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	EASI ZERo **GA n°101091531**
Deliverable	**ENVELOPE MATERIAL SYSTEM WITH LOW IMPACT FOR ZERO ENERGY RENOVATION AND CONSTRUCTION**

Deliverable ID	**D7.4**
Deliverable name	**"Material passport for new construction products"**
Deliverable description	"This deliverable is a dataset ready for passport definition for EASI ZERo products, by sharing all relevant information with relevant stakeholders. Digitalized information will be stored in a digital database, ready to be inserted in a BIM model."

WP	7	"Eco-Design and Sustainability Assessment"
Task	7.5	"Material passport definition",

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Glossary

AI: Artificial Intelligence
BE: Built Environment
BIM: Building Information Modeling
CE: Circular Economy
CPR: Construction Products Regulation
DL: Deep Learning
DPP: Digital Product Passport
DTs: Digital Technologies
EPD: Environmental Product Declaration
EU: European Union
GIS: Geographic Information Systems
IFC: Industry Foundation Classes
ML: Machine Learning
MP: Material Passport
PV: Photovoltaic
VOC: Volatile Organic Compound
WP: Work Package

1. Executive Summary

1.1 *Description of the Deliverable Content and Objectives*

This deliverable presents the work carried out under Task 7.5 for the definition and implementation of a Material Passport framework for the innovative renovation products developed in EASI ZERo. The objective was to transform dispersed technical and sustainability information into a structured digital system that can be used by designers, manufacturers, sustainability experts and future end-of-life operators.
The concept of the Material Passport was applied to the EASI ZERo project product portfolio, with particular attention to bio-based, low-carbon and circular solutions. The work included the definition of common data fields, collection and harmonization of partner inputs, creation of a centralized digital database, and conversion of relevant information into BIM-compatible objects.
The final outputs attached to this deliverable are:

- Master Excel Material Passport Database
- BIM-compatible Library containing passport parameters

Together, these outputs provide a practical tool for integrating innovative materials into digital renovation workflows.

1.2 *Deviation from Objectives, Corrective Action*

No substantial deviations affecting completion of the task were identified. However, some products were still progressing through testing and validation activities during the reporting period. As a result, a limited number of parameters were not yet finalized at the moment of database consolidation.
This mainly affected values such as durability indicators, certain thermal validations, fire classifications, or product-specific functional properties still under development.
To address this, the database was intentionally designed as a flexible and updateable system. Placeholder entries and source references were maintained so that validated data can be inserted in future updates without changing the passport structure or BIM interoperability.

1.3 *Technical Progress*

The activities foreseen under Task 7.5 were successfully completed. A common passport logic was established and applied across the entire material portfolio. Information supplied by project partners was reviewed, normalized and structured into a single repository.

The database was then used as the source for digital conversion into Bim-compatible objects. Relevant material parameters were embedded into BIM components, and Industry Foundation Classes (IFC) versions of the database have been created to facilitate easy sharing and interoperability, demonstrating the feasibility of using project products directly in design environments.

1.4 *Impact of the Results*

The developed Material Passport system improves the quality and usability of product information generated within the project. Instead of isolated technical datasheets, stakeholders now have access to integrated product records combining engineering data, environmental indicators and circularity guidance. This improves product specification, supports sustainability assessments and strengthens future market uptake. The results also position the developed materials in line with European priorities related to circular construction, transparency of product data and emerging Digital Product Passport requirements.

1.5 *Dissemination Activities Carried Out / Planned*

The Material Passport methodology represents a valuable exploitation and dissemination output of the project. It can be presented during final project events, stakeholder workshops, technical

meetings and future replication activities. The digital nature of the tool also facilitates transfer to external users, demonstration buildings and future product commercialization pathways.

2. TECHNICAL CONTENT

2.1 *State of the Art*

The built environment (BE) is one of the major contributors to environmental pollution. Therefore, it is fundamental to shift from the traditional linear model of make-take-dispose to a circular model based on reuse, repair, recycle, reduce, to effectively face climate change [1]. To support this transition, digital technologies (DTs) have been increasingly explored as enablers of circular strategies. Among these, Material Passports (MPs) have been identified as one of the DTs capable of supporting the implementation of circular strategies throughout a building's lifecycle.

The term MPs refers to structured digital datasets for storing extensive data regarding the materials used in buildings. These data may include the materials' physical characteristics, origin and recycling potential [2]. The MPs can allow all the stakeholders involved to make more informed decisions in relation to building materials at various stages of the building's lifespan. With their use, the CE principles are enabled, as the materials are used as long as feasible, decreasing waste and increasing resource effectiveness.

In parallel, the revision of the Construction Products Regulation (CPR), formalised through Regulation (EU) 2024/3110, represents the European Commission's strategic response to the structural limitations of the previous regulatory framework (Regulation (EU) 305/2011). That Regulation (EU) 305/2011, indeed, had revealed significant issues - including inconsistencies, overlapping requirements, and insufficiently effective market surveillance - which limited both harmonisation and innovation within the construction ecosystem. [3]

The accelerating digital transformation of the construction sector is creating new demands for accessible, machine-readable, and transparent product information flows across the supply chain. To address these challenges, the European Commission introduced a more comprehensive and forward-looking regulatory architecture that integrates sustainability, circular economy objectives, and digitalisation as core pillars. One of the most relevant innovations emerging from this new framework is the establishment of the Construction Digital Product Passport (DPP). The DPP is conceived as a central tool to enhance traceability, ensure reliable product information throughout the life cycle, and enable data-driven approaches to reuse, repair, recycling, and circular material flows. This regulatory shift creates the foundation for broader applications of digital material documentation - such as MPs - which extend DPP logic beyond product compliance, supporting asset-level resource management and sustainability strategies.

MPs fulfil multiple roles, addressing key functions such as material tracking and management, circularity assessment, sustainability assessment, and quality assessment. Material tracking and

management are the most addressed functions, as they enable the traceability of materials from origin to EoL and support resource recovery. [4]

Concurrently with this regulatory evolution, a variety of research-based and commercial initiatives have emerged to carry out MPs in practice. Research-based initiatives primarily focus on developing and validating knowledge, methods, and tools that support circular economy strategies, often relying on grants or sponsorships for funding [3]. For example, the UK's NICER (National Interdisciplinary Circular Economy Research) program - supported by a GBP 30 million investment from UKRI (Research and Innovation) - aims to build a national research and innovation community dedicated to advancing circular economy practices. Several journal-developed MP frameworks have also been tested in real-world case studies, demonstrating their practical applicability across different construction contexts.

In contrast, commercial initiatives operate as businesses that provide paid services or tools enabling companies to track materials and generate MPs for operational use. These commercial MPs are typically delivered through online platforms that integrate data from BIM or product data spreadsheets, processing this information to produce material-related circularity indicators.

There is a range of methodologies for creating MPs based on the technologies used. A Systematic Literature Review showed that the prevalent approach used is BIM-based methodologies, followed by platform-based and blockchain methodologies, GIS and QR code/RFID approaches, and at the last place was the Level(s) approach [1].

Although each approach has strong potential to advance CE and sustainability in the BE through the digitalization of MPs, several gaps and limitations still restrict their effectiveness and wider adoption. For example, BIM-based methodologies adopt Building Information Modelling to create, manage, and track material data throughout a building's lifecycle, enhancing sustainability, circular economy principles, and recyclability. By integrating digital 3D models with material data - including material properties, EPDs, and disassembly information - this approach enables optimised waste management, supports material reuse, and facilitates environmental impact assessment.

However, while theoretically enabling automation, it still relies on manual data entry, which reduces efficiency and limits full process integration. It also struggles with data inconsistencies, particularly in the critical end-of-life stages, due to fragmented material standards and coordination issues between industrial sectors [4].

Addressing these issues requires advancements in data automation, enhanced model flexibility, and improved interoperability across various construction disciplines.

To fully unlock the potential of MPs, further technological innovation, stronger regulatory support, and active stakeholder engagement are essential. This includes policies that incentivise adoption and investments in data quality and management systems. Also integrating AI techniques such as Machine Learning (ML) and Deep Learning (DL), could enhance data collection, enable real-time updates, and automate the process of creating and maintaining MPs [1].

Within this context, the present deliverable focuses on the concept and structure of material passports, giving a baseline for future applications.

2.2 *Material Passport Methodology*

The methodology developed for this task was based on the principle that construction products should be documented not only for installation purposes, but for their complete lifecycle. For this reason, the passport structure combines four complementary dimensions:

- **Identity information**, describing what the product is, who developed it and where it should be used.
- **Performance information**, describing how the product behaves technically once integrated into a building.
- **Environmental information**, quantifying impacts and sustainability indicators.
- **Circularity information**, explaining how the product can retain value at the end of use.

Figure 1: extract of parameters list

Parameter
Identity Data
Application
Commercial Product Name (if decided)
Compatibility with finishing
Density (kg/m^3)
Efficiency % [BIPV only]
Embodied GWP kgCO2eq/xx
Fire Classification
Installation
Minimum and maximum allowable thickness
Power density kWp/m2 [BIPV only]
Recommended thickness
Resistance to humid environment
Specific heat capacity (J/kg·K)
Thermal Conductivity W/(mK)
Thermal Resistance m2 K/W
Vapour Permemability
VOC removal capacity [only paint]

This integrated logic enables the passport to remain useful from design stage to deconstruction stage.

Life Cycle Cost (LCC) information was also collected. For some EASIZERo products this data is sensitive. For this reason, we do not share them in this deliverable and in the public accessible data.

2.3 *Material Passport Database Development*

A centralized master database was created in spreadsheet format as the common data environment for all EASI ZERo material passports. The structure follows a matrix logic: each column corresponds

to one product and each row corresponds to a standardized passport parameter. This format allows efficient benchmarking across very different product families while preserving consistency.
The database includes the following products:

- Mycelium low-density insulation panels
- Mycelium decorative boards
- Wood-fibre insulation panels
- Sprayable bio-PUR foam
- Bio-based windows
- PCM-filled wall bricks
- Insulating render
- VOC-removal paint
- Bio-based frame paint
- Insulated blind box (Bio-PUR)
- Insulated blind box (PCM)
- BIPV roof tiles

Figure 2: EASI ZERo Products

Mycelium-Based Inside-The-Wall Thermal Insulating Panels (Low Density)	Mycelium-Based Decorative Insulating Panels For Inner Walls (High Density)	Wood-Fibre Insulation Panel In Wall Assembly	Sprayable Low Density Bio-Pur Foam	Biobased Windows	Filled Wall Bricks With Pcms	Insulating Render	Voc Removal Paint	Biobased Paint For Window Frames	Insulated Blind Box (Bio-Pur)	Insulated Blind Box (Pcm)	BIPV On The Roof (Pv Tiles)

For each product, the database captures:
Product and market data: commercial name, responsible partner, intended application, installation method, benchmark market prices and estimated EASI ZERo target prices.
Technical properties: recommended thickness, minimum and maximum dimensions, density, specific heat capacity, thermal conductivity, thermal resistance, vapor permeability, resistance to humid environments, fire classification and compatibility with finishing systems.
Functional performance: specific indicators were added where relevant, such as, PV power density and efficiency for roof-integrated photovoltaic tiles, VOC removal capacity for active paints, construction tolerances for integrated façade components
Environmental indicators: Embodied Global Warming Potential values were included using declared units adapted to each product type (m^2, m^3, kg or linear meter).
Data traceability: Each parameter row contains a source reference field indicating the originating deliverable or validation stage. This ensures transparency and future updateability.
Circularity screening: the database links each material to the applicable 14R strategies, including reduce, reuse, repair, remanufacture, renew, recycle and recover.

The resulting file therefore acts simultaneously as a technical repository, comparison tool and source for BIM integration.

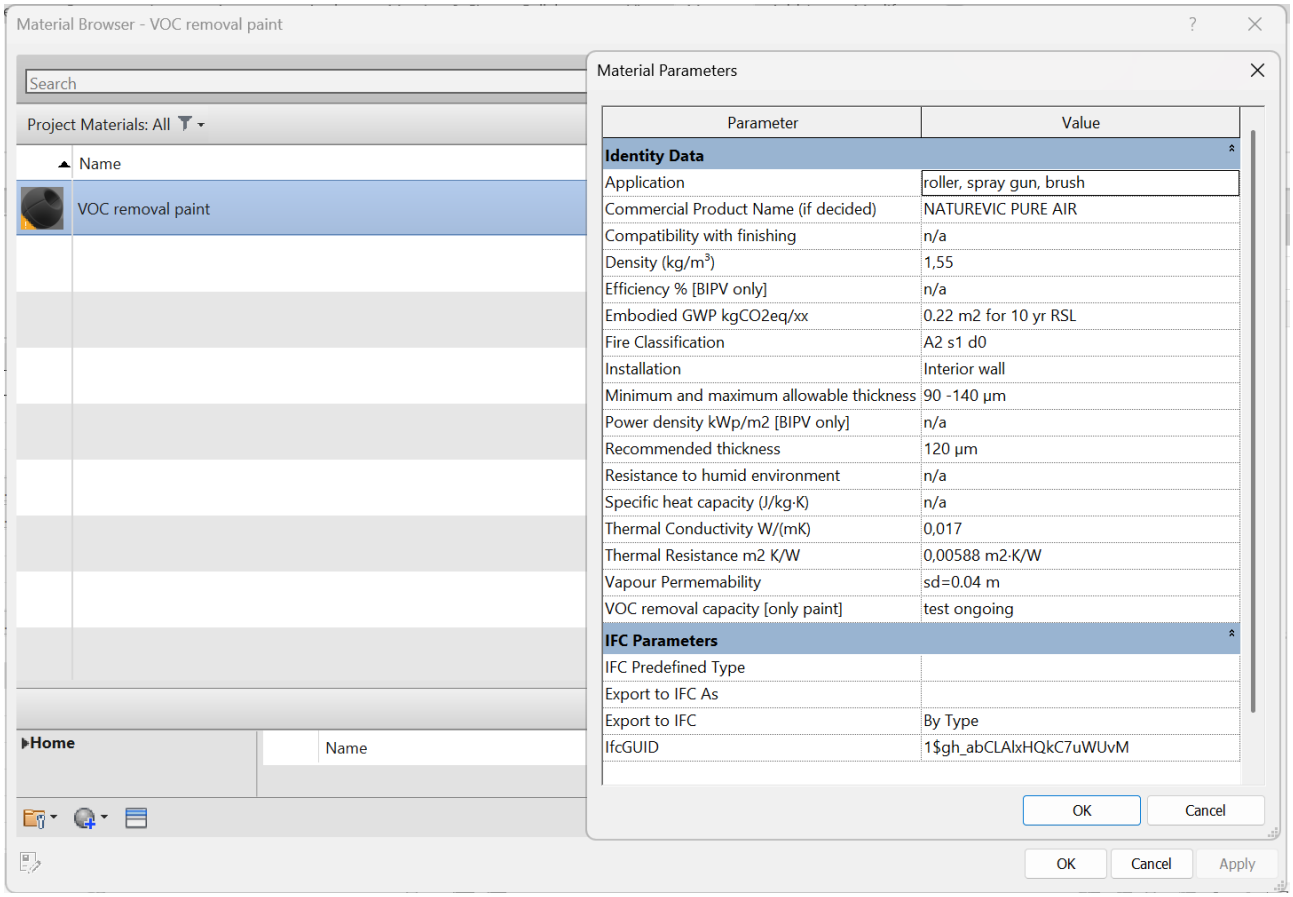
2.4 *BIM Integration and Revit Conversion*

Once the database was completed, relevant parameters were mapped into BIM-compatible attributes and transferred into Autodesk Revit objects. This conversion transformed static spreadsheet data into design-operable digital assets. Each object was configured to contain material intelligence such as:

- Thermal conductivity
- Density
- Fire behaviour
- Application area
- Sustainability indicators
- Lifecycle notes

The resulting Revit library enables architects and engineers to specify EASI ZERo materials directly within renovation models while maintaining passport information. To support interoperability, Industry Foundation Classes (IFC) versions of the Revit objects have been created and exported, enabling the widespread of EASI ZERo products across different BIM software applications.

Figure 3: Extract of the Revit database of Material Passports



This also creates future opportunities for:

- Quantity take-off automation
- Embodied carbon calculations
- Digital twins
- Building logbooks
- Maintenance planning
- Circular deconstruction strategies

The complete database is attached to this deliverable Annex 1.

2.5 *Strategic Relevance*

The work developed under Task 7.5 directly supports current European priorities in sustainable construction. Material transparency, traceability and lifecycle management are becoming essential elements of future regulation and market expectations. The passport system developed in EASI ZERo demonstrates how innovative bio-based products can be prepared for this transition using practical and scalable digital tools. It also supports wider objectives related to renovation wave policies, circular economy implementation and low-carbon building transformation.

3. CONCLUSIONS

Task 7.5 successfully delivered a complete Material Passport framework for the EASI ZERo product portfolio.

A common methodology was established, partner data were transformed into a structured database, and practical BIM integration was demonstrated through a dedicated Revit library and the creation of IFC file for each EASI ZERo product. The deliverable confirms that innovative renovation materials can be documented in a professional, transparent and market-ready manner combining technical, environmental and circularity information in one coherent system. The attached database and BIM library provide tangible project outputs with long-term value beyond the project duration. They support product commercialization, digital design integration and future compliance with European Digital Product Passport developments. The work carried out under this task therefore represents a concrete contribution to more circular, intelligent and climate-neutral renovation practices in Europe.

4. References

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[2] S. Mao and W.-J. Cao, 'Evaluating material passports for circularity in the construction industry', *Sustain. Prod. Consum.*, vol. 54, pp. 88–101, Mar. 2025, doi: 10.1016/j.spc.2024.12.021.

[3] 'Regulation (EU) 2024/3110 of the European Parliament and of the Council of 27 November 2024 laying down harmonised rules for the marketing of construction products and repealing Regulation (EU) No 305/2011 (Text with EEA relevance)'.

[4] H. N. Y. Senarathne, N. P. Weerasinghe, and G. Zhang, 'Developing a Standardized Materials Passport Framework to Unlock the Full Circular Potential in the Construction Industry', *Sustainability*, vol. 17, no. 14, p. 6337, Jul. 2025, doi: 10.3390/su17146337.

[5] C. Bernier and F. Danash, 'DPP Prototypes', May 2024, doi: 10.5281/ZENODO.11393742.

5. Annex 1

Table 1: Extract of the Excel database of Material Passports

	Mycelium-based inside-the-wall thermal insulating panels (low density)	Mycelium-based decorative insulating panels for inner walls (high density)	Wood-fibre insulation panel in wall assembly	Sprayable Low density Bio-PUR foam	Biobased windows	Filled Wall Bricks with PCMs	Insulating render	VOC removal Paint	Biobased paint for window frames	Insulated Blind Box (Bio-PUR)	Insulated Blind Box (PCM)	BIPV on the roof (PV tiles)
Commercial Product Name (if decided)	n/a	n/a	n/a	BIOPURethane® SF	KLIMA-PUR®	PCM Brick	n/a	NATUREVIC PURE AIR	n/a	Bio-PUR Blind Box	PCM Blind Box	ER-INTEGRATION

Recommended thickness	4 cm	2 cm	30-250	50-200 mm	70 mm	36.5 cm	2-12 cm	120 µm	n/a	36.5 cm	36.5 cm	n/a
Minimum and maximum allowable thickness	2-5 cm	2-5 cm	According to NS-EN 13171+A1 Class T1	40-300 mm	60-80 mm	- 10 mm + 8 mm	2-12 cm (Multilayered)	90-140 µm	60-100 µm	- 10 mm + 8 mm	- 10 mm + 8 mm	n/a
Density (kg/m³)	133.8 kg/m³	231.7 kg/m³	50	40-45	400-450	600 kg/m³	150-160 kg / m³	1.55	n/a	tbe	tbe	n/a
Specific heat capacity (J/kg·K)	not evaluated	not evaluated	2000	0.422	1.5	not evaluated	not tested	n/a	n/a	not evaluated	not evaluated	n/a
Thermal Conductivity W/(mK)	$\lambda_{23/50}$ = 0.04385 W/mK	$\lambda_{23/50}$ = 0.06097 W/mK	0.03599	0.02676 - 0.03266	$\lambda_{5°C}$ = 0,04502 W/mK; $\lambda_{25°C}$ = 0,04919 W/mK; $\lambda_{45°C}$ = 0,05187 W/mK	0,07	$\lambda_{dry,10}$ =0.03240 W/mK $\lambda_{23°C/50\%}$ =0.03367 W/mK $\lambda_{23°C/80\%}$ =0.03398 W/mK	0.017	n/a	λdry, 10 = 0.03355 W/mK (PUR); λdry, 10 = 0.451 W/mK (clay)	λdry,10,PCM = 0.1553 W/mK (PCM)	n/a
Thermal Resistance m²K/W	R=0.04385/ 0.04≈0.91 m²K/W	R≈0.33 m²K/W	0.83 - 6.95	4.0891- 3.3501	0.81	fire resistance = alpha fi <= 0.4- 0.52	R (min) 0,02m /0.03240= 0.62 R(max) 0,12m /0.03240= 3.70 --> 0.62 - 3.70	0.00588 m²·K/W considering an average thickness of 100 µm	n/a	1.69	1.23	n/a
Vapour Permeability	Water vapour diffusion resistance: µ = 2.7 (dry-cup-method) µ = 2.0 (wet-cup-method)	Water vapour diffusion resistance: µ = 2.7 (dry-cup-method) µ = 1.4 (wet-cup-method)	µ 3/5 (dry/wet)	µ = 80 (dry-cup-method) µ = 65 (wet-cup-method)	Water tightness -Class 9A (UNE-EN 12208:2000)	n/a	3 µ (wet-cupmethod) 5.5 µ (dry-cupmethod)	sd=0.04 m	n/a	not evaluated	not evaluated	n/a
Resistance to humid environment	not evaluated	not evaluated	Should not be exposed to high humidities over time.	High or Good	High or Good	Good	High or Good	n/a	Water liquid permeability = impermeable (clase W3)	not evaluated	not evaluated	very good
Fire Classification	E	E	E	E	V0 and HB (UL 94)	tbt	A2	A2 s1 d0	n/a	not tested	not tested	not tested
Compatibility with finishing	n/a	n/a	Used between studs / rafters etc.	Good	Good	Good	Good	n/a	n/a	Good	Good	n/a
Application	internal wall	wall coverings	Walls, Roof & Ceiling and Floors	Walls, Roof & Ceiling and Floors	High performance Window	Walls	Spraying machine	roller, spray gun. brush	roller, spray gun	Wall installation	Wall installation	n/a
Installation	Glue fixing system	Glue fixing system, Velcro fixing system, Magnet-based fixing system	Installed (fitted between studs /rafters)	Spray method	Fabricated at IND and Installed on site	Exterior wall	interior/exterior wall	interior wall	window frame	Exterior Wall	Exterior Wall	manual
Power density kWp/m2 [BIPV only]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.23
Efficiency % [BIPV only]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	23%
VOC removal capacity [only paint]	NA	NA	NA	NA	NA	NA	NA	65%	NA	NA	NA	n/a
Selling Price benchmark product €/xx	Confidential	Confidential	Confidential	Confidential	Confidential	Confidential	Confidential	Confidential	Confidential	Confidential	Confidential	70 €/m²
Selling Price EZ0 product €/xx[estimated or target]	Confidential	Confidential	Confidential	Confidential	Confidential	Confidential	Confidential	Confidential	Confidential	Confidential	Confidential	62 €:m²
Embodied GWP kgCO2eq/xx Indicator A1-A3	Confidential	Confidential	Confidential	21.069 kgCO2eq/m² with R=4.0 m²·K/W	141,552 kgCO2eq/m² of standard window 1.23m x 1.48m	267 kgCO2eq/m³	Confidential	0.22 kgCO2eq/m² for 10 yr RSL	0.498 kgCO2eq/m²	24.42 kgCO2eq/m	NA	95,5 kgCO2eq/m²
Embodied energy (Mj/xx)(PERT+PENRT) Indicator A1-A3	Confidential	Confidential	Confidential	480.05 kgCO2eq/m² with R=4.0 m²·K/W	3376,87 kgCO2eq/m² standard window	6740 kgCO2eq/m³	Confidential	3.73 kgCO2eq/m² for 10 yr RSL	9.12 kgCO2eq/m²	NA	NA	1629 kgCO2eq/m²
Embodied GWP kgCO2eq/xx Indicator A-C	Confidential	Confidential	Confidential	21.479 kgCO2eq/m² with R=4.0 m²·K/W	165,821 kgCO2eq/m² standard window	NA	Confidential	0.244 kgCO2eq/m² for 10 yr	9.121 kgCO2eq/m²	NA	NA	105 kgCO2eq/m²

Embodied energy (Mj/ xx)(PERT+PENRT) Indicator A-C	Confidential	Confidential	Confidential	494.093 kgCO2eq/m^2 with R=4.0 m^2·K/W	4155.634 kgCO2eq/ m^2 standard window	NA	Confidential	4.042 kgCO2eq/m^2 for 10 yr	9.173 kgCO2eq/m^2	NA	NA	1707 kgCO2eq/ m^2
Source [Deliverable, Version]	D7.2 (first results) D7.5 (M42)	D7.2 (first results) D7.5 (M42)	D7.5 on A1-A5 +C1-C4	D7.5 (M42)	D7.5 (M42)	D7.5 (M42)	D7.2 (first results) D7.5 (M42)	D7.5 (M42)	D7.5 (M42)	D7.2 (first results)	NA	D7.2 (first results) D7.5 (M42)
Link with the 14 R's	Mycelium-based inside-the-wall thermal insulating panels (low density)	Mycelium-based decorative insulating panels for inner walls (high density)	Wood-fibre insulation panel in wall assembly	Sprayable Low density Bio-PUR foam	Biobased windows	Filled Wall Bricks with PCMs	Insulating render	VOC removal Paint	Biobased paint for window frames	Insulated Blind Box (Bio-PUR)	Insulated Blind Box (PCM)	BIPV on the roof (PV tiles)
R1: Refuse	x	x		x				x				
R2: Rethink	x	x	x	x	x	x		x				
R3: Reduce	x	x	x	x	x	x		x				
R4: Re-use	x	x	x		x							
R5: Repair	x	x										
R6: Refurbish												
R7: Re-Manufacture			x		x							
R8:Repurpose												
R9: Renew			x	x								
R10: Refill												
R11: Replant			x									
R12: Replace	x	x						x				
R13: Recycle	x	x	x		x			x				
R14: Recover						x						