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RE-SKIN

D5.14 - Envelope components for on-field demonstration II

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History of changes

Version	Date	Comments	Main Authors
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1.0	22/02/2024	Final version addressing all further comments	A. Llamas, A. Saráchaga (GAR)

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Disclaimer

1. Executive summary

This document provides an overview of the RE-SKIN envelope components designed for on-field demonstration, detailing their manufacturing status and intended deployment. The content presented in this document represents an advancement from the content found in D5.13 Envelope components for on-field demonstration I.

The technological components described in this deliverable are designed for the cladding, insulation and waterproofing of façades and pitched roofs, while also providing ventilation of the cavity.

After conducting a thorough analysis, efforts are underway to integrate the multifunctional façade cladding and BIPVT roof with other building components. 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 facilitate the integration of wiring, pipes, vents, and sensors. This design also incorporates an adaptable sealed chamber that can be opened in warmer seasons to facilitate air circulation, preventing moisture and heat buildup, or closed to maintain the building's internal temperature. This innovative approach creates a holistic building envelope design that optimises hygrothermal performance.

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.

Two additional versions of this report are scheduled for release in months 21 and 29, respectively. These subsequent deliverables will incorporate further specifications and/or modifications based on the project's progress.

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 detailed description of the RE-SKIN façade system can be found in deliverable D5.2 '*Manufacturing Design of the Multifunctional Façade Cladding II.'* The system incorporates recycled, recyclable, reusable, and bio-based materials. In the RE-SKIN sandwich panel, innovative bio-based PUR foam replaces conventional thermal insulation foam, while sustainable steel (i.e., containing a large proportion of recycled material) replaces standard metallic sheet coating. Additionally, the use of recycled aluminium substructure profiles and optimised assembly processes further contributes to a sustainable and cost-effective solution compared to a traditional system. Note that all metal parts are further recyclable, and that panels and profiles are also potentially reusable. Additional details regarding the life-cycle assessment of the façade cladding can be found in WP7.

Throughout the assessment of the façade implementation on the Milan demo case study, a preliminary design layout has been generated. 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. This work will be undertaken within WP3, which focuses on ensuring all RE-SKIN components have features guaranteeing long-term reliability and resilience to disruptive events. In particular, testing procedures have been developed in deliverable D3.1 *'Methodology to test the reliability of subsystems I'* to assess the durability of the façade cladding. Furthermore, within WP2, specifically in Task 2.6, an assessment of the system's physical vulnerability to various hazards in its context is currently underway.

The detailed drawings of the façade connections for the Milan demo can be found in Annex 4.2.

The manufacturing of the façade sandwich panel is awaiting the finalisation of the façade layout design and colour selection for the demos. In the current phase, the process involves selecting the steel coils needed for the outer layer to align with the façade's aesthetic requirements, including colour selection and panel layout, and ensuring compatibility with the panel system. Additionally, the steel coils are chosen based on criteria for the appropriate thickness, guaranteeing that any impact does not damage the panels. This also ensures the panels maintain a continuous flat surface, avoiding any bulging or irregular appearance. Simultaneously, the thickness is optimised to avoid increasing the weight of the panels and to facilitate handling during installation.

Prototyping, testing, and adjustment phases will be performed prior shipping to the final demonstration cases.

The multifunctional façade system is comprised of different components:

Substructure	Cover	Insulation	Auxiliary

• Brackets
• Fixings
• Profiles
• Clamps
	• Metallic insulation panel
	• Finishing metallic sheet
	  ▪ Corners
	  ▪ Windows (jambs, lintels, windowsills)
	  ▪ Doors (jambs, lintels)
	  ▪ Eaves
		• BioPUR in sandwich panel
		• BioPUR boards
		  ▪ Panels
		  ▪ Jambs
		  ▪ Lintels
		  ▪ Windowsills
		• PIR sealing
			• Sealing
			• Rubber strip
			• Coupling ducts system
			• Ventilation grilles
			• Adaptable sealed chamber

2.1. Façade system components

2.1.1. Substructure

RE-SKIN's multifunctional façade system is composed of a mounting structure to apply weatherproof, 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.

Before installation, a dynamometric test (Pull-off Test) is carried out to assess the tensile strength of the walls and the load capacity of the fixings. Details of this test methodology can be found in deliverable D5.2 '*Manufacturing Design of the Multifunctional Façade Cladding II*.' The selection of the appropriate anchoring method, either mechanical or chemical, depends on the findings of this test. The dynamometric test will need to be conducted in all demos to validate that the supporting wall has sufficient resistance to install the façade.

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

The substructure is assembled by attaching the supporting brackets to the façade walls using fixings and plugs. Upright profiles are then fixed to the brackets. Finally, the panels are affixed directly to the walls. The profiles serve as a guide to install all the panels.

Brackets

Various brackets with different shapes will be manufactured, considering the specific connection type and span length requirements of the façade panels.

Figure 1. L-shaped aluminium bracket

Figure 2. L-shaped steel bracket

A special connection was developed for the panels to minimise installation time, consisting of a bracket, a profile, and a connecting element as depicted in Figure 3. The vertical profile is connected to the façade using three components: a wall bracket (1), a profile (2), and an auxiliary piece (3). This auxiliary piece serves a dual function: firstly, it facilitates connections with a large chamber (chamber depth > 50 mm) and secondly, it enables vertical profile-to-profile connections. All three components are made using recycled aluminium.

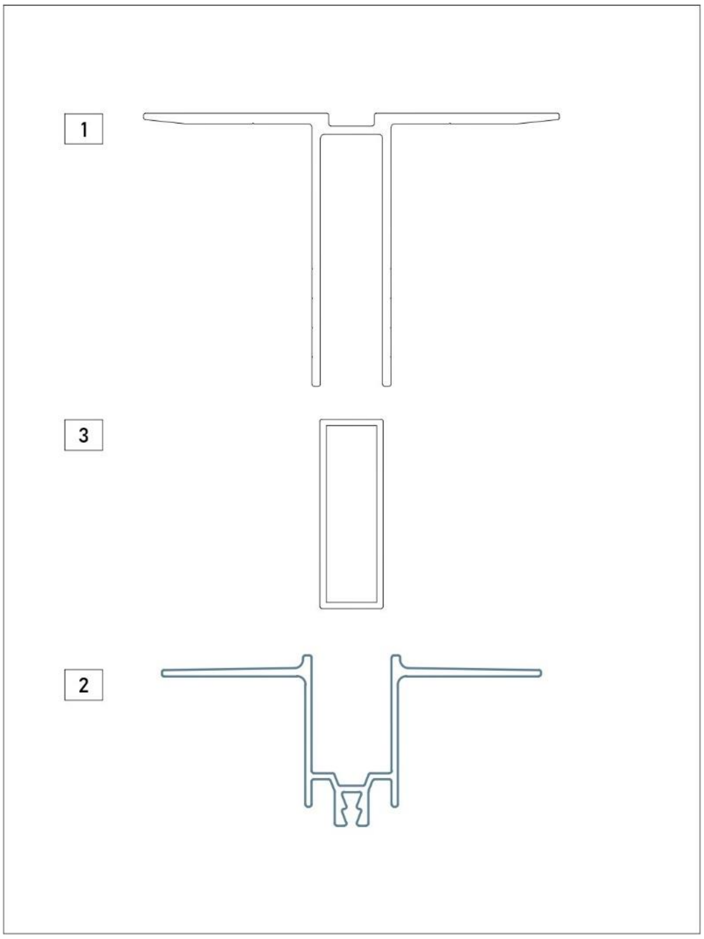


Figure 3. Components for the connection of the vertical profile to the façade [drawing created using AutoCAD]

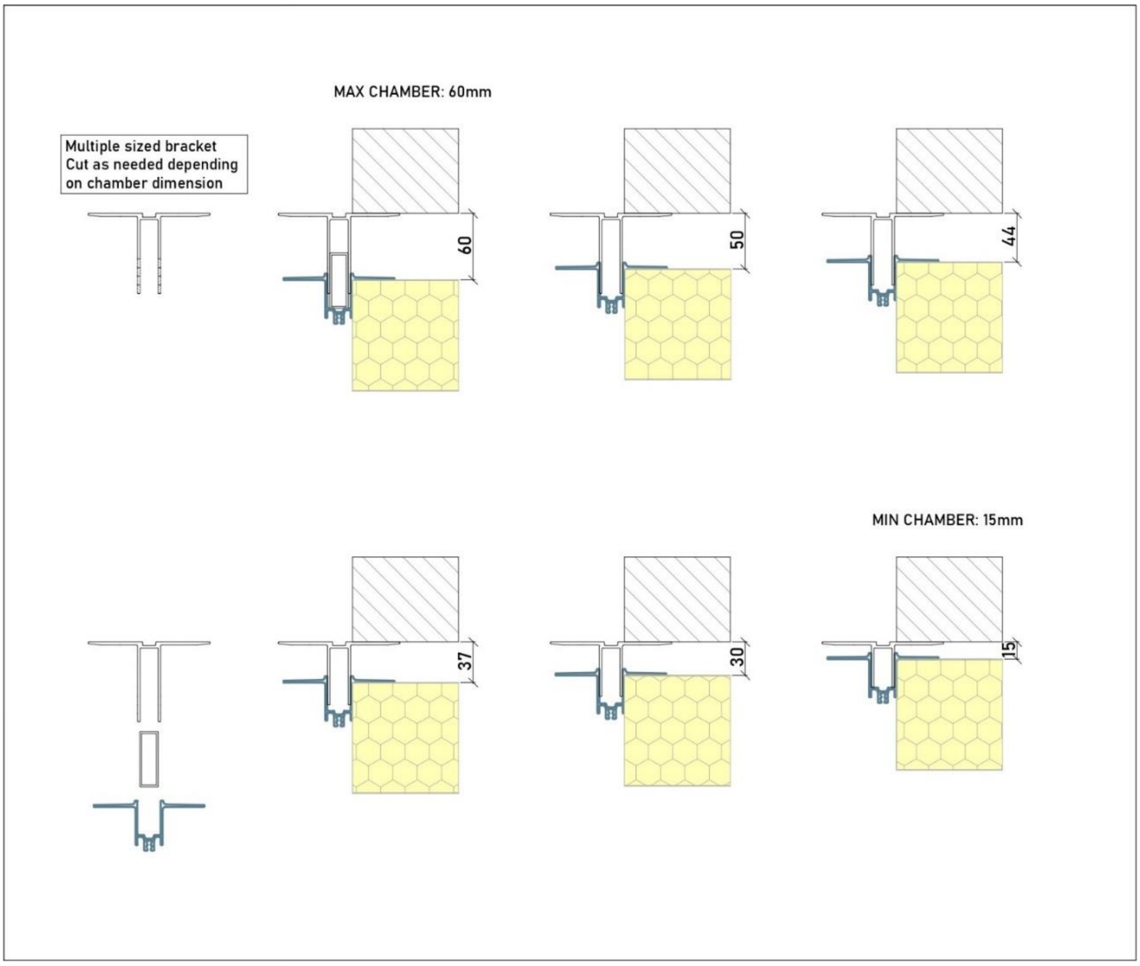


Figure 4. Connection of the vertical profile and bracket adapted to the size of the chamber [drawing created using AutoCAD]

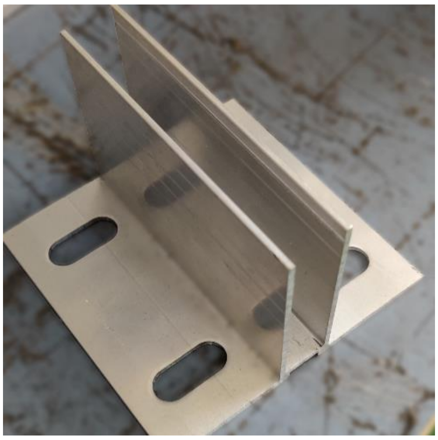


Figure 5. U-shaped bracket for horizontal connection

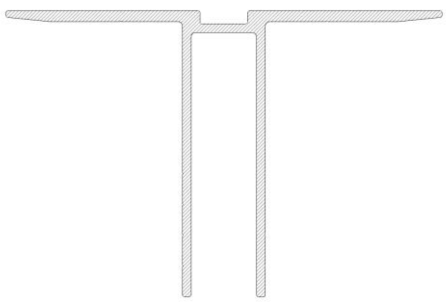


Figure 6. Detail drawing of the façade system's bracket [drawing created using AutoCAD]

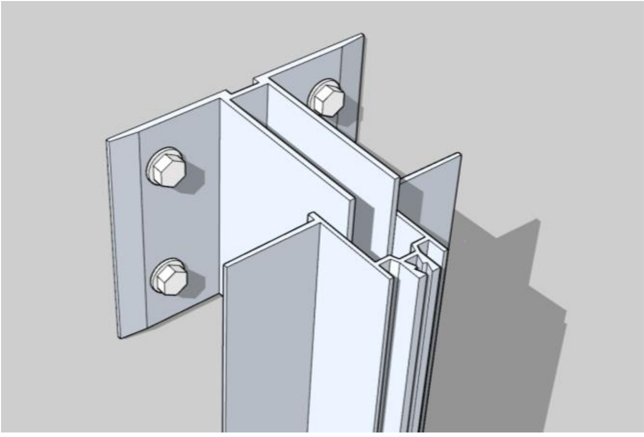


Figure 7. 3D view of the joint connection [drawing created using SketchUp]

When the air gap space exceeds 35 mm, it is necessary to install reinforcement brackets before anchoring the panels. These brackets are available in three sizes: 30 mm, 45 mm, and 65 mm, see Figure 8.

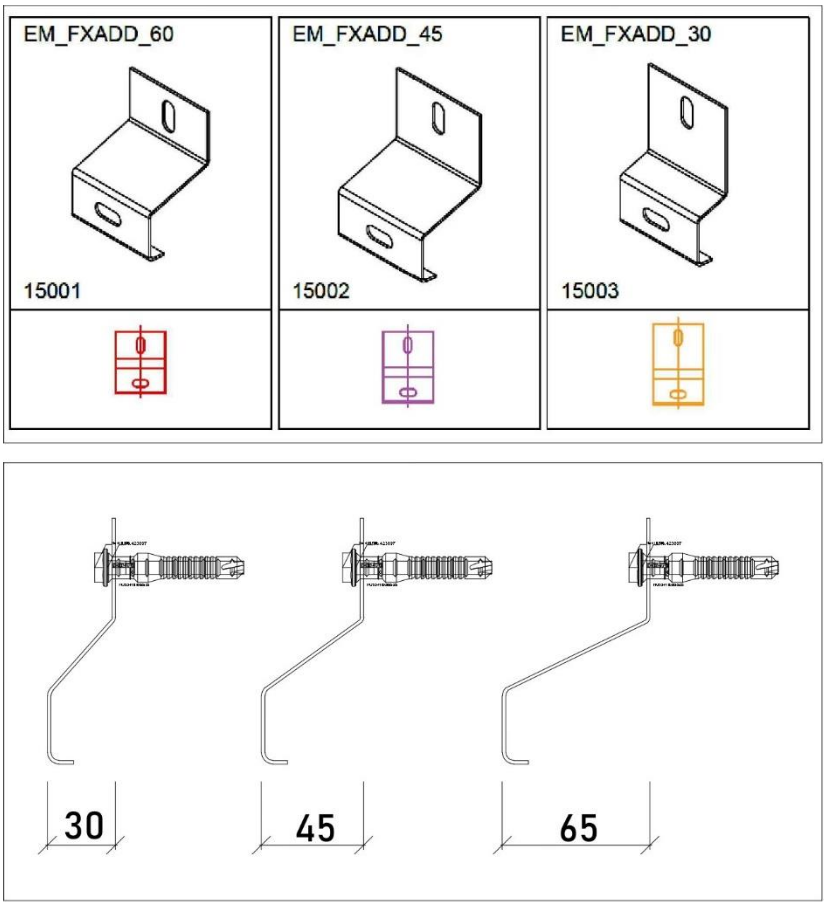


Figure 8. Reinforcement brackets and their various dimensions [drawing created using AutoCAD]

Profiles

The substructure profiles will be manufactured according to the chosen panel thickness. These profiles consist of recycled aluminium with a content rate of 98%.

Figure 9. Upright profile for panel-to-panel connection

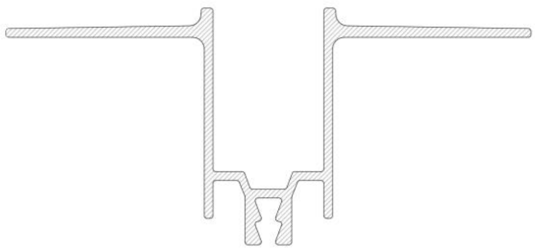


Figure 10. Detail drawing of the façade system's profile [drawing created using AutoCAD]

A dedicated extrusion die was developed to produce vertical aluminium profiles used in the panel-to-panel connection. These profiles are manufactured using recycled aluminium.

Figure 11. Extrusion dies for profile manufacturing as developed by EXLABESA for the RE-SKIN façade system.

Figure 12. Upright Profile for plumbing

Figure 13. Connection for vertical profiles

Figure 14. Horizontal starting profile of the system

Fixing elements

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

Following the results of the dynamometric test (Pull-off Test) referred to in Chapter 2.1.1 of this deliverable, assessing the tensile strength of the walls and load capacity of the fixings, the appropriate anchoring method will be determined. Mechanical anchoring (Fig. 16) is employed if the test determines the supporting walls have satisfactory tensile strength capacity. Alternatively, chemical anchoring is used in cases where the wall's tensile strength is not satisfactory, as it provides a better grip for the screw within the wall.

Chemical anchoring (Fig. 17), as opposed to relying solely on mechanical friction with a conventional plug, involves injecting a strong chemical resin into a specially designed plug positioned within a pre-drilled hole. Subsequently, the screw is inserted, and the resin expands. Once the resin has hardened, it forms a strong bond between the fixture and the substrate, guaranteeing a secure attachment.

Figure 15. Self-tapping metal screw

Figure 16. HILTI HRD or similar fastening screw with insulated plastic anchor

Figure 17. Screw secured using chemical anchoring

Figure 18. Interior spacer

Figure 19. Exterior spacer

2.1.2. Sandwich panels

As outlined in deliverables D5.1 ‘*Manufacturing design of the multifunctional façade cladding I*’ and D5.2 ‘*Manufacturing design of the multifunctional façade cladding II*’, the sandwich panels comprise a GreenCoat sustainable steel outer layer sourced from SSAB, a bio-based polyurethane (BioPUR) foam core from project partner INDRES, and an inner steel layer sourced from SSAB. The panels will be interconnected through a tongue-and-groove joint and subsequently affixed to the existing wall, as outlined in chapter 2.1.1 of this deliverable, which describes the substructure and fixing elements of the façade system.

The manufacturable thickness of the sandwich panel ranges from 60 to 250 mm. Panel thickness will be determined based on the project's calculations, which consider building code requirements and energy consumption specifications for the different demo cases to be carried out. The typical range for thickness is expected to be between 80 to 100 mm. Panel width has been standardised at 1000 mm to align with the standard width of the steel coil for the metal sheets. However, the panel length can be adjusted based on project requirements and is expected to fall within the range of 250 to 6000 mm.

Upon obtaining the panels, GAR will undertake the adaptation and assembly phase. Then, a mock-up of the façade system will be sent to DTI for 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.

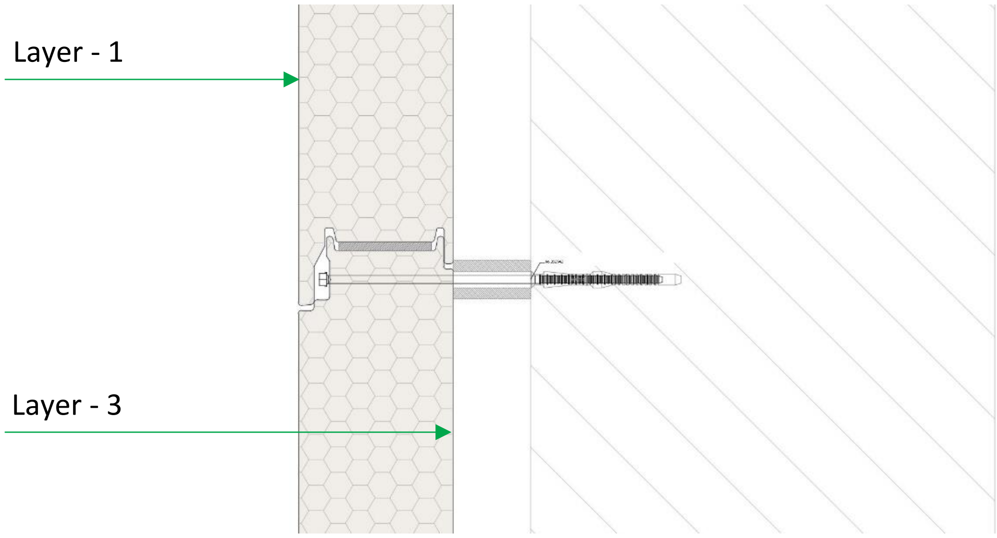


Figure 20. Preliminary sandwich panel design [drawing created using AutoCAD]

Outer layer

The GreenCoat outer steel layer consists of sustainable steel produced by SSAB. The coating incorporates a significant amount of rapeseed oil, replacing fossil oil, making it more sustainable compared to regular steel coatings. The material thickness for the external layer is 0.7 mm. This metallic sheet will also be used for manufacturing and machining finishing elements, such as for corners, windows, and doors.

Inner layer

The internal finishing layer is made of steel sourced from SSAB. For the inner layer, as it is not exposed to external environmental conditions, manufacturers utilise a primer that ensures galvanic neutrality and adhesion. The thickness of the sandwich panel's inner steel layer is 0.45 mm.

Insulation

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

The façade panel will integrate BioPUR foam as its insulation material. BioPUR is a versatile foam that can be applied in multiple forms for insulation purposes, including spraying, injection, or incorporation into sheets or sandwich panels. Further information about BioPUR can be found in deliverable D5.2 '*Manufacturing Design of the Multifunctional Façade Cladding II*.'

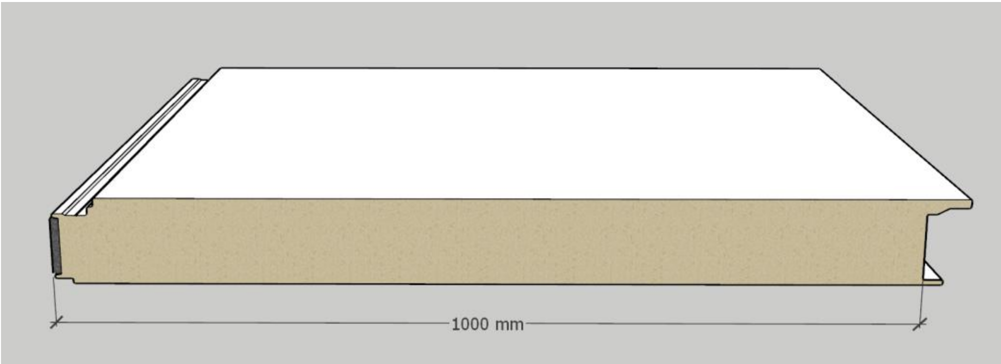


Figure 21. Demo sandwich panels made from BioPUR [drawing created using SketchUp]

2.1.3. Auxiliary elements

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

Additionally, manual ventilation grilles will be integrated to create an adaptable sealed chamber, aiming to optimise airflow and enhance thermal conditions. Positioned at both the base and the top of the façade, these grilles enable air intake and exhaust. Manufactured from stainless steel or aluminium, these grilles will be procured from existing market designs, ensuring effective prevention of water ingress and debris. The selection of grilles will be conducted in accordance with the characteristics of the façade panels once they are manufactured.

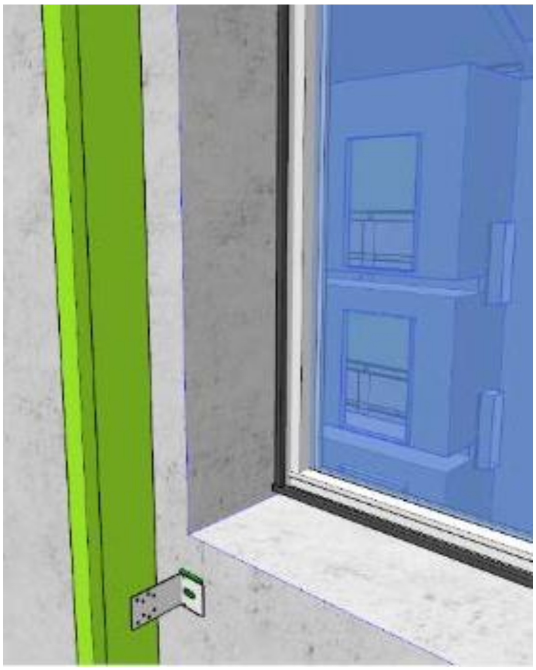


Figure 22. Rubber strip at windows [drawing created using SketchUp]

Figure 23. Clamp profiles for jambs

The following section provides a table with a detailed inventory of all components comprising the multifunctional façade cladding system, accompanied by their respective technical specifications.

2.2. List of façade system elements

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 – 0.04 W/mk.
1.3	Layer - 3	Three-layer of steel base with protective zinc layer for internal layer.
1.4	Spacers	Galvanised steel Z275 of 1 mm, shaped.

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	Reinforcement 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.

2.3. 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.

2.4. Façade aesthetics

As previously explained, the outer layer consists of GreenCoat sustainable steel manufactured by SSAB. The colour choices available are limited to those specified in the accompanying chart. It is essential to note that placing an order usually entails meeting a minimum quantity requirement. This aspect should be taken into consideration when drafting the proposal for the layout and colours of the façades for the demo projects.

Figure 24. Selection of colours for the outer layer[1]

In order to achieve an ideal balance between architectural aesthetics and energy optimisation, POLIMI and GAR will collaborate to select appropriate palette and colour combination according to the specific aesthetic-architectural requirements and the context of the 4 case studies.

2.5. Panel distribution

The preliminary façade layout for the Milan demo building is available in the Annex 4.1.

The provided drawings in Annex 4.1 present a preliminary panel distribution layout for installation on the façade. However, it is important to note that this distribution may undergo changes once the manufactured panel becomes available. 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, input from the building's owner and users has been sought, collaborating closely with project partner, Comune di

[1] https://www.ssab.com/en/brands-and-products/greencoat/colors

Milano, the owner of the Italian pilot building, to ensure that their perspectives are considered during the decision-making process.

3. BIPVT roofing system

As outlined in deliverable D5.10 '*Manufacturing design of the BIPVT roof system II*', the BIPVT (Building Integrated Photovoltaic-Thermal) system has been conceived for installation on various types of sloped roofs. This involves covering 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. However, it requires selecting only one specific type of PV module for each building since the system does not allow for the combination of different types of PV modules within the same building. 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 the RE-SKIN sandwich panels made of BioPUR and SSAB steel, which increase radiant heat absorption and provide thermal insulation and weatherproofing to the building's roof. An air gap is formed between the PV panels and the insulation panels. The airflow within this 80 mm gap, as illustrated in Fig. 24, 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, see also Figure 24:

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.

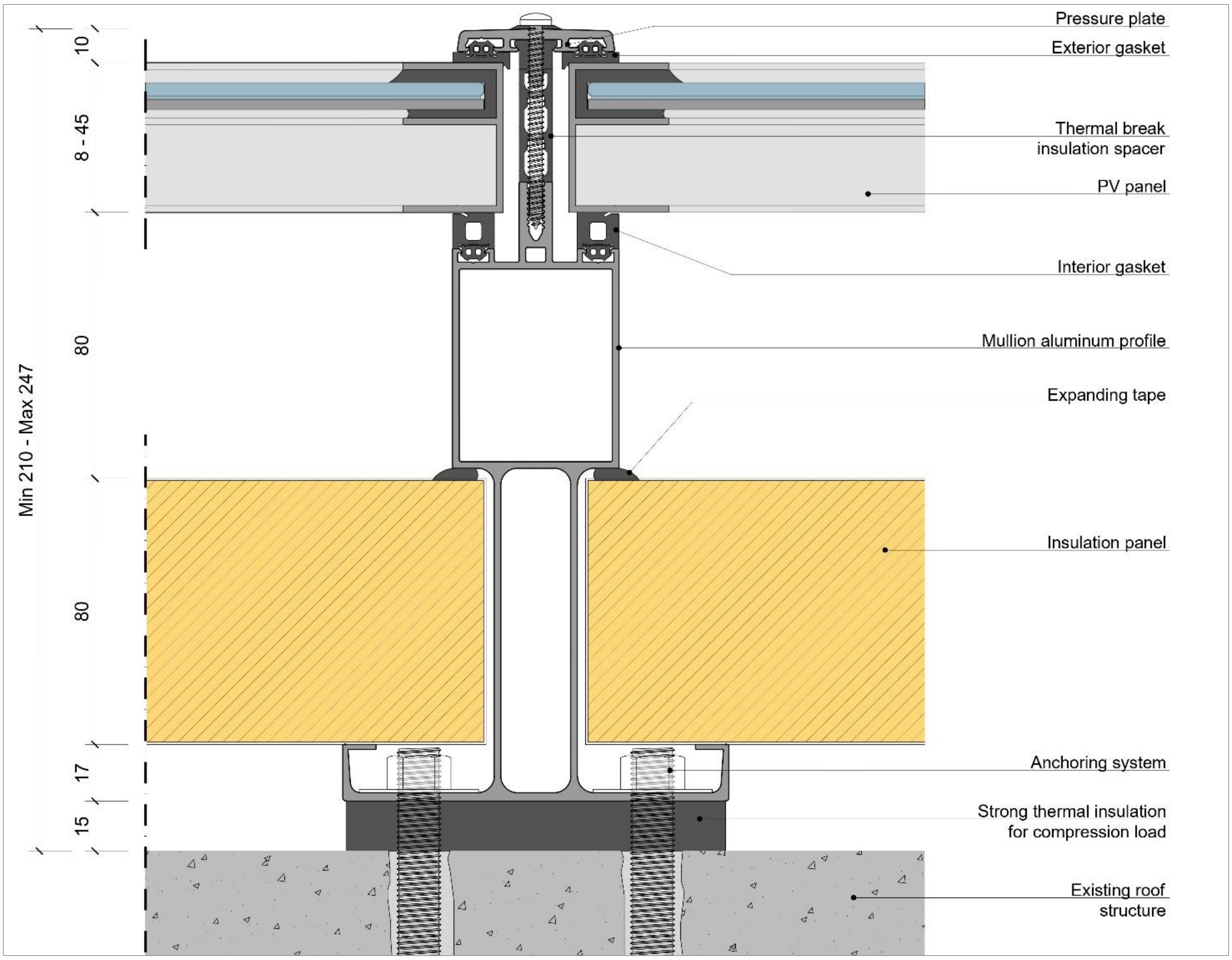


Figure 25. Cross-section of the BIPVT roof system with insulation panel [drawing created using AutoCAD]

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 PV 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. The table presented in chapter 3.2 of this document outlines the specific elements intended for use in the Milan demonstration case. Further research will explore solutions tailored to the remaining specific case study applications.

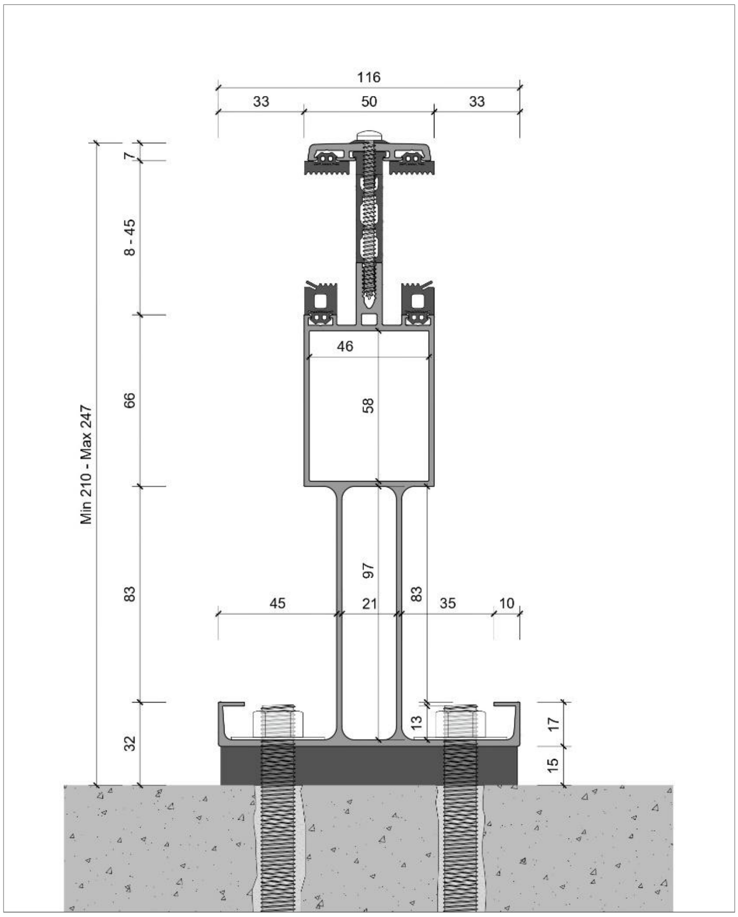


Figure 26. Cross-section of aluminium profile [drawing created using AutoCAD]

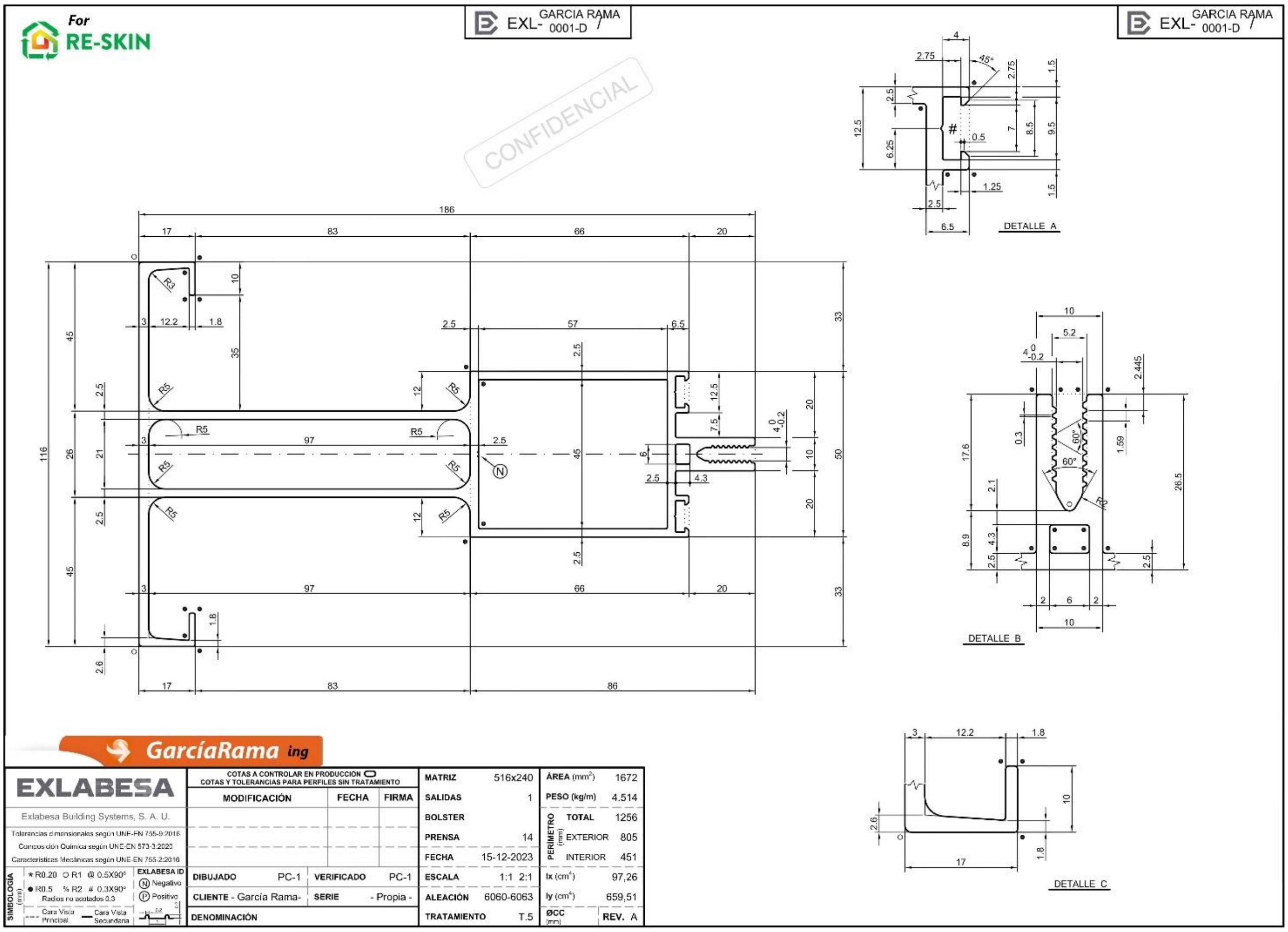


Figure 27. Drawing of the roof profile with specifications produced by the manufacturer (Source: Exlabesa)

The extrusion die for the mullion aluminium profiles was produced by the manufacturer Exlabesa, and the profiles have been extruded accordingly.

Figure 28. Image showing the test extrusion of the roof 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.

The datasheet for the PV modules intended for installation in the Milan demonstration building can be found in the Annex 4.3.

3.1.3. Thermal insulation panel

The thermal insulation layer consists of a sandwich panel comprising a bio-based polyurethane (BioPUR) foam core, manufactured by project partner INDRES, and an outer layer made of sustainable steel sourced from SSAB. The panel's thickness is 80 mm to meet the specific thermal insulation needs for all the demonstration cases, 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.

Outer layer

The external steel layer is made of GreenCoat sustainable steel produced by SSAB with a thickness of 0.7 mm. This metallic sheet will also be used for manufacturing and machining of finishing trims.

Inner layer

The inner finishing layer also consists of steel sourced from SSAB. For the inner layer, as it is not exposed to external environmental conditions, manufacturers utilise a primer that ensures galvanic neutrality and adhesion. The thickness of the sandwich panel's inner steel layer is 0.45 mm.

Insulation

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

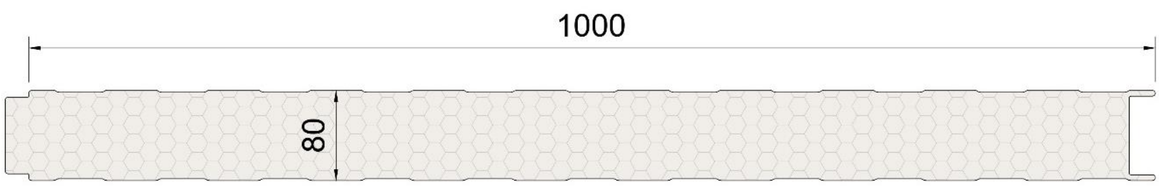


Figure 29. Detail drawing of the RE-SKIN roof sandwich panel

Figure 30. RE-SKIN sandwich panels manufactured for the roof

3.1.4. Ventilation complementary components

To allow ventilation within the air gap in order to recover warm air for thermal purposes while also preventing debris infiltration, a specific air intake and recovery system is being 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.

The table in the following section presents a comprehensive inventory of all components comprising the BIPVT roof system, along with their corresponding technical characteristics.

3.2. List of BIPVT elements

1	**Roof Sandwich 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	80 mm BioPUR insulation. Lambda (λ) 0.03 – 0.04 W/mk.

1.3	Layer - 3	Three-layer of sustainable steel base with protective zinc layer for internal layer.

2	**Substructure**	
item	*Name*	*Description*
2.1	Roof profile	Recycled aluminium, 2.5 mm in thickness, with a length of 6000 mm.
2.2	Interior gaskets	EDPM, polyamide
2.3	Spacer	EDPM, polyamide
2.4	Exterior gaskets	EDPM, polyamide
2.5	Pressure plate	Recycled aluminium
2.6	Auxiliary brackets	Galvanised steel Z275 of 1.5 mm shaped. Length on demand, up to 230 mm.
2.7	‘U’ shaped profile	Galvanised steel Z275. Length on demand.
2.8	Fixings	Self-tapping galvanised steel screws. Length on demand up to 230 mm.
2.9	Insulation for thermal bridge break	EDPM, polyamide

3	**Finishing trims, covers and sealings**	
item	*Name*	*Description*
3.1	Finishing trim at bottom	Steel base with protective zinc layer and bio-based colour coating.
3.2	Finishing trim at sides	Steel base with protective zinc layer and bio-based colour coating.
3.3	Finishing trim at corners	Steel base with protective zinc layer and bio-based colour coating.
3.4	Finishing trim at top	Steel base with protective zinc layer and bio-based colour coating.

3.5	Metallic ventilation grid profile	Aluminium
3.6	L-shaped profile	Galvanised steel Z275.
3.7	Fixings	Self-tapping galvanised steel screws. Length on demand up to 230 mm.
3.8	Adhesive tape	Polyethylene tape with adhesive for exterior applications
3.9	Neutral silicone	Silicone sealing, neutral type, high range.
3.10	Pop rivets	Aluminium or steel, on demand.
3.11	Auxiliary wooden elements	Structural wood.
3.12	Adjustable washer for fixings	Polypropylene

4	**PV panel**	
item	*Name*	*Description*
4.1	PV module	Refurbished PV modules
4.2	T-profile	EPDM rubber
4.3	Perimeter profile	Galvanised steel Z275. Length on demand.

The components for the BIPVT system solution in the Milan demonstration case have been designed and manufactured. If improved solutions are identified during the implementation phase, they will be incorporated.

4. Annex

4.1. Preliminary Layout of the Façade for the Milan Demonstration Building

GREENCOAT - Almond BrownRR30 / SS0187
Traditional metal sheet - RAL 3013
1 / 200 West Elevation
SCALE: 1:100
2 / 200 East Elevation
SCALE: 1:100
PROJECT TITLE
RE-SKIN
SITE LOCATION
Milan Demo Case
Via Amantea n.5
20153 Milan
PROJECT PHASES
PRELIMINARY
Drawing Title
Elevations West and East
Project
Drawing by LM
Checked by AM
Date 25.03.2024
Revision
Scale 1:100
Format A3
Drawing Code
200
ZH Spin-off
Via Ariberto 20,
20123 - Milano
email: info@zhspinoff.com
www.zhspinoff.com
CAD FILE NAME: 240320_PANNELLATURE.dwg

4.2. Detail drawings of façade connections in the Milan demo

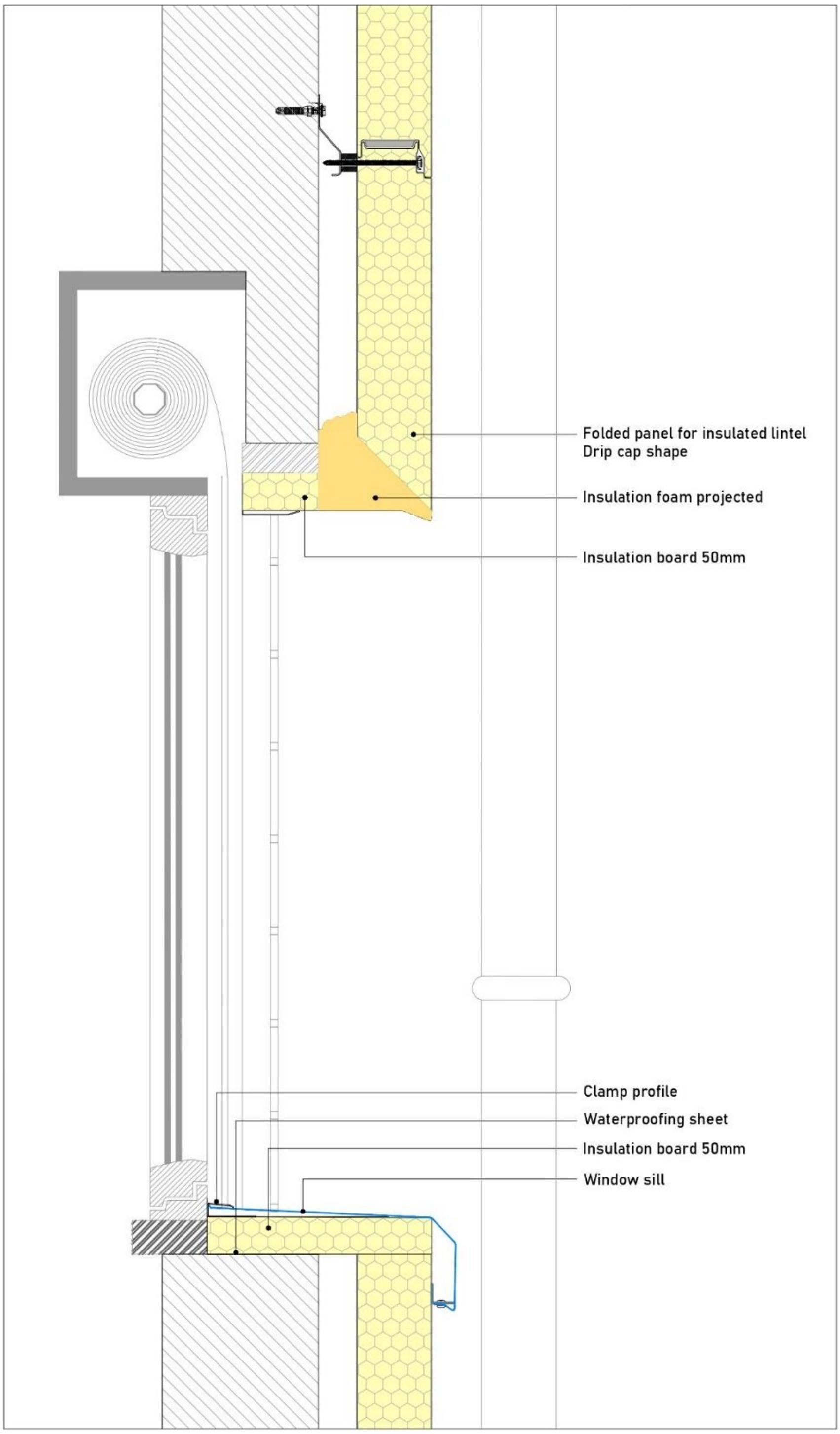


Figure 31. Vertical section detail of Milan demo window [drawing created using AutoCAD]

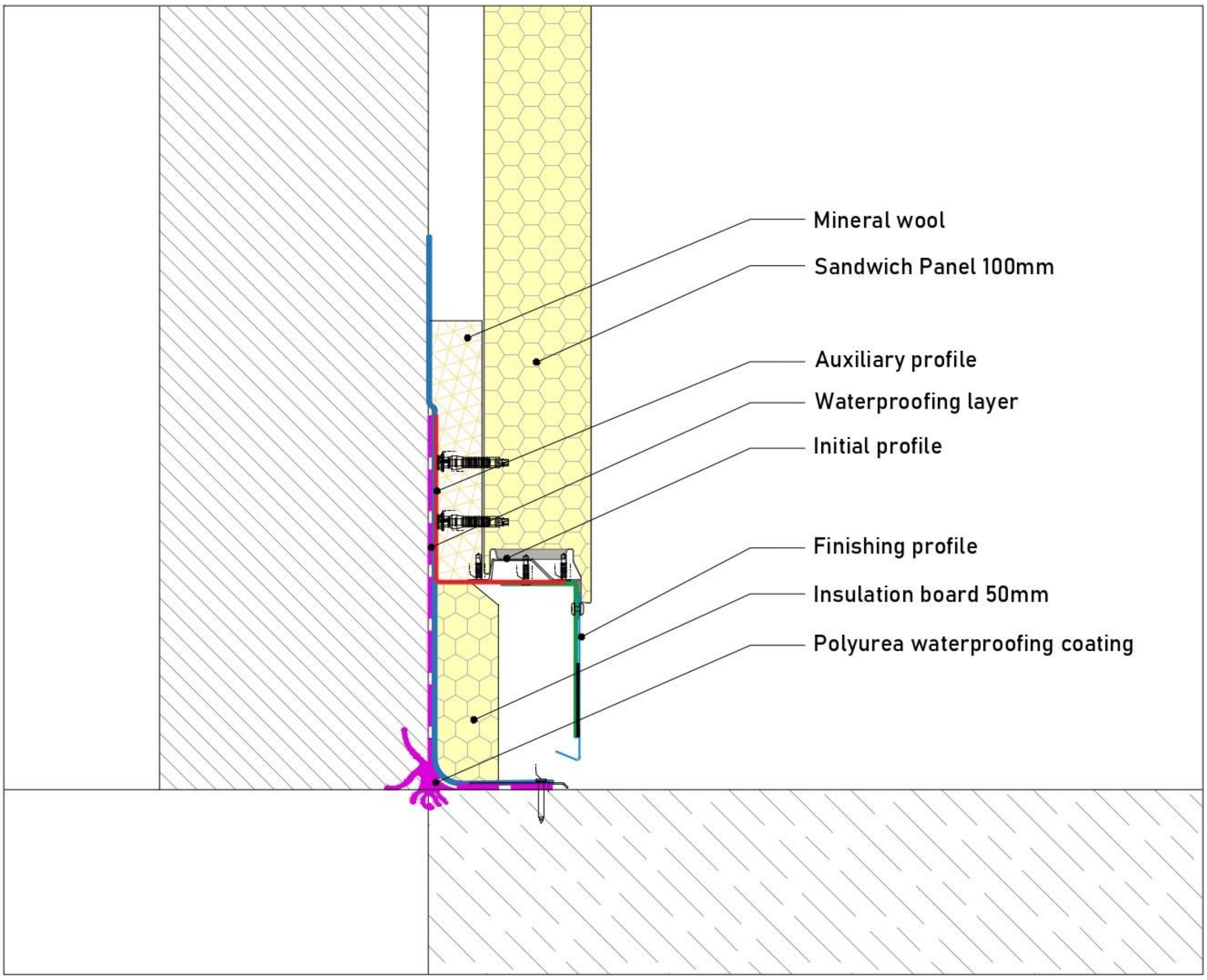


Figure 32. Detail drawing of the façade system's starting point [drawing created using AutoCAD]

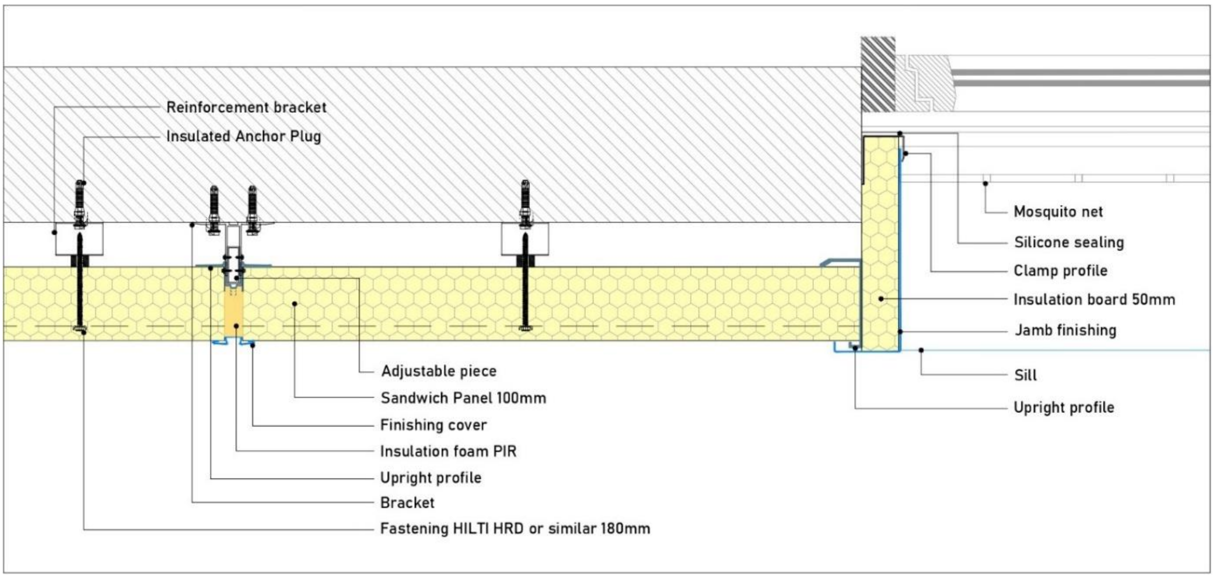
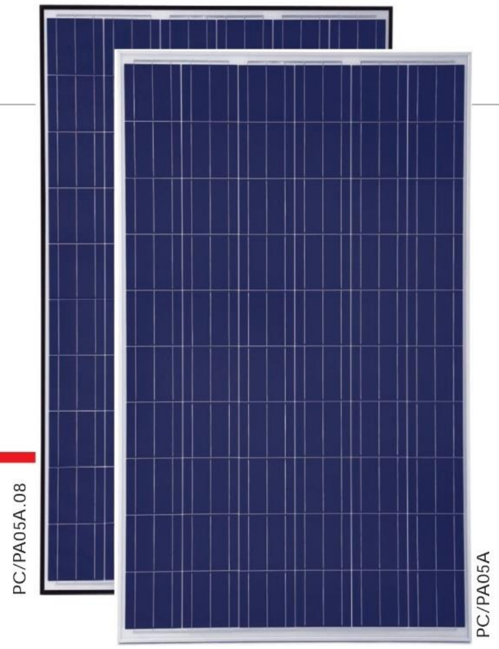


Figure 33. Horizontal section detail of Milan demo window [drawing created using AutoCAD]

4.3. PV module datasheet

Mono Multi Solutions



TSM-PC05A
TSM-PA05A
THE Honey MODULE
by Trinasolar

15.9%
MAX EFFICIENCY

260W
MAX POWER OUTPUT

10 YEAR
PRODUCT WARRANTY

25 YEAR
LINEAR POWER WARRANTY

Founded in 1997, Trina Solar (NYSE: TSL) has established itself as a leader in the solar community with its vertically integrated business model. Our modules and system solutions provide clean solar power in on-grid and off-grid residential, commercial, industrial and utility-scale systems.

With more than 22 offices worldwide, Trina Solar has partnerships with leading installers, distributors, utilities and developers in all major PV markets. Trina Solar is committed to driving smarter energy choices.

Trina Solar Limited
www.trinasolar.com

Trinasolar
Smart Energy Together

Module can bear snow loads up to **5400Pa** and wind loads up to **2400Pa**

Guaranteed power output
0~+3%

High performance under low light conditions
Cloudy days, mornings and evenings

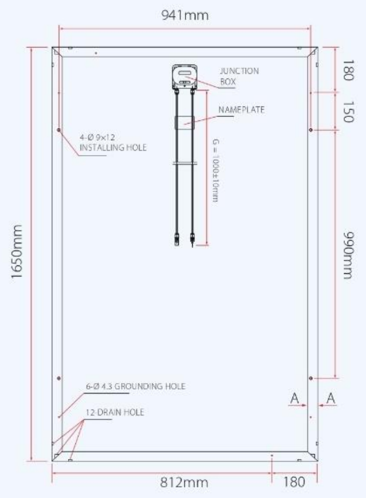
Manufactured according to International Quality and Environment Management System Standards
ISO9001, ISO14001

MC4 photovoltaic connectors increase system reliability

TSM-PC05A / TSM-PA05A THE Honey MODULE

by Trinasolar

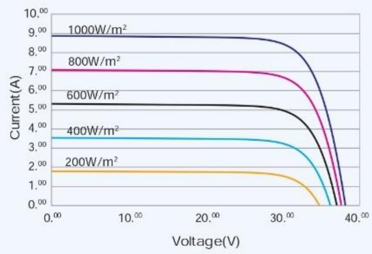
DIMENSIONS OF PV MODULE TSM-PC/PA05A



Back View

A-A

I-V CURVES OF PV MODULE TSM-255 PC/PA05A



Average efficiency reduction of 4.5% at 200W/m² according to EN 60904-1.

CERTIFICATION

ELECTRICAL DATA @ STC	TSM-250 PC/PA05A	TSM-255 PC/PA05A	TSM-260 PC/PA05A
Peak Power Watts-P_{MAX} (Wp)	250	255	260
Power Output Tolerance-P_{MAX} (%)	0/+3	0/+3	0/+3
Maximum Power Voltage-V_{MP} (V)	30.3	30.5	30.6
Maximum Power Current-I_{MPP} (A)	8.27	8.37	8.50
Open Circuit Voltage-V_{OC} (V)	38.0	38.1	38.2
Short Circuit Current-I_{SC} (A)	8.79	8.88	9.00
Module Efficiency η_m (%)	15.3	15.6	15.9

Values at Standard Test Conditions STC (Air Mass AM1.5, Irradiance 1000W/m², Cell Temperature 25°C).
Power measurement tolerance: ±3%

ELECTRICAL DATA @ NOCT	TSM-250 PC/PA05A	TSM-255 PC/PA05A	TSM-260 PC/PA05A
Maximum Power-P_{MAX} (Wp)	183	186	190
Maximum Power Voltage-V_{MP} (V)	27.3	27.4	27.5
Maximum Power Current-I_{MPP} (A)	6.70	6.79	6.91
Open Circuit Voltage (V)-V_{OC} (V)	34.8	34.9	35.0
Short Circuit Current (A)-I_{SC} (A)	6.99	7.11	7.20

NOCT: Irradiance at 800W/m², Ambient Temperature 20°C, Wind Speed 1m/s.
Power measurement tolerance: ±3%

MECHANICAL DATA	
Solar cells	Multicrystalline 156 × 156mm (6 inches)
Cell orientation	60 cells (6 × 10)
Module dimensions	1650 × 992 × 35mm (64.95 × 39.05 × 1.37 inches)
Weight	18.6kg (41.0 lb)
Glass	High transparency solar glass 3.2mm (0.13 inches)
Frame	Anodized aluminium alloy
J-Box	IP 65 rated
Cables	Photovoltaic Technology cable 4.0mm² (0.006 inches²), 1000mm (39.4 inches)
Connector	Original MC4

TEMPERATURE RATINGS	
Nominal Operating Cell Temperature (NOCT)	44°C (±2°C)
Temperature Coefficient of P_{MAX}	- 0.41%/°C
Temperature Coefficient of V_{OC}	- 0.32%/°C
Temperature Coefficient of I_{SC}	0.053%/°C

MAXIMUM RATINGS	
Operational Temperature	-40~+85°C
Maximum System Voltage	1000V DC(IEC)/ 600V DC(UL)
Max Series Fuse Rating	15A

WARRANTY
10 year Product Workmanship Warranty
25 year Linear Power Warranty

(Please refer to product warranty for details)

PACKAGING CONFIGURATION
Modules per box: 29 pieces
Modules per 40' container: 812 pieces

TSM_EN_Nov_2012

Trinasolar
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CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.