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EASI ZERo

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Deliverable

ENVELOPE MATERIAL SYSTEM WITH LOW IMPACT FOR ZERO ENERGY RENOVATION AND CONSTRUCTION

Deliverable ID	**D4.1**
Deliverable name	**"Catalogue of energy and resource-efficient products for renovation and construction"**
Deliverable description	This deliverable reviews all products and application processes developed in tasks 4.2, 4.3 and 4.4. This cover performance of sprayable PUR, wood-based insulation panels attached to walls, insulating filled bricks, dry and wet procedure for insulation render application and field efficiency of VOC removal paints (task 4.2). This report also covers the bio-PUR window frames evaluation of performance (4.3) and the integration of PV specific components on roof and façades (4.4).

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ACRONYM

PCM: phase-change material
PUR: Polyurethane
SSdB: Safe and Sustainable by Design
UV: Ultra Violet
VOC: Volatile Organic Compound

1. Executive summary

1.1 *Description of the Deliverable content and objectives*

The deliverable 4.1 of the EASI ZERo project provides a comprehensive overview of all products (table 1) and application methods developed in tasks 4.2, 4.3 and 4.4. This includes the performance characteristics of sprayable PUR, wood-based insulation panels attached to walls, insulating filled bricks, dry and wet procedure for insulating render applications, and the efficiency of VOC-removing paints in use. In addition, the report includes an evaluation of the performance of bio-PUR window frames (task 4.3) and the integration of PV-specific components on roofs and facades (task 4.4).

The aim of the report is to present and evaluate the technical properties and application methods of all developed products. Both ecological and functional aspects are considered to provide a comprehensive overview for further implementation and market launch. The report documents and communicates the innovative materials and systems developed in the project in terms of their efficiency, environmental friendliness, and practical applicability.

Product	**main characteristics**	**achievements**	**TRL before the project**	**TRL end of the project**
Sprayable method of bioPUR/SAFE-PUR	Low density (40-44 kg/m^3) Biobased Polyurethane foams with high reactivity for spray foaming insulation	Developed bioPUR formulation with 60-70% bio-based content, successfully tested/adopted the spray ability of the formulation through a commercial gun-spray machine.	TRL-4	TRL-9
Mycelium-based thermal insulating panels attached to walls	Thermal and acoustic insulation panels for interior design	Decreased lambda value and improvement of fire resistance with a new aesthetic	TRL-9	TRL-9
Wood-fiber insulating panels	Flexible, wood-fiber based insulation panels designed for thermal and acoustic insulation in construction. Lambda value pilot scale: λ = 0.0309 W/(m.K) Lambda value full scale: λ = 0.0360 W/(m.K)		TRL-1 TRL-7	TRL-5 TRL-8
Filled Wall Bricks	Clay bricks with integrated PCM capsules replacing part of the standard	Integration of two rows of PCM into clay bricks successfully	TRL-9	TRL-9

	mineral wool filling. The solution aims to increase thermal storage capacity while maintaining full structural performance and compatibility with conventional masonry systems.	demonstrated. The developed solution achieved stable mechanical integrity.		
High-performance insulating render	Lambda value render: $\lambda \leq 0.03$ W/(m.K). The bio-mineral thermal insulation render is more resource-efficient due to its organic content, which reduces its carbon footprint. In addition, less material is used because the functions of surface finishing and insulation are combined in one product. Furthermore, locally available materials are used, which reduces transport emissions. The manufacturing process for bioaerogel is less energy-intensive resulting in lower product costs.	Easy application in technical preconstruction site scale. Homogeneous mixture, no cracks in the render (lab scale and spraying by machine).	TRL-3	TRL-5-6
VOC Removal painting	Bio-based interior wall paint based on recycled polymers and bio-based additives. Reduces Carbon footprint. Near zero VOC content. Indoor air pollutant elimination capacity, especially formaldehyde reduction. Accomplishing Ecolabel criteria and main European certifications for its use.	Formulation and validation of an interior wall paint using bio based and recycled materials maintaining standard end-users quality requirements. Reformulation to achieve VOC removal capacity in indoor air mainly formaldehyde reduction.	TRL-4	TRL-7
High energy efficient windows with insulated blind box	Prefabricated insulated blind box for brick masonry. Initial Neo-PUR insulation was replaced by PCM capsules or bio-based PU foam (INDRESMAT), improving thermal	Prototyping and validation of an insulated blind box fully compatible with the EASI ZERo wall system. The solution improves the thermal continuity of the	TRL-9	TRL-9

	performance and sustainability while ensuring airtightness and easy installation.	envelope and simplifies installation.		
Bio-PUR window frames	High density (450 kg/m3) Biobased Polyurethane frames.	Successful bioPUR formulation with 60-70% biobased content developed, resulting in excellent properties for bio-based window.	TRL-6	TRL-9
Integration of PV-specific components on roofs and facades	Specific PV tiles (0.5 m²) and standard PV modules (2 m²) for integration in roof and façade	Specific PV tiles and standard PV modules ready for integration in roof. Integration on façade still depends on façade material and structure.	TRL-5	TRL-7 (tiles) TRL-8 (modules)

Table 1: Deliverable content and objectives

1.2 *Deviation from objectives, corrective action*

WP4 experienced some delays due to missing test results. As the deliverable is directly related to milestone 7, D4.1 was postponed and updated in March 2026.
Regarding water glass foam, the thermal conductivity did not reach the minimum acceptable value to achieve the KPI defined in the GA for the performance of the high-performance thermal insulating render. Therefore, partners decided to integrate a biomineral aerogel from a start-up instead which reach the minimum thermal conductivity.

1.3 *Technical progress*

Sprayable method of bioPUR/SAFE-PUR

The system uses a high-pressure spray machine to apply two liquid components that react and foam directly on the surface, creating a closed-cell layer. This layer bonds well to materials like concrete, wood, or metal and provides seamless insulation without gaps, making it ideal for roofs, façades, and internal cavities.

Mycelium-based thermal insulating panels attached to walls

The panels are made for indoor walls and ceilings. They improve a room's acoustic and thermal insulation and can be customized in appearance thanks to advanced manufacturing technology.

Wood-fiber insulating panels

Hunton Nativo® wood fibre insulation boards can be installed in various parts of a building — floors, walls, ceilings, and roofs — for both new constructions and renovations. They fit both wooden and steel structures. The boards should be cut slightly oversized for a tight fit and joints staggered when using multiple layers. Installation should start from the bottom upward, with each board fitting snugly to prevent settlement. A Hunton cutting table and a hand saw or knife ensure precise cuts.

Filled Wall Bricks

The PCM bricks are installed just like regular clay bricks with standard tools. They need no special treatment because the prefabricated filling guarantees consistent quality. They fit normal wall systems and work with traditional mortars, thin-bed adhesives, or dry-stacking methods.

High-performance insulating render

The thermal insulation render is applied after thorough substrate preparation. The render, sprayed with a PFT G4 machine onto absorbent brick masonry, showed very good workability and stability. Layers up to 3 cm of thickness were leveled, reinforced with mesh for strength, and finished with a top coat to ensure insulation, durability, and structural integrity.

VOC Removal painting

It is applied like standard interior paint using a roller, brush, or airless sprayer. Stir well before use. Surfaces must be clean, dry, and stable. Good surfaces: first coat with 10% water, second with 5–10%. Poor surfaces: clean and repair, then apply first coat with 10% water and second with 5%. Let each coat dry 4–6 hours.

High energy efficient windows with insulated blind box

Significant progress has been made in the development of the bio-based PUR systems for window frame applications, achieving 60–70 wt% bio-based content through the incorporation of renewable polyols. The formulations maintain mechanical and physical properties comparable to conventional PUR materials. Initial moulding trials confirm good processability and compatibility with standard manufacturing processes. In addition, bioPUR paint was properly applied to the foams and window frames, showing good spray ability, strong coverage, and good adhesion.

Integration of PV-specific components on roofs and facades

The aluminum substrate or module is mounted on an aluminum railing attached to the façade beneath the insulation layer. Unframed modules use a special fastening component. The PV modules are wired in series and connected to an inverter.

1.4 *Impact of the results*

Sprayable method of bioPUR/SAFE-PUR

The material has a thermal conductivity of 0.026–0.032 W/(m.K) and a density of 40–44 kg/m³. Its compressive strength is 160–170 kPa. Water absorption is 1.6%. Tests for water vapour permeability and dimensional stability are ongoing. It has fire classification Class E (EN 135011) and up to 70% biobased content.

Mycelium-based thermal insulating panels attached to walls

The performance varies by panel density. High-density panels have much higher tensile and compression strength. Low-density panels show slightly lower thermal conductivity. Both types have the same fire resistance rating (B-s1-d0) when painted.

Wood-fiber insulating panels

The wood fibre insulation boards show improved thermal performance, with thermal conductivity reduced from 0.0380 W/(m.K) to 0.0315 W/(m.K) in pilot scale. Fire resistance aims to reach Euroclass A2 but is not yet achieved. Tensile strength improved from class TR 1 to TR 2.5. Other properties like air flow resistivity, water vapor transmission, and dimensional stability remain under evaluation.

Filled Wall Bricks

The PCM integration is expected to improve thermal storage and energy efficiency while maintaining the brick's strength, durability, and size. Its fire, sound, and moisture performance remain similar to conventional clay brick systems.

High-performance insulating render

The insulating render has very low thermal conductivity (≤ 0.03 W/(m.K)), showing strong insulating properties. Its fire reaction class is A2 due to a small organic content. Water absorption is within the required range (0.251 kg/(m²·min$^{0.5}$)), and vapor permeability is high (μ= 3−5.5), allowing the material to breathe effectively.

VOC Removal painting

Naturevic Pure Air paint has wet scrub resistance (Class 2), a matt finish with gloss below 10, and opacity Class 2. It allows high water vapor permeability (sd < 0.14 m). Tests for fire resistance, VOC removal, emissions, and ecolabel certification are still in progress.

High energy efficient windows with insulated blind box

The obtained results demonstrate that the developed bio-based window system meets high performance requirements for energy-efficient building applications. Excellent air permeability (Class 4), water tightness (Class 9A), and wind load resistance confirm robust envelope performance and suitability for demanding climatic conditions. High static torsion resistance and RC2 burglary security indicate strong mechanical integrity and user safety. In addition, the achieved airborne sound insulation (40 dB) supports improved indoor comfort. Overall, these results validate the

technical feasibility of bio-based window solutions as competitive alternatives to conventional systems.

Integration of PV-specific components on roofs and facades

The PV-specific module produces 100 Wp, equivalent to 170 Wp per square meter. The standard PV module produces 470 Wp, equivalent to 235 Wp per square meter.

1.5 *What are the next steps?*

Sprayable method of bioPUR/SAFE-PUR

The next developments will aim to increase bio-based content to over 80%, improve fire resistance using phosphorus additives, enhance recyclability through chemical depolymerisation, optimize spray processes for efficiency, and scale up production while conducting long-term durability tests.

Mycelium-based thermal insulating panels attached to walls

SQIM is improving its panels by reducing costs and raw material use while developing new aesthetic designs.

Wood-fiber insulating panels

Hunton will continue the work to further realize the insights gained. This includes increasing the share of recycled fibres, implementing the findings on optimal fibre morphology, and adjusting the production process. These activities will lead to a significantly improved environmental profile of the insulation material.

Filled Wall Bricks

The thermal tests of the PCM-filled bricks are still in progress, and the full wall system has not yet been validated. The main uncertainty is whether the PCM melts within normal indoor temperatures. The filling process was done manually and will need automation for future use. Further steps depend on test results, as PCM is expensive and only worthwhile if it significantly improves energy efficiency or comfort. Cost and scalability analyses will follow if results are positive.

High-performance insulating render

Sievert plans to launch the thermal insulation render after minor formula adjustments and continue working with the aerogel start-up. The key goals are improving aerogel's price performance and reducing CO_2 emissions in building materials. Future improvements include using more biopolymers, considering fire safety classes, replacing cement with low-CO_2 binders like paper ash, and using recycled perlite for greater sustainability.

VOC Removal painting

The optimization depends on the formaldehyde removal results. If efficiency is low, it can be improved by adding more VOC removal additives. Thermal insulation was tested using hollow glass microspheres, but all current formulations fail to meet the required 8 m^2/L spreading rate at 98% opacity per ISO 6504. The microspheres raise cost and reduce opacity and wet scrub resistance. Further tests continue, balancing Ecolabel certification and price against thermal comfort benefits.

High energy efficient windows with insulated blind box

Bio-based window frames can be improved through optimized bio-composite formulations that enhance mechanical strength, durability, and thermal performance. Increasing renewable content through the use of locally sourced natural fibers or wood by-products reduces environmental impact and supports recyclability and biogenic carbon storage. Standardized profiles and design for disassembly can further support scalability and cost competitiveness.

Integration of PV-specific components on roofs and facades

Roof integration is fully developed. Remaining work is about façade integration with external thermal insulation and different types of façades material. Façade integration on concrete walls is available.

2. Technical content

2.1 *Sprayable method of bioPUR/SAFE-PUR*

2.1.1 Description of the product

The bioPUR sprayable system is a biobased polyurethane (BioPUR) formulation designed for thermal insulation and air-tightness applications in buildings. The system is composed of a polyol blend containing up to 70 % renewable content (vegetable oils and recycled polyols) and a conventional isocyanate aromatic system. The resulting foam combines high insulation capacity (λ ≤ 0.030 W/m·K), dimensional stability, and low emissions, while being compliant with SSbD principles.

2.1.2 Application process

The system is applied by spraying the two liquid components (A and B) using a high-pressure spraying machine, depending on the surface and layer thickness required. The reaction and foaming occur in situ, forming a closed-cell structure that adheres strongly to substrates such as concrete, wood, or metal. This method ensures a continuous insulation layer without joints or thermal bridges, suitable for roofs, façades, and internal cavities.

2.1.3 Performance characteristics

The performance of the sprayable bio-based PUR foam was evaluated by preparing the bio-based PUR spray samples as per the standards. The performance results are depicted in the Table below.

Table 2: Bio-based sprayable PUR foam performance characteristics

Property	Test Standard	Results
Thermal conductivity (λ)	UNE-EN 12667:2002	0.026 – 0.032 W/m·K
Density (applied foam)	EN 1602	40 - 44 kg/m³
Compressive strength	UNE-EN 826:2013	160 - 170 kPa
Water vapour permeability		Test ongoing
Water absorption	UNE-EN ISO 29767:2020	1.6 % after 24h related to initial mass
Dimensional stability	DIN EN 1603, method A	Test ongoing
Fire behaviour	EN13501-1	Class E
Bio-based content	NA	up to 70 %

2.1.4 Next steps and possible improvement planned

The next developments will focus on:

- **Increasing bio-based content** above 80 % through integration of recycled CO_2-based polyols.
- **Enhancing fire resistance** (target Class C) with reactive phosphorus-based additives.

- **Improving recyclability** via chemical depolymerisation routes compatible with rigid and spray foams.
- **Optimization of spray process parameters** to reduce material losses and ensure homogeneous mixing.
- **Scaling up pilot production** and performing **long-term ageing and durability tests** under real conditions.

2.2 *Mycelium-based thermal insulating panels attached to walls*

2.2.1 Description of the product

The product is a 100% circular wall-covering panel with sound-absorbing and thermal-insulating properties. The standard mycelium-based panel can be designed in two formats: high-density and low-density. It is made from soft, foam-like mycelium materials and upcycled low-value substrates. The panel has been produced with a new aesthetics: “Kiwi”, incorporating recycled wool.

2.2.2 Application process

The panels are designed for indoor use as wall coverings and ceiling, enhancing the acoustic and thermal insulation properties of rooms. Thanks to the innovative technology behind the manufacturing process, the product's appearance can also be customized.

2.2.3 Performance characteristics

The performances depend on the format: high-density and low-density.
In EASI-ZERO, the tensile strength, resistance to compression, thermal conductivity and fire resistance have been tested. The results are shown below.

Table 3: Performance characteristics

Property	High-density panel (231.7 kg/m3)	Low-density panel (133.8 kg/m3)
Tensile strength (kPa)	23.6 kPa (values between 20.5-27.4 kPa)	25.1 kPa (values between 21.8-27.7 kPa)
Compressive strength (kPa)	358.5 kPa (values between 254.7-488.9 kPa)	44.8 kPa (values between 23.5-63.0 kPa)
Thermal conductivity (W/(m.K))	0.06097 W/(m.K)	0.04385 W/(m.K)
Fire resistance (class)	B-s1-d0 (for painted panel)	B-s1-d0 (for painted panel)

2.2.4 Next steps and possible improvement planned

SQIM is continuously working for improving the panel and adding new aesthetics.

The work focuses on reducing the cost as well as reducing the use of raw material.
In terms of aesthetics, SQIM is working on the release of new designs.

2.3 *Wood-fiber insulating panels*

2.3.1 Description of the product

Hunton Nativo® Wood Fibre Insulation Boards are a flexible, wood-based material designed for thermal and acoustic insulation in construction. The boards are manufactured at Hunton Fiber's facility in Gjøvik, southern Norway. A notable environmental benefit of wood-based insulation is its renewable origin. The wood fibres used in Hunton Nativo® are sourced entirely from sustainably managed forests certified under the PEFC scheme (Program for the Endorsement of Forest Certification). The primary raw material, wood chips, is a by-product of local sawmills, ensuring efficient resource utilization and minimal waste.

Like other plant-based building materials, wood fibre insulation acts as a carbon sink throughout its lifecycle.

2.3.2 Application process

Hunton Nativo® Wood Fibre Insulation Boards are suitable for use under floors, within walls, between storeys, and in roofs, and can be applied in load-bearing structures made from wood or steel. The product is effective for both new construction and renovation projects. Installation follows standard procedures for thermal insulation: boards should be cut slightly oversized to ensure a tight fit against posts, rafters, beams, sills, and other structural elements, and to prevent gaps at butt joints. Oversizing may require compressing the boards vertically with some tension. When installing in several layers, joints should be offset to ensure a seamless fit. It is recommended to use the Hunton cutting table and hand saw or knife, specifically designed for cutting Nativo boards. Installation should always begin at the bottom and progress upwards, ensuring the insulation sits snugly before placing the next board to minimize the risk of settlement after installation.

2.3.3 Performance characteristics

The most important characteristics of the wood fibre insulation boards are summarized in the table below. Both the initial performance and the improvements achieved so far are listed.

Table 4: Performance characteristics

Characteristic	Product Standard	Initial performance	Target in EASI-ZERo	Achieved to date in EASIZERo		Unit
				Full scale	Pilot scale	

Thermal conductivity	EN 12667	0.0380	0.0320	0.0360	0.0309	W/m.K
Reaction to fire	EN 13501	Euroclass E	Euroclass A2	Euroclass E	not yet determined	Euroclass
Tensile strength	EN 1607	TR 1	TR 1	TR 2.5	not yet determined	TR Class
Air flow resistivity	EN 29053	6	10	not yet determined	not yet determined	kPa *s/m^2
Water vapor transmission	EN 12086	2 / 5	2 / 5	not yet determined	not yet determined	µ
Length	EN 822	+/- 2	+/- 2	+/- 2	not yet determined	%
Width	EN 822	+/- 1.5	+/- 1.5	+/- 1.5	not yet determined	%
Thickness	EN 823	T2	T2	T2	not yet determined	T Class

2.3.4 Next steps and possible improvement planned

By implementing sensors in the production process (during EASI ZERo), we measured the actual temperature inside the insulation panels during their residence time in the curing oven. The results indicate that there are substantial margins. Operating the oven at lower temperatures will lead to considerable energy savings, which will have a positive effect on both the environmental profile and production costs.

The installed mill, which enables the reintegration of used fibres into the production process, is not yet fully utilised. Further optimization is required to increase and ultimately maximise the proportion of recycled fibres. At present, the recycled fibres originate from internal production waste. In the longer term, incorporating material from external sources would provide an opportunity for a higher degree of circularity.

Due to the limited adjustment possibilities of the existing processing equipment, Hunton plans to establish more advanced alternatives. This will create opportunities to reduce the amount of binder and to introduce other binder types. Such developments will potentially improve the environmental profile of the final product.

A processing procedure developed at DTI show potential for reducing the thermal conductivity of the material. This approach appears promising and should be further developed. Possible applications should be examined in more detail, as well as how a production on industrial-scale could be designed.

Analysis showed that the current fibre structure within the insulation material is neither optimally sized nor optimally oriented with respect to thermal performance. These insights will be incorporated into further experiments and optimisation efforts.

2.4 *Filled Wall Bricks*

2.4.1 Description of the product

The filled wall bricks are hollow clay masonry units incorporating phase change material (PCM) capsules in combination with mineral wool insulation. In the standard configuration, the cavities of the bricks are filled with mineral wool to enhance thermal insulation. In the developed variant, part of the mineral wool was replaced by PCM capsules to provide additional heat-storage capacity and to stabilize indoor temperature fluctuations. The bricks maintain the same geometry and mechanical performance as conventional products and can be used within existing masonry systems without modification.

2.4.2 Application process

The PCM-filled bricks are installed using conventional bricklaying techniques, identical to those used for standard filled clay bricks. No special tools, adhesives, or handling procedures are required. The prefabricated filling avoids any additional on-site work and ensures consistent quality. The product is compatible with existing wall construction practices and can be combined with standard mortars, thin-bed adhesives, or dry-stacking systems.

2.4.2.1 Performance characteristics

PCM (phase-change material) capsules are small, sealed capsules filled with a salt-based solution. At or below room temperature, the material remains in a solid, crystalline state. Once a defined activation temperature slightly above room temperature is reached, the PCM undergoes a phase transition and liquefies, absorbing a substantial amount of thermal energy in the process. As the ambient temperature decreases, the stored heat is gradually released, thereby mitigating rapid indoor temperature drops and contributing to a more stable thermal environment. The integration of PCM capsules is therefore expected to significantly enhance the thermal storage capacity of the building envelope. This supports passive temperature regulation, reduces temperature fluctuations, and contributes to improved overall energy efficiency and thermal comfort in buildings.

The PCM can be selected for different locations and regions and the prevailing temperatures there. Commercial PCMs are readily available with an energy absorption at phase transition of approx. 180 kJ/kg over a temperature range of 19–30°C.

However, final experimental validation based on full-scale measurements of PCM-filled bricks integrated in the EOTA wall assembly is still pending.

The brick maintains the same mechanical strength, dimensional accuracy, and durability as conventional mineral-wool-filled products. Fire resistance, acoustic insulation, and moisture regulation remain within the range of existing clay-brick systems.

2.4.3 Next steps and possible improvement planned

At this stage, the thermal performance measurements of the PCM-filled bricks are still ongoing, and the behavior of a complete wall system incorporating such bricks has not yet been validated. One of the main uncertainties concerns the activation temperature of the PCM capsules, which must be aligned with realistic indoor temperature ranges. If the melting point within the bricks is too high, the PCM might not be activated under typical building conditions, reducing the expected benefit.
From a manufacturing perspective, the filling process was carried out manually during the development phase, and both the upper and lower openings were sealed to prevent material loss. For future application, this process will need to be automated or semi-automated to ensure reproducibility and economic feasibility.
Further optimization will depend on the measured performance results. The PCM capsules are more expensive than mineral wool, so their use will only be justified if they demonstrate a clearly measurable and significant improvement in energy efficiency or comfort compared to the standard mineral wool filling. Cost-benefit analysis and scalability assessment will therefore be part of the next development phase in case of beneficial test results.

2.5 *High-performance insulating render*

2.5.1 Description of the product

The high-performance insulating render was manufactured in the technical pilot plant. Production and subsequent testing were conducted at Sievert's facilities in Karlstadt, Bavaria.
The initial step involved evaluating whether the dry-mix process was suitable for producing the insulating render. In the second step, a spraying machine was employed to mix the render and apply it to brick substrates, serving as an application test.
For the render formulation, various types of lightweight aggregates were incorporated to balance economic considerations with the technical requirements of the project. The objective was to develop an optimized product that combines minimal raw material costs with the lowest possible thermal conductivity (λ-value).

The high-performance insulation render was mixed with raw materials previously identified and selected in project phases M12-M18. In addition, a biomineral-silica aerogel in combination with a confectioned silica aerogel was evaluated (see figure). The biomineral-silica aerogel consists of an inorganic silica (75%) and a biopolymer (25%). It is currently still in the development stage and only available for pilot-scale research projects.



a b

a) biomineral-silica aerogel b) conventional silica aerogel

Figure 1: Different types of aerogel

The most promising materials for the insulating plaster were selected and tested.

2.5.2 Application process

The application process for thermal insulation render in the EASI ZER0 project begins with a careful inspection and preparation of the substrate, which must be solid, load-bearing, clean, frost-free, and dry. Loose surface layers or dust must be removed. As spraying machine, a PFT G4 with snail sheath and a spiral for insulating plaster was used. The render was sprayed on a water-absorbent brick masonry as substrate.
The fresh render showed excellent stability and very good processing properties (see figure 2). Up to 3 cm layer thickness could be applied per layer.



a b c

a) Spraying of the render b) processing c) applied plaster

Figure 2: Mortar application to test walls by using spraying machine

After application, the render is levelled (see Figure 2b) to achieve the required surface finish. Subsequently, a mesh reinforcement layer is incorporated to provide additional structural stability, as thermal insulation renders exhibit low mechanical strength due to their specific composition. Finally, a top coat is applied. This multilayer configuration, combined with precise application techniques, ensures optimal thermal insulation, mechanical integrity, and long-term durability of the façade system.

2.5.3 Performance characteristics

The most important characteristics of the high-performance insulating render are summarized in the table below.

Table 5: Characteristics of the render

Characteristic	Product Standard	Target in EASI ZERo	Achieved to date in EASI ZERo	Unit
Thermal conductivity λ	EN 1745	<=0.034	yes	W/(m.K)
Reaction to fire class	EN 13501-1	A1	A2 (7.9 % organic content)	-
Capillary water absorption after 90 min	EN 1015-18 998-1	<=0.4	yes	kg/(m²·min$^{0.5}$)
Water vapor permeability	EN 1015-19 998-1	<=15 µ	yes	-

2.5.4 Next steps and possible improvement planned

Next steps

After the EASI ZERo project, Sievert plans to launch the thermal insulation render on the market with small modifications to the product formula and to continue cooperating with the aerogel start-up. Furthermore, the price performance of aerogel must be adjusted. Integrating the new thermal insulation render into existing construction methods and minimizing CO_2 emissions throughout the life cycle of building materials are key goals for the future, which also support climate targets in the construction sector.

Opportunities for improvement

In the future, even more biopolymers could be used, which would have a positive effect on environmental sustainability. The fire reaction class must be taken into account here, whether it is A1 or A2. Furthermore, the formula could be adapted in the future by replacing the cement with alternative binders or lower-CO_2 alternatives such as paper ash. In addition, recycled perlite could be used, which would have an impact on the sustainability of the render.

2.6 *VOC Removal paint*

2.6.1 Description of the product

Naturevic Pure Air is a bio-based interior wall paint based on recycled polymers and bio-based additives. All its components have been selected with a very low or near zero VOC content reducing the VOC emissions and odour. The paint has indoor air pollutant elimination capacity, especially formaldehyde to fulfil indoor decontamination properties not requiring UV light. Accomplishes Ecolabel criteria and main European certifications for its use. It shows a high coverage achieving class 2 according to EN13300 and good washability. Easy application with no sagging nor spattering problems. Finish in matt white colour. Other colours reproducible with the Decor System Color. Nature Pure Air can be applied on plaster, plasterboard, painted walls, render and mycelium panel. Packaging made of 100% recycled material.

2.6.2 Application process

It can be applied by means roller, brush and airless. Application does not differ from a standard interior wall paint.
Stir well in the container manually or with a low-speed agitator. The surfaces to be painted must be clean, dry and consistent. On surfaces in good condition, it is recommended to apply a first coat diluted with 10% water with a second coat that can be diluted with 5-10% water. On surfaces in poor condition, it is recommended to sanitize all affected areas, removing all material that is not well adhered and is not consistent, cleaning all dirt and dust that may be present. Let dry the surface. Apply a first coat diluted with 10% water, let dry and apply a second 5% diluted coat. Minimum drying time between coats is 4-6 hours.

2.6.3 Performance characteristics

The most important characteristics of Naturevic Pure Air paint are:

- Wet scrub resistance: class 2 (ISO 11998)
- Matt finish, gloss <10 (ISO 2813).
- Opacity: class 2 (ISO 6504-3).
- High water vapour permeability, s_d <0,14 m (s_d=0,04 m) measured according to ISO 7783-2.
- Fire resistance test according to Euroclasses (EN 13501-1:2018): determination in process.
- VOC removal test (ISO 16000-23): determination in process.
- (VOC, SVOC) in indoor (emission) (EN 16402): determination in process.

- Determination of volatile organic compounds (VOC) and/or semi volatile organic compounds (SVOC) content (ISO 11890-2): determination in process.
- Ecolabel criteria accomplishment: processing with the administration in progress

2.6.4 Next steps and possible improvement planned

Further optimization will depend on the results of formaldehyde removal test. If the efficiency is not enough it could be enhanced by increasing the dosage of the VOC removal additives. Thermal insulation properties have been already studied by reformulation and addition of hollow glass microspheres. However, so far in all the formulations studied, the main handicap is the fact that it does not reach a minimum spreading rate of 8 m²/l for an opacity of 98% determined according to ISO 6504, which is a requirement in Ecolabel Criteria. The addition of hollow microspheres increases the price and negatively affects opacity and wet scrub resistance. Further tests are still going out but it must be considered pros and cons as Ecolabel is an important green certification, as well as the price, in front of the thermal comfort which can be achieved with a material with such a low thickness in comparison with the whole system (wall).

2.7 *High energy efficient windows with insulated blind box and BIO-PUR window frames*

2.7.1 Description of the product

BIO-PUR window frames are a high-density bio-based PUR framing solution designed for highly energy-efficient buildings, offering improved thermal, acoustic and moisture-barrier performance and enabling reduced thermal bridging. The system supports multiple opening types and integrates high-performance hardware and glazing solutions. When combined with an insulated concealed blind box installed within the wall/ceiling build-up above the window, the assembly delivers improved comfort, clean architectural detailing, and enhanced energy performance through shading and an additional insulating layer at the glazing plane provides insulation continuity and airtightness at the window head.

Waterbased BioPUR paints were prepared by LEITAT to be applied on BioPUR window frames. A waterbased polyurethane dispersion with 50% of biobased content, biobased additives and VOC free additives were employed to formulate BioPUR paints, contributing to greater sustainability of the final paint. The paint properties and characteristics have been classified according to UNE-EN 1062, achieving the Class 1 in wet scrub resistance (ISO 11998:2006) and Class W2 impermeable category in liquid water permeability (ISO 1062-3:2008). 1 kg of BioPUR paint was successfully prepared in laboratory by LEITAT. The scale-up of the paint was realized in MVIC installations.

2.7.2 Application process

The bioPUR window application process begins with the correct specification of the window frame and glazing according to the project's thermal, acoustic, and airtightness requirements. Windows are manufactured and pre-assembled off-site and installed on site within the insulated layer of the façade to minimize thermal bridging. The frame is mechanically fixed, levelled, and sealed using a continuous airtight, insulated, and weather-resistant sealing concept around the perimeter. The insulated blind box is then integrated into the wall or ceiling build-up above the window, ensuring continuity of insulation and airtightness at the window head and around the access panel. Finally, the glazing and blind system are commissioned, joints are checked for air and moisture tightness, and the installation is inspected to ensure long-term energy efficiency, comfort, and durability.

BioPUR paint have been applied properly on the BioPUR foams and window frames, presenting a good applicability by spray application achieving with high opacity and good adhesion. The scale-up process of BioPUR paint in MVIC installations have been realized in 3 stages:

1. Optimization of dispersion stage with cowless: additives + pigments
2. Grinding stage. Hegman fineness ≥7
3. Let down stage: addition of the resin and final additives.

After the scale up process, BioPUR paint has been obtained with a good dispersion characteristic. The applicability has been carried out by spray, presenting a good and homogeneous applicability of the BioPUR paint.



Figure 3: Grinding stage of BioPUR paint

2.7.3 Performance characteristics

The performance characteristics for high energy-efficient bio-based windows were evaluated and the test standards and the results are depicted in the table below.

Table 6: The performance characteristics for bio-based window.

Property	Test Standard	Results
Thermal transmittance	UNE-EN ISO 10077-1	On going

Air permeability	UNE-EN 1026	Class 4 (UNE-EN 12207:2017)
Water tightness	UNE-EN 1027, test method A	Class 9A (UNE-EN 12208:2000)
Wind load resistance	UNE-EN 12211	Class C1, Class A2 (UNE-EN 12210:2017)
Static torsion resistance	UNE-EN 13115:2021	Class 4, 350N
Air borne sound insulation	UNE-EN ISO 10140-2:2022.	Sound reduction 40 (-2; -6) dB
Burglary security	EN 1628, EN 1629, EN 1630	RC2

2.7.4 Next steps and possible improvement planned

Bio-based window frames can be improved by enhancing their mechanical strength, durability, and thermal performance through optimized bio-composite formulations, improved bio-based resins, and protective surface coatings that increase resistance to moisture, UV exposure, and weathering. From a sustainability perspective, higher renewable content, the use of locally sourced natural fibers or wood by-products, and design for disassembly can significantly reduce environmental impacts while enabling better recyclability and biogenic carbon storage. From a process and cost point of view, adapting bio-based materials to existing manufacturing processes, reducing cycle times with faster-curing resins, and using low-cost bio-fillers or standardized profiles can improve scalability and make bio-based window frames more cost-competitive with conventional alternatives.

2.8 *Integration of PV-specific components on roofs and facades*

2.8.1 Description of the product

One PV-specific component is a made of specific PV module 1.5 meter long and 0.4 meter wide. The module is fixed to an aluminum substrate.
A second system uses standard PV modules from the market. The PV module is typically 1.134 m x 1.750 mm². For aesthetic reason, unframed modules are preferred. Colored modules is an option.

2.8.2 Application process

For the specific module, the aluminum substrate will be fastened onto an aluminum railing system fixed to the façade.
For the standard module, a specific component is used to fasten the unframed module onto the railing.
This aluminum railing will be fastened to the main wall under the external insulation layer.
The PV modules are electrically connected in series and connected to an inverter.

2.8.3 Performance characteristics

The PV-specific module is a rated at 100 Wp, what is 170 Wp/m².
The standard PV module is typically rated at 470 Wp, what is 235 Wp/m².

2.8.4 Next steps and possible improvement planned

Next work is on development of a (nearly) standard fastening solution of large (2 m²) PV modules to façade. The system will require pre-installation of a wood or aluminum railing structure onto the façade before addition of external thermal insulation. The system should include a way to balance the weight of PV modules when thick external thermal insulation offsets the PV module by >150 mm in cantilever.

3. Conclusion

This deliverable presented the EASI ZERo portfolio including for each product a description, their application process, their performance characteristics and the next steps and possible improvement planned