11	Uw after [W/m²K]	*1,8-2*
	13	U-value glazing [W/(m²K)]	*no data*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*0,5*
	16	Frame factor	*wood*
	17	Frame materials	*no data*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*no*
	23	Material impact	*no*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 136 Example Knablhof

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*2A4d_E01*
	2	Solution Name	*Example Knablhof*
	3	Documentation type	*example*
	4	Category (solution type)	*Replacing inner glazing*
	5	Applicable to/ applied to	*box type window*
	6	Category (product type)	*double glazing*
	7	Source	*Planfenster – Knablhof*
	8	Examples	*https://webassets.eurac.edu/31538/1623081427-03replanfensterknabelhof03.pdf*
Technical specifications	10	Uw before [W/m²K]	*2,36*
	11	Uw after [W/m²K]	*1,26*
	13	U-value glazing [W/(m²K)]	*5,75/5,75 | 1,1/5,75*
	14	Composition of glazing (from inside to outside)	*2-152-2 | 2-136-4-10-4*
	15	U-value frame [W/(m²K)]	*2,66/2,66 | 1,721/2,66*
	16	Frame factor	*68,00%*
	17	Frame materials	*wood*
	18	Ψ-value (glass edge) [W/mK]	*0,008 | 0,044*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*0,71 | 0,5*
	21	Weight (kg/m²)	
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the inside*
	23	Material impact	*partial loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 137 Example Eisenbahnerhaus

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*2A4d_E02*
	2	Solution Name	*Example Eisenbahnerhaus*
	3	Documentation type	*example*
	4	Category (solution type)	*Replacing inner glazing*
	5	Applicable to/ applied to	*box type window*
	6	Category (product type)	*double glazing*
	7	Source	*Planfenster - Eisenbahnerhaus*
	8	Examples	*https://webassets.eurac.edu/31538/1623081404-10replanfensterapartment-troi03.pdf*
Technical specifications	10	Uw before [W/m²K]	*2,39*
	11	Uw after [W/m²K]	*1,05*
	13	U-value glazing [W/(m²K)]	*5,78/5,78 | 1,1/5,68*
	14	Composition of glazing (from inside to outside)	*3-133-4 | 3-121-4-14-4*
	15	U-value frame [W/(m²K)]	*1,66/1,76 | 1,35/1,82*
	16	Frame factor	*78,06%*
	17	Frame materials	*wood*
	18	Ψ-value (glass edge) [W/mK]	*0 | 0,031*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*0,71 | 0,5*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the inside*
	23	Material impact	*partial loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 138 Example Trikåfakriken

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*2A4d_E01*
	2	Solution Name	*Example Trikåfakriken*
	3	Documentation type	*example*
	4	Category (solution type)	*Replacing inner glazing*
	5	Applicable to/ applied to	*box type window*
	6	Category (product type)	*double glazing*
	7	Source	*HIBERATLAS - Trikåfakriken*
	8	Examples	*https://hiberatlas.eurac.edu/en/trikfabriken--2-299.html#section3*
Technical specifications	10	Uw before [W/m²K]	*2,5*
	11	Uw after [W/m²K]	*2*
	13	U-value glazing [W/(m²K)]	*no data*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*no data*
	16	Frame factor	*no data*
	17	Frame materials	*Wood*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from the inside*
	23	Material impact	*partial loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 139 Example Ryesgade

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*2C1d_E01*
	2	Solution Name	*Example Ryesgade*
	3	Documentation type	*example*
	4	Category (solution type)	*Adding an additional glass layer on the inside*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*double glazing*
	7	Source	*HIBERATLAS – Ryesgade*
	8	Examples	*https://hiberatlas.eurac.edu/en/ryesgade-30-a-c--2-143.html#section3*
Technical specifications	10	Uw before [W/m²K]	*4,2*
	11	Uw after [W/m²K]	*0,89*
	13	U-value glazing [W/(m²K)]	*0,8*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*1,6*
	16	Frame factor	*no data*
	17	Frame materials	*wood*
	18	Ψ-value (glass edge) [W/mK]	*krypton*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*0,86*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*from the inside*
	23	Material impact	*no*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 140 Example Giatla

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*2D1m_E01*
	2	Solution Name	*Example - Giatla*
	3	Documentation type	*example*
	4	Category (solution type)	*Adding a new window on the inside*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*wooden window with double glazing*
	7	Source	*HIBERATLAS - Giatla*
	8	Examples	*https://hiberatlas.eurac.edu/en/giatla-house--2-212.html*
Technical specifications	10	Uw before [W/m²K]	*3,628*
	11	Uw after [W/m²K]	*1,5*
	13	U-value glazing [W/(m²K)]	*1,1*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*2,2*
	16	Frame factor	*0,61811024*
	17	Frame materials	*no data*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*0,4*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*from the inside*
	23	Material impact	*no*
	24	Spatial impact	*yes*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 141 Example Varvstaden

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*2D1m_E02*
	2	Solution Name	*Example Varvstaden*
	3	Documentation type	*example*
	4	Category (solution type)	*Adding a new window on the inside*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*wooden window with double glazing*
	7	Source	*Hiberatlas - Varvstaden*
	8	Examples	*https://hiberatlas.eurac.edu/en/magasinet-i-varvsstaden-malmoe--2-302.html#section3*
Technical specifications	10	Uw before [W/m²K]	*no data*
	11	Uw after [W/m²K]	*1,3*
	13	U-value glazing [W/(m²K)]	*no data*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*no data*
	16	Frame factor	*no data*
	17	Frame materials	*no data*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*0,58*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*from the inside*
	23	Material impact	*no*
	24	Spatial impact	*yes*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 142 Example Kaiserstraße

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*2E4m_E01*
	2	Solution Name	*Example Kaiserstraße*
	3	Documentation type	*example*
	4	Category (solution type)	*Replacing the window sashes on the inside*
	5	Applicable to/ applied to	*box type window*
	6	Category (product type)	*wooden window with double glazing*
	7	Source	*HIBERATLAS Kaiserstraße*
	8	Examples	*https://hiberatlas.eurac.edu/en/klostergebaeude-kaiserstrasse--2-35.html*
Technical specifications	10	Uw before [W/m²K]	*2,4*
	11	Uw after [W/m²K]	*0,9*
	13	U-value glazing [W/(m²K)]	*5/5 | 5 /1,2*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*no data*
	16	Frame factor	*0,74 / 0,64*
	17	Frame materials	*Wood*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*0,6*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*from the inside*
	23	Material impact	*partial loss of original material*
	24	Spatial impact	*yes*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 143 Example Single family house Bern

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*3A1e_E01*
	2	Solution Name	*Example Single family house Bern*
	3	Documentation type	*example*
	4	Category (solution type)	*Replacing (outer) glazing*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*thin double glazing*
	7	Source	*HIBERATLAS – single family house Bern*
	8	Examples	*https://hiberatlas.eurac.edu/en/single-family-house-bern-switzerland--2-174.html*
Technical specifications	10	Uw before [W/m²K]	*3*
	11	Uw after [W/m²K]	*0,928*
	13	U-value glazing [W/(m²K)]	*0,7*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*1,3*
	16	Frame factor	*0,62*
	17	Frame materials	*wood*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*0,45*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from both sides*
	23	Material impact	*partial loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 144 Example Holyrood Park Lodge

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*3A1e_E02*
	2	Solution Name	*Example Holyrood Park Lodge*
	3	Documentation type	*example*
	4	Category (solution type)	*Replacing (outer) glazing*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*thin double glazing*
	7	Source	*HIBERATLAS – Holyrood Park Lodge*
	8	Examples	*https://hiberatlas.eurac.edu/en/holyrood-park-lodge--2-120.html#section3*
Technical specifications	10	Uw before [W/m²K]	*4,48*
	11	Uw after [W/m²K]	*1,26*
	13	U-value glazing [W/(m²K)]	*1,2*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*1,4*
	16	Frame factor	*0,7*
	17	Frame materials	*wood*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from both sides*
	23	Material impact	*partial loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 145 Example Villa Castelli

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*4A1n_E01*
	2	Solution Name	*Example Villa Castelli*
	3	Documentation type	*example*
	4	Category (solution type)	*Substitute the window with a replica*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*wooden window with triple glazing*
	7	Source	*Planfenster - Villa Castelli*
	8	Examples	*https://webassets.eurac.edu/31538/1623081382-06replanfenstervilla-castelli03.pdf*
Technical specifications	10	Uw before [W/m²K]	*4,8*
	11	Uw after [W/m²K]	*0,95*
	13	U-value glazing [W/(m²K)]	*0,7*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*1,12*
	16	Frame factor	*0,40*
	17	Frame materials	*wood + aluminium*
	18	Ψ-value (glass edge) [W/mK]	*0,03*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*0,62*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*minor from both sides*
	23	Material impact	*complete loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 146 Example Timber-framed house in Alsace

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*4A1o_E01*
	2	Solution Name	*Example Timber-framed house in Alsace*
	3	Documentation type	*example*
	4	Category (solution type)	*Substitute the window with a replica*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*wooden window with thin double glazing*
	7	Source	*HIBERATLAS – Timber-framed house in Alsace*
	8	Examples	*https://hiberatlas.eurac.edu/en/timber-framed-house-in-alsace-france--2-45.html*
Technical specifications	10	Uw before [W/m²K]	*4*
	11	Uw after [W/m²K]	*2,4*
	13	U-value glazing [W/(m²K)]	*no dat*
	14	Composition of glazing (from inside to outside)	*no dat*
	15	U-value frame [W/(m²K)]	*no dat*
	16	Frame factor	*0,66*
	17	Frame materials	*Wood*
	18	Ψ-value (glass edge) [W/mK]	*no dat*
	19	Ψ-value (installation) [W/mK]	*no dat*
	20	g-value	*0,5*
	21	Weight (kg/m²)	
Sustainability and Lifecycle	22	Aesthetic impact	*minor from both sides*
	23	Material impact	*complete loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 147 Example Ritterhof (double gölazing)

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*4B1m_E01*
	2	Solution Name	*Example Ritterhof (double glazing)*
	3	Documentation type	*example*
	4	Category (solution type)	*Substitute the window*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*wooden window with double glazing*
	7	Source	*HIBERATLAS - Ritterhof*
	8	Examples	*https://hiberatlas.eurac.edu/en/ritterhof--2-262.html*
Technical specifications	10	Uw before [W/m²K]	*4,62*
	11	Uw after [W/m²K]	*1,56*
	13	U-value glazing [W/(m²K)]	*1,1*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*2,1*
	16	Frame factor	*0,54*
	17	Frame materials	*no data*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*from both sides*
	23	Material impact	*complete loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 148 Example Ritterhof (triple glazing)

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*4B1n_E01*
	2	Solution Name	*Example Ritterhof (triple glazing)*
	3	Documentation type	*example*
	4	Category (solution type)	*Substitute the window*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*wooden window with triple glazing*
	7	Source	*HIBERATLAS - Ritterhof*
	8	Examples	*https://hiberatlas.eurac.edu/en/ritterhof--2-262.html*
Technical specifications	10	Uw before [W/m²K]	*4,62*
	11	Uw after [W/m²K]	*1,29*
	13	U-value glazing [W/(m²K)]	*0,6*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*2,1*
	16	Frame factor	*0,54*
	17	Frame materials	*wood*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*from both sides*
	23	Material impact	*complete loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 149 Example Kindergarten Chur

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*4B1n_E02*
	2	Solution Name	*Example Kindergarten Chur*
	3	Documentation type	*example*
	4	Category (solution type)	*Substitute the window*
	5	Applicable to/ applied to	*single window with single glazing*
	6	Category (product type)	*wooden window with triple glazing*
	7	Source	*HIBERATLAS - Kindergarten Chur*
	8	Examples	*https://hiberatlas.eurac.edu/en/kindergarten-and-apartments-chur-switzerland--2-148.html#section3*
Technical specifications	10	Uw before [W/m²K]	*3*
	11	Uw after [W/m²K]	*1*
	13	U-value glazing [W/(m²K)]	*0,71*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*no data*
	16	Frame factor	*no data*
	17	Frame materials	*wood and aluminium*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*0,66*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*from both sides*
	23	Material impact	*complete loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 150 Example Villa Capodivacca

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*4B2n_E01*
	2	Solution Name	*Example Villa Capodivacca*
	3	Documentation type	*example*
	4	Category (solution type)	*Substitute the window*
	5	Applicable to/ applied to	*single window with double glazing*
	6	Category (product type)	*wooden window with triple glazing*
	7	Source	*HIBERATLAS - Villa Capodivacca*
	8	Examples	*https://hiberatlas.eurac.edu/en/villa-capodivacca--2-246.html#section3*
Technical specifications	10	Uw before [W/m²K]	*2,615*
	11	Uw after [W/m²K]	*1,31*
	13	U-value glazing [W/(m²K)]	*1,1*
	14	Composition of glazing (from inside to outside)	*3e-6a-3*
	15	U-value frame [W/(m²K)]	*1,7*
	16	Frame factor	*0,65*
	17	Frame materials	*wood*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*0,51*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*from both sides*
	23	Material impact	*complete loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 151 Example Notarjeva vila

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*4B4m_E01*
	2	Solution Name	*Example Notarjeva vila*
	3	Documentation type	*example*
	4	Category (solution type)	*Substitute the window*
	5	Applicable to/ applied to	*box type window*
	6	Category (product type)	*wooden window with double glazing*
	7	Source	*HIBERATLAS Notarjeva vila*
	8	Examples	*https://hiberatlas.eurac.edu/en/notarjeva-vila--2-43.html#section3*
Technical specifications	10	Uw before [W/m²K]	*2,3*
	11	Uw after [W/m²K]	*1,44*
	13	U-value glazing [W/(m²K)]	*1,1*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*1,5*
	16	Frame factor	*no data*
	17	Frame materials	*no data*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*from both sides*
	23	Material impact	*complete loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 152 Example Town Hall Burgkunstadt

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*4B2n_E02*
	2	Solution Name	*Example Town Hall Burgkunstadt*
	3	Documentation type	*example*
	4	Category (solution type)	*Substitute the window*
	5	Applicable to/ applied to	*single window with double glazing*
	6	Category (product type)	*wooden window with triple glazing*
	7	Source	*HIBERATLAS - Burgkunstadt*
	8	Examples	*https://hiberatlas.eurac.edu/en/town-hall-burgkunstadt--2-271.html#section3&gid=null&pid=image4*
Technical specifications	10	Uw before [W/m²K]	*3*
	11	Uw after [W/m²K]	*1,3*
	13	U-value glazing [W/(m²K)]	*no data*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*no data*
	16	Frame factor	*no data*
	17	Frame materials	*wood*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*from both sides*
	23	Material impact	*complete loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 153 Example Ansitz Kofler

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*4B4n_E01*
	2	Solution Name	*Example Ansitz Kofler*
	3	Documentation type	*example*
	4	Category (solution type)	*Substitute the window*
	5	Applicable to/ applied to	*box type window*
	6	Category (product type)	*wooden window with triple glazing*
	7	Source	*HIBERATLAS Ansitz Kofler*
	8	Examples	*https://hiberatlas.eurac.edu/en/ansitz-kofler--2-25.html#section3*
Technical specifications	10	Uw before [W/m²K]	*2,78*
	11	Uw after [W/m²K]	*0,8975*
	13	U-value glazing [W/(m²K)]	*0,6*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*1,45*
	16	Frame factor	*0,65*
	17	Frame materials	*Wood*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*from both sides*
	23	Material impact	*complete loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Table 154 Example Haus Moroder

Type	Nr	Parameter	Parameter Assessment
General information	1	Code	*4B4n_E02*
	2	Solution Name	*Example Haus Moroder*
	3	Documentation type	*example*
	4	Category (solution type)	*Substitute the window*
	5	Applicable to/ applied to	*box type window*
	6	Category (product type)	*wooden window with triple glazing*
	7	Source	*HIBERATLAS – Haus Moroder*
	8	Examples	*https://hiberatlas.eurac.edu/en/house-moroder--2-255.html#section3*
Technical specifications	10	Uw before [W/m²K]	*2,5*
	11	Uw after [W/m²K]	*0,876*
	13	U-value glazing [W/(m²K)]	*0,7*
	14	Composition of glazing (from inside to outside)	*no data*
	15	U-value frame [W/(m²K)]	*1,1*
	16	Frame factor	*0,56*
	17	Frame materials	*wood*
	18	Ψ-value (glass edge) [W/mK]	*no data*
	19	Ψ-value (installation) [W/mK]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*no data*
Sustainability and Lifecycle	22	Aesthetic impact	*from both sides*
	23	Material impact	*complete loss of original material*
	24	Spatial impact	*no*
	25	Embodied energy impact	*no data*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	28	Reversibility	*no data*
	29	Cost	*no data*

Products

Table 155 Histoglass D10, gas filled

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNe_S01*
	2	Solution Name	*Histoglass D10, gas filled*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*thin double glazing*
	7	Source	*https://histoglass.co.uk/thin-double-glazing/hd10-thin-double-glazing/*
	8	Examples	
	9	Possible supplier	*https://histoglass.co.uk/thin-double-glazing/* *https://www.histoglas.de*
	13	U-value glazing [W/(m2K)]	*1,9*
	14	Composition of glazing (from inside to outside)	*3e-4-3*
	18	Ψ-value (glass edge) [W/mK]	*aluminium space bar*
		Thickness [mm]	*10*
	20	g-value	*no data*
	21	Weight (kg/m²)	*15*
	25	Embodied energy impact	*low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 156 Histoglass D10, krypton filled, hand drawn glass

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNe_S02*
	2	Solution Name	*Histoglass D10, krypton filled, hand drawn glass*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*thin double glazing*
	7	Source	*https://histoglass.co.uk/period-glass/genuine-hand-drawn-glass/*
	8	Examples	
	9	Possible supplier	*https://histoglass.co.uk/thin-double-glazing/ https://www.histoglas.de*
	13	U-value glazing [W/(m2K)]	*1,9*
	14	Composition of glazing (from inside to outside)	*3e-4k-4*
	18	Ψ-value (glass edge) [W/mK]	*aluminium space bar*
		Thickness [mm]	*11*
	20	g-value	*no data*
	21	Weight (kg/m²)	*17,5*
	25	Embodied energy impact	*low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 157 Histoglass D11, gas filled

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNe_S03*
	2	Solution Name	*Histoglass D11, gas filled*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*thin double glazing*
	7	Source	*https://histoglass.co.uk/thin-double-glazing/hd11-thin-double-glazing/*
	8	Examples	
	9	Possible supplier	*https://histoglass.co.uk/thin-double-glazing/ https://www.histoglas.de*
	13	U-value glazing [W/(m2K)]	*1,9*
	14	Composition of glazing (from inside to outside)	*4e-4k-3 or 3e-4k-4*
	18	Ψ-value (glass edge) [W/mK]	*aluminium space bar*
		Thickness [mm]	*11*
	20	g-value	*no data*
	21	Weight (kg/m²)	*17,5*
	25	Embodied energy impact	*low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 158 Histoglass D12, gas filled

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNe_S04*
	2	Solution Name	*Histoglass D12, gas filled*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*thin double glazing*
	7	Source	*https://histoglass.co.uk/thin-double-glazing/hd12-thin-double-glazing/*
	8	Examples	
	9	Possible supplier	*https://histoglass.co.uk/thin-double-glazing/ https://www.histoglas.de*
	13	U-value glazing [W/(m2K)]	*1,5*
	14	Composition of glazing (from inside to outside)	*3e-6k-3*
	18	Ψ-value (glass edge) [W/mK]	*aluminium space bar*
		Thickness [mm]	*12*
	20	g-value	*no data*
	21	Weight (kg/m²)	*15*
	25	Embodied energy impact	*low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 159 Histoglass D13, gas filled

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNe_S05*
	2	Solution Name	*Histoglass D13, gas filled*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*thin double glazing*
	7	Source	*https://histoglass.co.uk/thin-double-glazing/hd13-thin-double-glazing/*
	8	Examples	
	9	Possible supplier	*https://histoglass.co.uk/thin-double-glazing/ https://www.histoglas.de*
	13	U-value glazing [W/(m2K)]	*1,5*
	14	Composition of glazing (from inside to outside)	*3e-6k-4*
	18	Ψ-value (glass edge) [W/mK]	*aluminium space bar*
		Thickness [mm]	*13*
	20	g-value	*no data*
	21	Weight (kg/m²)	*17,5*
	25	Embodied energy impact	*low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 160 Histoglass D13/1.3

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNe_S06*
	2	Solution Name	*Histoglass D13/1.3*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*thin double glazing*
	7	Source	*https://histoglass.co.uk/thin-double-glazing/hd13-thin-double-glazing/*
	8	Examples	
	9	Possible supplier	*https://histoglass.co.uk/thin-double-glazing/ https://www.histoglas.de*
	13	U-value glazing [W/(m2K)]	*1,3*
	14	Composition of glazing (from inside to outside)	*3e-7k-3*
	18	Ψ-value (glass edge) [W/mK]	*aluminium space bar*
		Thickness [mm]	*13*
	20	g-value	*no data*
	21	Weight (kg/m²)	*15*
	25	Embodied energy impact	*low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 161 Histoglass MONO RT

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNc_S01*
	2	Solution Name	*Histoglass MONO RT*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*low-e single glazing*
	7	Source	*https://histoglass.co.uk/mono-single-glazing/mono-rt/*
	8	Examples	
	9	Possible supplier	*https://histoglass.co.uk/thin-double-glazing/ https://www.histoglas.de*
	13	U-value glazing [W/(m2K)]	*3,6*
	14	Composition of glazing (from inside to outside)	*e4*
	18	Ψ-value (glass edge) [W/mK]	*no data*
		Thickness [mm]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*10*
	25	Embodied energy impact	*very low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 162 Histoglass MONO laminate

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNc_S02*
	2	Solution Name	*Histoglass MONO laminate*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*low-e single glazing*
	7	Source	*https://histoglass.co.uk/mono-single-glazing/mono-rt/*
	8	Examples	*no data*
	9	Possible supplier	*https://histoglass.co.uk/thin-double-glazing/* *https://www.histoglas.de*
	13	U-value glazing [W/(m2K)]	*3,6*
	14	Composition of glazing (from inside to outside)	*7 to 9*
	18	Ψ-value (glass edge) [W/mK]	*no data*
		Thickness [mm]	*no data*
	20	g-value	*no data*
	21	Weight (kg/m²)	*17.5-20*
	25	Embodied energy impact	*very low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 163 HistoFein 8

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNe_S07*
	2	Solution Name	*HistoFein 8*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*thin double glazing*
	7	Source	*www.histoglas.de*
	8	Examples	*no data*
	9	Possible supplier	*https://histoglass.co.uk/thin-double-glazing/* *https://www.histoglas.de*
	13	U-value glazing [W/(m2K)]	*1,9*
	14	Composition of glazing (from inside to outside)	*2e-4-2?*
	18	Ψ-value (glass edge) [W/mK]	*no data*
		Thickness [mm]	*8*
	20	g-value	*no data*
	21	Weight (kg/m²)	*10*
	25	Embodied energy impact	*low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 164 HistoFein 10

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNe_S08*
	2	Solution Name	*HistoFein 10*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*thin double glazing*
	7	Source	*www.histoglas.de*
	8	Examples	*no data*
	9	Possible supplier	*https://www.histoglas.de*
	13	U-value glazing [W/(m2K)]	*1,5*
	14	Composition of glazing (from inside to outside)	*2e-6-2?*
	18	Ψ-value (glass edge) [W/mK]	*no data*
		Thickness [mm]	*10*
	20	g-value	*no data*
	21	Weight (kg/m²)	*10*
	25	Embodied energy impact	*low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 165 HistoFein 11

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNe_S09*
	2	Solution Name	*HistoFein 11*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*thin double glazing*
	7	Source	*www.histoglas.de*
	8	Examples	*no data*
	9	Possible supplier	*https://www.histoglas.de*
	13	U-value glazing [W/(m2K)]	*1,3*
	14	Composition of glazing (from inside to outside)	*2e-7-2?*
	18	Ψ-value (glass edge) [W/mK]	*no data*
		Thickness [mm]	*11*
	20	g-value	*no data*
	21	Weight (kg/m²)	*10*
	25	Embodied energy impact	*low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 166 Fineo Heritage

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNh_S01*
	2	Solution Name	*Fineo Heritage*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*vacuum glazing*
	7	Source	*www.fineoglass.eu*
	8	Examples	*no data*
	9	Possible supplier	*https://www.fineoglass.eu/de/produkt/historisches-fensterglas/*
	13	U-value glazing [W/(m2K)]	*0,7*
	14	Composition of glazing (from inside to outside)	*11,3*
	18	Ψ-value (glass edge) [W/mK]	*no data*
		Thickness [mm]	*no data*
	20	g-value	*0,58*
	21	Weight (kg/m²)	*27,5*
	25	Embodied energy impact	*medium*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 167 Fineo 8/10/12

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNh_S02*
	2	Solution Name	*Fineo 8/10/12*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*vacuum glazing*
	7	Source	*www.fineoglass.eu*
	8	Examples	
	9	Possible supplier	*https://www.fineoglass.eu/de/produkt/historisches-fensterglas/*
	13	U-value glazing [W/(m2K)]	*0,7*
	14	Composition of glazing (from inside to outside)	*4-0,1-4/6-0,1-4/6-0,1-6*
	18	Ψ-value (glass edge) [W/mK]	*no data*
		Thickness [mm]	*no data*
	20	g-value	*0,6*
	21	Weight (kg/m²)	*no data*
	25	Embodied energy impact	*medium*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 168 Pilkington K Glass N

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNc_S03*
	2	Solution Name	*Pilkington K Glass N*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*low-e single glazing*
	7	Source	*www.pilkington.com*
	8	Examples	*no data*
	9	Possible supplier	*https://www.pilkington.com/de-de/de/produkte/produktkategorien/waermedaemmung/pilkington-k-glass-n#bersicht*
	13	U-value glazing [W/(m2K)]	*3,6*
	14	Composition of glazing (from inside to outside)	*4e*
	18	Ψ-value (glass edge) [W/mK]	*no data*
		Thickness [mm]	*no data*
	20	g-value	*0,75*
	21	Weight (kg/m²)	*10*
	25	Embodied energy impact	*very low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 169 Duplo Duplex

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNi_S01*
	2	Solution Name	*Duplo Duplex*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*minimised window with single low-e glazing*
	7	Source	*www.duplo-fenster.com*
	8	Examples	*no data*
	9	Possible supplier	*https://www.duplo-fenster.com/*
	13	U-value glazing [W/(m2K)]	*3,6*
	14	Composition of glazing (from inside to outside)	*4e*
	18	Ψ-value (glass edge) [W/mK]	*no data*
		Thickness [mm]	*4*
	20	g-value	*no data*
	21	Weight (kg/m²)	*10*
	25	Embodied energy impact	*very low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 170 Kramp - single

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNi_S02*
	2	Solution Name	*Kramp*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*minimised window with single low-e glazing*
	7	Source	*www.kramp-lemgo.de*
	8	Examples	*no data*
	9	Possible supplier	*Kramp & Kramp https://www.kramp-lemgo.de/*
	13	U-value glazing [W/(m2K)]	*3,6*
	14	Composition of glazing (from inside to outside)	*4e*
	18	Ψ-value (glass edge) [W/mK]	*no data*
		Thickness [mm]	*4*
	20	g-value	*no data*
	21	Weight (kg/m²)	*10*
	25	Embodied energy impact	*very low*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

Table 171 Kramp - vacuum

Type	Nr	Parameter	Parameter Assessment
General information	1	code	*NNNj_S01*
	2	Solution Name	*Kramp*
	3	Documentation type	*product*
	4	Category (solution type)	*not specified*
	5	Applicable to/ applied to	*not specified*
	6	Category (product type)	*minimised window with single vacuum glazing*
	7	Source	*www.kramp-lemgo.de*
	8	Examples	*no data*
	9	Possible supplier	*Kramp & Kramp https://www.kramp-lemgo.de/*
	13	U-value glazing [W/(m2K)]	*0,7*
	14	Composition of glazing (from inside to outside)	*8*
	18	Ψ-value (glass edge) [W/mK]	*no data*
		Thickness [mm]	*8*
	20	g-value	*no data*
	21	Weight (kg/m²)	*20*
	25	Embodied energy impact	*medium*
	26	Average lifetime [years]	*no data*
	27	Recyclability	*no data*
	29	Kosten	*no data*

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