D5.13 - Envelope components for on-field demonstration I

Funded by
the European Union

Deliverable Information Sheet

Version	1.0
Grant Agreement Number	101079957
Project Acronym	RESKIN
Project Title	Renewable and Environmental-Sustainable Kit for building Integration
Project Call	HORIZON-CL5-2021-D4-02-02
Project Duration	42
Deliverable Number	D5.13
Contractual Delivery Date	31/07/2023
Actual Delivery Date	31/07/2023
Deliverable Title	Envelope components for on-field demonstration I
Deliverable Type	DEM
Deliverable Dissemination Level	PU
Work Package	5
Lead Partner	GAR
Authors	S. García, J. García, A. Llamas, R. Menor, F. Gabaldón, A. Saráchaga (GAR)
Contributing Partners	ZH
Reviewers	Ludovico Maestri (ZH), Niccolò Aste (POLIMI)

History of changes

Version	Date	Comments	Main Authors
0.1	07/07/2023	First draft, establishing document structure	S. García, J. García, A. Llamas, R. Menor, F. Gabaldón, A. Saráchaga (GAR)
0.2	13/07/2023	First version, incorporating input from all participants	S. García, J. García, A. Llamas, R. Menor, F. Gabaldón, A. Saráchaga (GAR)
0.3	18/07/2023	Quality review	Ludovico Maestri (ZH), Niccolò Aste (POLIMI)
1.0	24/07/2023	Final version addressing all further comments	S. García, J. García, A. Llamas, R. Menor, F. Gabaldón, A. Saráchaga (GAR)

Table of Contents

List of Figures

Disclaimer

1. Executive summary

This document provides an overview of the RE-SKIN envelope components designed for on-field demonstration, highlighting their manufacturing status and intended deployment.

The technological components concerned are intended for the cladding, insulation and waterproofing of façades and pitched roofs, while providing at the same time ventilation of the cavity within the stratification.

The components are currently at various stages of production and will be dispatched to the first-case study building in Milan once the manufacturing process is completed.

In particular, at this stage a comprehensive analysis has been conducted to seamlessly integrate the multifunctional façade cladding with other building elements. Different solutions are being developed to allow the integration of envelope technologies with RE-SKIN components and existing building elements. The system concept has been enhanced to accommodate the integration of wiring, pipes, vents, and sensors, enabling a holistic approach to the building's envelope design.

2. Multifunctional façade cladding

The multifunctional façade, developed as a subcomponent of the RE-SKIN project, improves upon the precast façade system from the previous H2020 HEART project, which constitutes the methodological and technological background of this project. It consists of self-supporting sandwich panels and a substructure, designed to enhance energy performance and reduce environmental impact. The system incorporates recycled, recyclable, reusable, and biosourced materials. Innovative biosourced PUR foam replaces conventional thermal insulation foam, while sustainable steel (i.e., containing a large proportion of recycled material) replaces standard metallic sheet coating. The use of recycled aluminium profiles and optimised assembly processes further contribute to a sustainable and cost-effective solution. Note that all metal parts are further recyclable, and that panels and profiles are also potentially reusable.

Throughout the assessment of the façade implementation on the Milan demo case study, a preliminary design layout has been generated. However, it is essential to develop prototypes and conduct tests on the new and modified solutions. These tests are crucial for the comprehensive evaluation of the product's technical performance and to ensure compliance with the required standards and regulations.

The completion of the manufacturing process for the façade sandwich panel is still pending as of the seventh month of the project.

The multifunctional façade system is comprised of different components:

Substructure	Cover	Insulation	Auxiliary

• Brackets
• Fixings
• Profiles
• Clamps
	• Metallic insulation panel
	• Aluminium composite panel
	• Finishing metallic sheet
	  ▪ Corners
	  ▪ Windows (jambs, lintels, windowsills)
	  ▪ Doors (jambs, lintels)
		• BioPUR
		  ▪ Panels
		  ▪ Jambs
		  ▪ Lintels
		  ▪ Windowsills
			• Sealing
			• Rubber strip
			• Coupling ducts system
			• Ventilation grilles

2.1. Façade system components

2.1.1. Substructure

RE-SKIN's multifunctional façade system is composed of a mounting structure to apply protective, insulating and waterproofing sandwich panels onto the existing façade.

A preliminary study of the substructure has been carried out. At the time of writing this report, sandwich panels are pending to be manufactured.

The panels are applied to the existing walls using structural profiles and secured in place using self-drilling screws to the supporting brackets, anchored to the façade walls using mechanical fixings and plugs.

The substructure of the installation system for the panels consists of various supporting elements, including brackets, profiles, splices, and fixings.

Brackets

Various brackets with different shapes will be manufactured, taking into account the specific connection type and span length requirements. Prototyping, testing, and adjustment phases will be performed prior shipping to the demo case. The panel connections involve the use of a bracket, an adjustable profile for clipped junctions, and an upright profile.

Figure 1. L-shaped Bracket.

Figure 2. U-shaped bracket for horizontal connection.

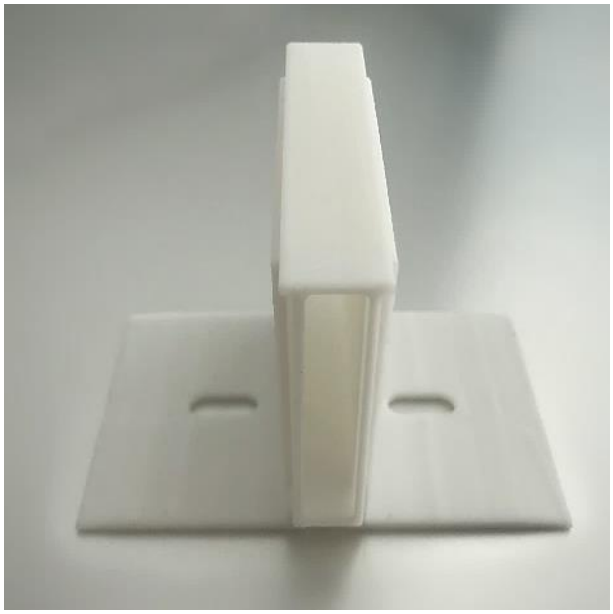

Figure 3. Upright profile for clipped junction.

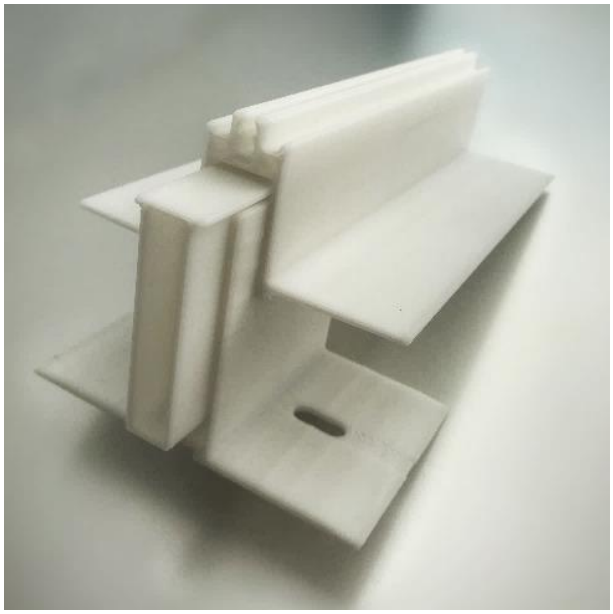

Figure 4. Panel lateral connection.

Profiles

The substructure profiles will be prototyped according to the chosen panel thickness.

Regarding the vertical aluminium profiles to be used in the vertical panel-to-panel connection, a special extrusion die will be created to subsequently manufacture the profiles with recycled aluminium. Once the prototypes are obtained, different tests will be carried out to adjust and correct errors.

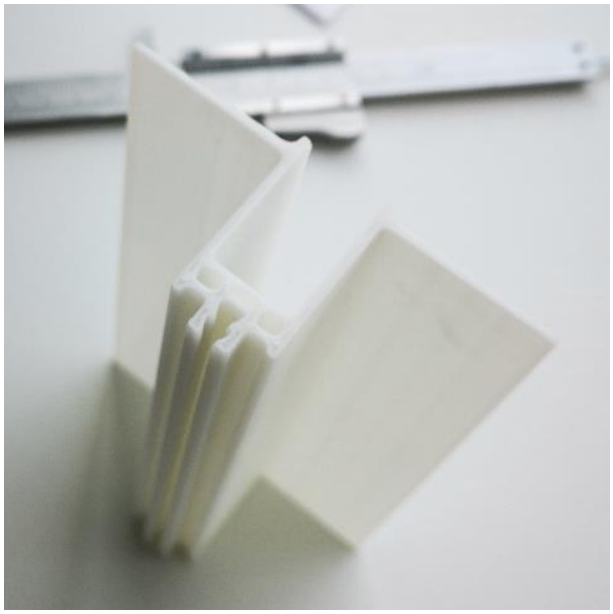

Figure 5. Upright Profile for panel-to-panel connection.

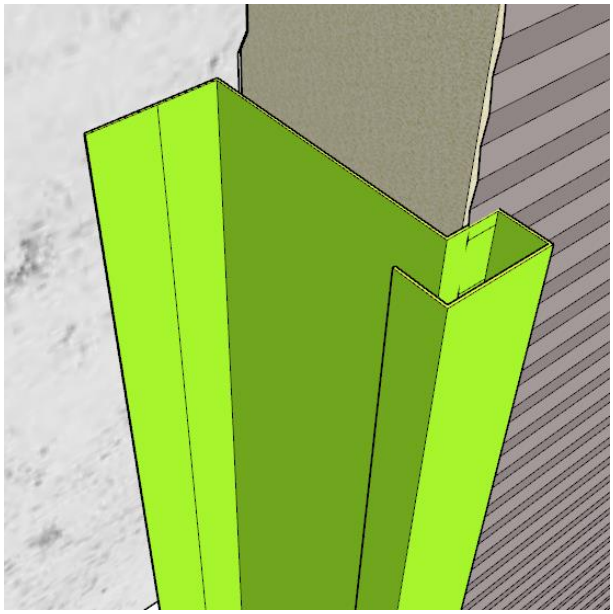

Figure 6. Upright Profile on splice joint for plumbing.

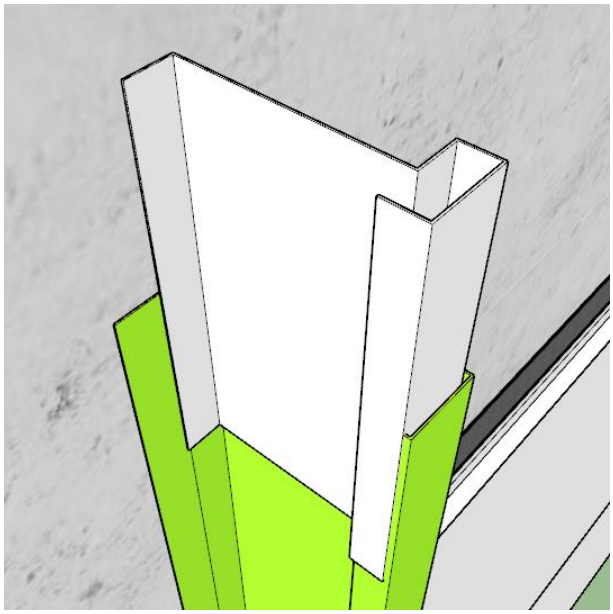

Figure 7. Connection for vertical profiles.

Figure 8. Horizontal starting profile of the system.

Fixing elements

The fixing elements encompass various types of screws, both interior and exterior spacers, and pop rivets.

Figure 9. Self-tapping sheet metal screw.

Figure 10. HILTI HRD or similar fastening screw with insulated plastic anchor.

Figure 11. Interior spacer.

Figure 12. Exterior spacer.

2.1.2. Sandwich panels

As outlined in deliverable D5.1 - *Manufacturing design of the multifunctional façade cladding I*, the sandwich panels comprise a Greencoat sustainable steel outer layer sourced from SSAB, a bio-sourced polyurethane (BioPUR) foam core from partner INDRES, and an inner sustainable steel layer. The panels are foreseen to be interconnected through a tongue-and-groove joint and subsequently affixed to the existing wall through the substructure.

At present, we are unable to provide specific dimensions for the panels as this information can only be obtained from the panel manufacturer. The selection of the manufacturer by partner INDRES is currently pending. However, a provisional height dimension of 1100 mm is anticipated. For length, it should not exceed 4000 mm due to expansion issues. Nevertheless, the final panel dimensions are yet to be determined.

Upon obtaining the panels, GAR will undertake the adaptation and prototyping phases. Then, a mock-up of the façade system will be sent to DTI for further testing. The machining process to customise the panels for the Milan demo case will be done after DTI test certification, followed by quality control measures and dispatch.

Outer layer

The outer layer steel coating consists of sustainable steel produced by SSAB. The material thickness for the external layer is 0.6 mm, whereas for the internal layer, it is 0.4 mm. The metallic sheet will also be utilised for the manufacturing and machining of finishing elements such as in correspondence of corners, windows, and doors.

Inner layer

The external finishing layer is made of Greencoat steel. For the inner layer, as it is not exposed to external environmental conditions, manufacturers utilise a primer that ensures galvanic neutrality and adhesion. Essentially, high-quality panels are produced with five coating layers on the exterior and three on the interior. The thickness of the sandwich panel's inner layer is 0.4 mm.

Insulation

The sandwich panel serves a dual purpose, acting as both a thermal insulation element and a protective outer layer in direct contact with the exterior.

The façade panel will incorporate BioPUR foam as an insulation material. BioPUR is a versatile foam that can be applied in various forms for insulation purposes, including spraying, injection, and utilisation as sheets or sandwich panels.

Figure 13. Demo sandwich panels made from BioPUR.

2.1.3. Auxiliary elements

The installation of the system requires additional elements, including silicone sealing and rubber strips for the windows.

Additionally, manual ventilation grilles will also be incorporated to optimise the airflow, enhancing thermal conditions, and enabling drainage in case of condensation within the air gap.

The ventilation flows are being studied to optimise the shape and placement of the grille. Ultimately, it will need to be adapted with some changes based on the final panel configuration.

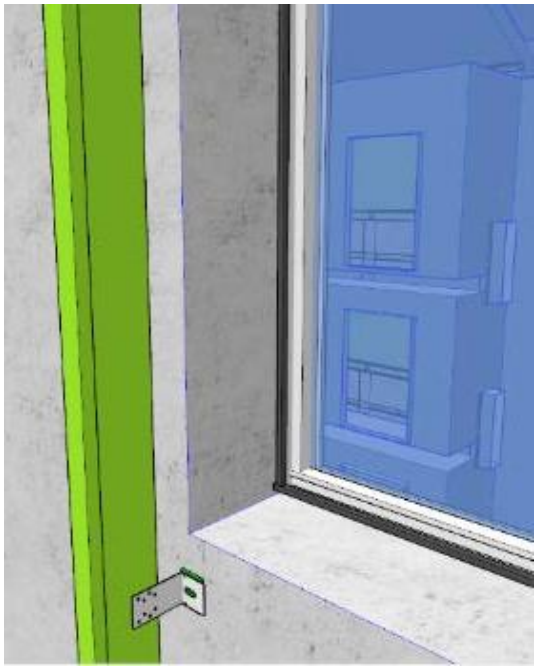

Figure 14. Rubber strip.

Figure 15. Clamp profiles for jambs.

The subsequent table presents a comprehensive inventory, along with their corresponding technical characteristics, of all components constituting the multifunctional façade cladding system, along with the corresponding technical characteristics, based on the concept of the sandwich panel previously mentioned.

The percentage of recycled aluminium to be used in the profiles is pending to be defined with the provider before its manufacture.

1	**Panel**	
item	*Name*	*Description*
1.1	Layer - 1	Greencoat sustainable steel base with protective zinc layer and bio-based colour coating for external layer.
1.2	Layer - 2	100 mm BioPUR insulation. Lambda (λ) 0.03 – 0.08 W/mk.
1.3	Layer - 3	Three-layer of sustainable steel base with protective zinc layer for internal layer.
1.4	Spacers	Tongue and groove spacers. Galvanised steel Z275 of 1 mm, shaped.

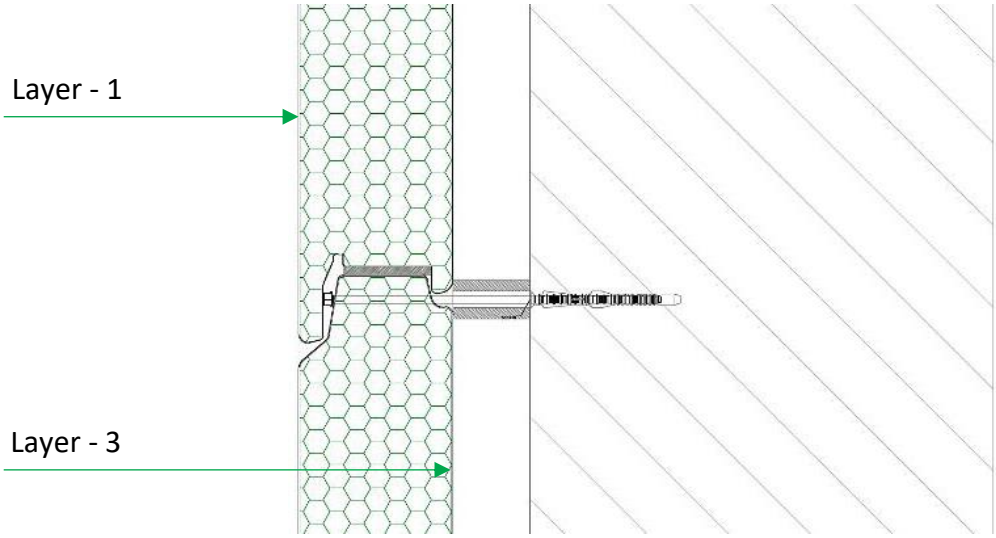

Figure 16. Preliminary sandwich panel design.

2	**Substructure**	
item	*Name*	*Description*
2.1	Upright profile for plumb	Recycled aluminium of 1.5 mm shaped, length on demand.
2.2	Upright profile for junction	Recycled aluminium of 1.5 mm shaped, length on demand.
2.3	Upright profile for clipped junction	Recycled aluminium 6063 2 mm. Length on demand.
2.4	Stop piece for panels	Recycled aluminium of 1.5 mm shaped.
2.5	Starting profiles	Recycled aluminium of 1.5 mm shaped, length on demand.
2.6	Fixings	Galvanised steel screws, M8 and length on demand up to 230 mm.
2.7	Adjustable washer for fixings	Polypropylene
2.8	Underlay of fixing brackets	Polyamide or polyethylene
2.9	Structural pop rivets	Ø4.8 mm. Aluminium or steel, on demand.
2.10	Supporting brackets	Galvanised steel Z275 of 1.5 mm shaped. Length on demand, up to 230 mm.
2.11	Auxiliary brackets	Galvanised steel Z275 of 1.5 mm shaped. Length on demand, up to 230 mm.

2.12	'U' shaped brackets	Recycled aluminium 6063 2 mm. Length on demand, up to 230 mm.
2.13	Draining tray	Galvanised steel Z275 of 1.5 mm shaped. Length on demand, up to 230 mm.
2.14	Draining barrier	Mineral wool
2.15	Snap-caps, plugs and washers	Steel, aluminium, polypropylene, polyamide
2.16	Joints	EDPM, polyamide
2.17	Auxiliary material	Steel, aluminium, polypropylene, polyamide

3	**Finishing trims, covers and sealings**	
item	*Name*	*Description*
3.1	Jambs	Steel base with protective zinc layer and bio-based colour coating.
3.2	Windowsill	Natural anodised aluminium 20-30 microns.
3.3	Lintels	Steel base with protective zinc layer and bio-based colour coating.
3.4	Cover for vertical grooves, panel connection.	Steel base with protective zinc layer and bio-based colour coating.
3.5	Clamp receiver-regulator	Steel base with protective zinc layer and bio-based colour coating.
3.6	Finishing trim at start	Steel base with protective zinc layer and bio-based colour coating.
3.7	Finishing trim at sides	Steel base with protective zinc layer and bio-based colour coating.
3.8	Finishing trim at corners	Steel base with protective zinc layer and bio-based colour coating.
3.9	Finishing trim at top	Steel base with protective zinc layer and bio-based colour coating.
3.10	Auxiliary supports	Aluminium 6063 1.8 mm, length on demand up to 120 mm.
3.11	Fixings	Screws with striking system. Galvanised steel, M (Metric) Ø5.5 mm x 65 mm and polyamide anchor.
3.12	Structural pop rivets	Ø4.8 mm. Aluminium or steel, on demand.
3.13	Neutral silicone	Silicone sealing, neutral type, high range.

3.14	Structural silicone	Silicone of structural joints, high range.

4	**Auxiliary**	
item	*Name*	*Description*
4.1	Supporting ducts strip	Supporting strip with clips for ducts of various installation. Z275 galvanised steel.
4.2	Holder	Supports for auxiliary installations and probes. Galvanised steel or aluminium.
4.3	Ventilation extensions	Aluminium, polypropylene, polyethylene.
4.4	Ventilation grille	Under study for optimisation. Ventilation flows being analysed to optimise grille shape and placement. Adaptations required based on final panel configuration.

2.2. Fire reaction

The system consists of the aforementioned elements, primarily sandwich panels and a substructure. The substructure components, such as profiles and brackets, are predominantly manufactured from steel or aluminium. Both steel and aluminium materials are classified as A1 (EN 13501-1) in terms of fire reaction, indicating their non-flammability and lack of contribution to fire.

Certain construction solutions and connections have been enhanced to expedite installation and align with RE-SKIN requirements. However, there is no variation in the material composition of the elements, with steel or aluminium being the sole constituents.

2.3. Façade aesthetics

As previously explained, the outer layer consists of Greencoat sustainable steel manufactured by SSAB. The colour choices available are limited to those indicated in the accompanying chart. It is essential to bear in mind that placing an order usually entails meeting a minimum quantity requirement, which should be taken into consideration while drafting the proposal.

Figure 17. Selection of colours for the outer layer.

In order to achieve an ideal balance between architectural aesthetics and energy optimisation, POLIMI and GAR will collaborate to meticulously select appropriate palette and colour combination according with the specific aesthetic-architectural requirements and the context of the 4 case studies. This design process will take into account the desired architectural appearance as well as the objective of energy efficiency.

2.4. Panel distribution

The preliminary façade layout for the Milan demo building is available in the Annex.

The provided drawings present a preliminary panel distribution layout for installation on the façade. However, it is important to note that this distribution is subject to modification once the panel manufacturer, selected by INDRES, determines the precise measurements and characteristics of the manufactured panel. Ongoing discussions with ZH and POLIMI will play a role in shaping the final distribution, seeking an optimised façade installation that not only meets functional requirements

but also carries architectural significance. Additionally, the input of the building's owner and users will be sought, ensuring their perspectives are considered during the decision-making process.

3. BIPVT roofing system

As outlined in deliverable D5.9 *Manufacturing design of the BIPVT roof system I*, the BIPVT (Building Integrated Photovoltaic-Thermal) system has been conceived for seamless installation on various types of sloped roofs. This involves overlapping the pre-existing roof structure and replacing the external covering, waterproofing, and insulation layers.

The system's modular matrix structure is designed to accommodate various types of refurbished PV modules. Recycled aluminium profiles serve as the building interface structure, housing and fixing the PV modules to the existing slab or roof framework. Positioned beneath the PV panels are bio-polyurethane foam-filled sheet metal panels that increase radiant heat absorption and provide thermal insulation, water tightness, and airtightness to the building's roof. An air gap is formed between the PV panels and the insulation panels. The airflow within this gap can be generated through forced-flow or natural convection, contributing to an improved electrical conversion efficiency, due to the lowering of the cells' operating temperature. In warm seasons, the ventilation also removes part of the heat load from the roof.

3.1. System components

The BIPVT system consists of the following components/sections:

1. Recycled aluminium mullion profiles.
2. Refurbished PV modules.
3. Air gap.
4. BioPUR thermal insulation panels.
5. Joining, sealing, and fixing elements
6. Thermal break insulation between the Recycled aluminium mullion profile and the existing roof structure.

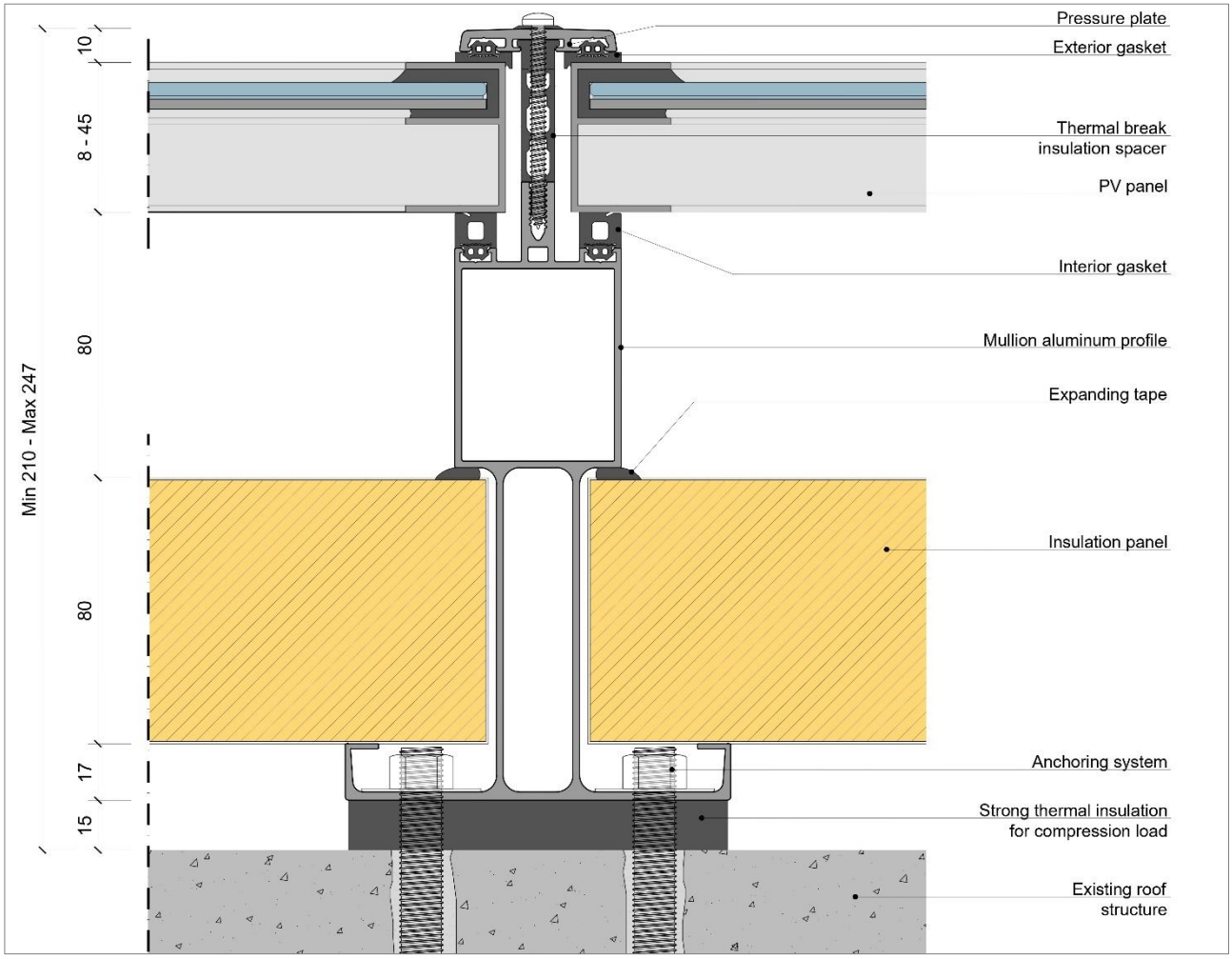

Figure 18. Cross-section of the system with insulation panel.

3.1.1. Aluminium profile

The system incorporates recycled aluminium special profiles that serve both as support and as building-interface structure. These profiles house the PV modules, similar to curtain wall glass façades, while also providing protective enclosure for the electrical wiring. The profiles are designed with a cup-shaped cross-section as a single extruded piece, enabling module placement in the upper part, installation of insulating panels at the base, and an intermediate ventilated air gap. The versatile configuration of the profiles can accommodate different PV module types, allowing adjustments in width spacing, length and thickness. For fastening, various elements are employed based on the underlying structure, including self-tapping screws for wood, chemical dowels for concrete, and nuts and bolts for steel frames. Further research will explore solutions tailored to specific case study applications.

NOTE: the shape and size of the aluminium roof profile is in the prototyping phase and some dimensions may vary.

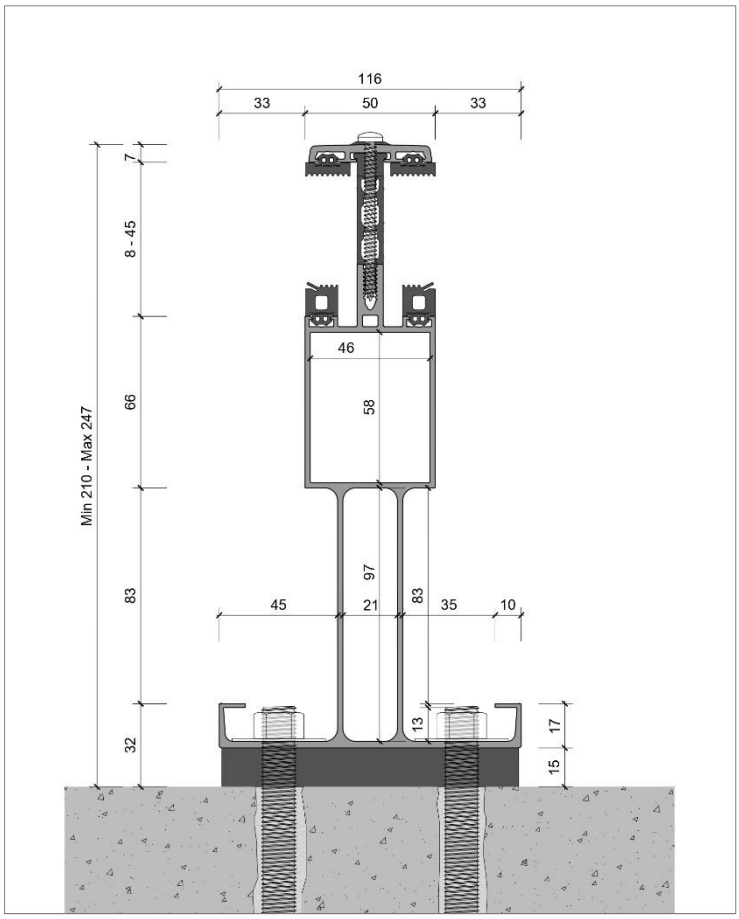

Figure 19. Cross-section of aluminium profile.

3.1.2. PV module

Following the circular economy approach of the RE-SKIN project, refurbished photovoltaic modules will be used. Due to the nature of reusing components, specific standard products cannot be defined. Generally, glass-tedlar laminates with mono- or polycrystalline cells and anodised aluminium perimeter frames will be employed. Commonly available PV module sizes on the market today are referred to, such as approximately 165 cm by 100 cm for residential installations and 195 cm by 100 cm for commercial applications. The module depth typically ranges from 8mm (for glass-glass PV laminate) to 45mm, with a deeper frame providing better structural stability. Weight also varies, with residential panels weighing around 18 kg and larger commercial panels about 22 kg. Prior to installation, a structural analysis is essential to assess roof capacity to support the additional weight of the PV system and its components. The BIPVT system can accommodate virtually any type of commercial module, with smaller sizes offering greater flexibility for rooftop installation.

3.1.3. Thermal insulation panel

The thermal insulation panel will consist of a sandwich comprising a biosourced polyurethane (BioPUR) foam core and an outer layer made of sustainable steel. The panel's thickness is 80mm to meet the specific thermal insulation needs, and the width between profiles can be adjusted to match the dimensions of the PV modules used. Placed into the grooves located at the base of the profiles, these panels are joined together through tongue-and-groove connections, ensuring effective waterproofing and insulation continuity. The option of further protecting the joint with a sealing tape will be considered in the testing phase.

3.1.4. Ventilation complementary components

In order to allow ventilation of the air gap, to recover warm air for thermal purposes and to protect the roof from infiltration and intrusion, a specific air intake and recovery system will be developed.

Air intake grilles from outside at the eaves line and extraction channels at the ridge are currently being studied. The Milan case study will be the test bed for the development of the related technological solutions.

4. Annex


P SIDE
P UNION
T 100x60 SFF
T 80x60
L 40x60
L 40x40
MFT - S (móvil)
MFT - L (Fijo)
MFT - S (Fijo)
FV - Montante Hz doble
FV - Montante Hz
Listado de materiales y equipos
SA101
Project | Proyecto
RESKIN
Milano Demo Case
Location | Situación
MILANO
Promotor
RESKIN
Drawing | Plano
Previous layout
Garciarama