D4.3 Report on currently existing standards and norms applicable to the different IPV products for specified regions.

WP4

Lead Partner: imec

Partner Contributors: SUPSI, TNO, SCHW, G2P

Dissemination Level: Public

Deliverable due date: M24 Actual submission date: M24

Deliverable Version: 2.0

Funded by the European Union

Project Acronym	MC2.0
Project Title	Mass customization 2.0 for Integrated PV
Grant Agreement n°	101096139
Call	HORIZON-CL5-2022-D3-01
Topic	HORIZON-CL5-2022-D3-01-03 Advanced manufacturing of Integrated PV
Starting Date	1 January 2023
Duration	38 months

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Funded by
the European Union

Executive Summary

The MC2.0 project focuses on the development of four different IPV products: a metal façade from Schweizer, a corrugated rooftile from Wienerberger, an insulated glass unit from Glass to Power and a blind integrated into an insulated glass unit from IWIN. The four products make use of PV semi-fabricates manufactured in a mass customization line. For the commercialization of the products, certification is required. However, due to the novel nature of the products, which involve a combination of building and PV elements, the most applicable norms need to be identified or do not yet exist. In this deliverable, the state of the art for BIPV certification at EU level is reviewed by the research institutes involved in the project. Existing standards applicable to the products studied are selected in collaboration with the product owners, and gaps (aspects that the available norms cannot certify) are identified. This deliverable will help product owners navigate through existing standards for future certification of their product. It will also serve as a basis for D4.4, where a more specific approach towards certification of mass-customised semi-fabricates will be proposed. The impact of such certification on the value-chain will also be studied. Moreover, some of the tests included in the norms listed in this deliverable will be applied in D2.7 for the determination of the life-time and reliability of the studied products.

Table of Contents

List of Figures

List of tables

Configuration item history log

Version	Date	Description
1.0	28/11/2024	Deliverable to reviewer
1.5	03/12/2024	Reviewer's version
2.0	17/12/2024	Final version

1 Introduction

Over the past 25 years, Integrated Photovoltaics (IPV), particularly Building Integrated (BIPV), as well as Infrastructure- (IIPV) and Vehicle-(VIPV) integrated products, have been developed and demonstrated. Despite their potential, widespread market adoption has yet to occur. With Europe on the verge of a major photovoltaic scale-up, it is crucial to make IPV products more accessible and affordable to meet the growing demand for solar electricity in urban environments and to optimize space usage. The MC2.0 project aims to achieve a cost breakthrough for IPV through an advanced "mass customization" manufacturing approach, where the photovoltaic (PV) component (mentioned here as PV semi-fabricate) is produced in a mass customization line (front-end process) and then integrated into IPV products (back-end process). The IPV products considered are listed in Table 1. For the commercialization of these products, certification is required. In this document, we review the existing norms and regulations applicable to each of the four specific products that are being developed within MC2.0, and identify the existing gaps. The information gathered will be used to propose norms suitable for product families to which the said products belong (D4.4). Tests included in the listed standards will also be applied to the four products to estimate their life-time (D2.7). The target audience that would benefit from this deliverable includes product owners that produce similar products and certification bodies. The product owners can use this document as guideline to identify what certification their product would need to go through in the current certification environment. The identified gaps in existing standards that are presented in this document can help the certification bodies to develop more suitable standards for similar BIPV product families. Moreover, anyone with interest in BIPV will find the content of this deliverable useful, such as BIPV companies, building developers, architects and local, national and international institutions.

Table 1 Overview of BIPV product families treated within MC2.0, with responsible project partner and target regions.

BIPV Product family	Responsible partner	Target region
Façade elements	Schweizer	Switzerland, Germany, Austria
Corrugated rooftiles	Wienerberger	The Netherlands
Blinds integrated in insulating glass units	iWin	Switzerland
Insulating Glass Units	Glass2Power	Italy

Certification of IPV is a notoriously challenging topic, since such products fall under standards for both photovoltaics and whichever product category they are integrated in. For some categories of IPV applications there is still a lack of unified international definitions of which product falls under which category. For BIPV, unified international definitions have been provided by the IEA PVPS Task 15 workgroup in 2018 (see Report IEA-PVPS T15-04:2018), which works on gathering relevant research on different aspects of BIPV. These definitions include three categories: roof elements (opaque and transparent), façade elements (opaque and transparent) and fall protections. All MC2.0 product categories fall under the first two definitions. International (IEC 63092) and European (EN 50583) umbrella standards for BIPV have also been defined, which mainly consist of references to already existing standards and requirements for the building and PV

industry. Both IEC 63092 and EN 50583 consists of two parts: Part I considers BIPV elements, while Part II considers BIPV systems. However, it can be unclear for the producers of BIPV products exactly which regulations and standards they should follow in their specific case, as there are often differences between national and regional regulations, in addition to the European or International standards. In the Horizon Europe project SEAMLESS-PV, the different regulations for countries and regions in Europe were neatly summarized (see SEAMLESS-PV D2.2 – Analysis of regulatory frameworks). Those were used as starting point for the product specific norms and regulations applicable in this deliverable.

In this document, the generalized regional, national, European and/or international standards are filtered on applicability to each of the MC2.0 product families, by taking into account the bill of materials, electrical layout etc. Since all the partners within MC2.0 intend to market their products within Europe, both the European EN 50583 and the international IEC 63092 standards are used as the main frameworks for each product, since they are essentially identical. One difference, however, is that the European ones refer more specifically to other European regulations such as fire safety. If relevant, national, regional or other product specific norms are added, when the European/international norms are not applicable. Despite the relatively large number of standards, there are certification gaps that may not be covered due to the innovative nature of the presented products. In order to list all the applicable norms and identify the mentioned gaps and other certification obstacles, a BIPV reliability and certification workshop was organized at SUPSI in collaboration with TNO and imec, where the research institutes and product owners exchanged information. This workshop triggered further investigation by the institutes. The methodology applied for the selection of the applicable standards and the identification of the gaps is summarized in Figure 1.

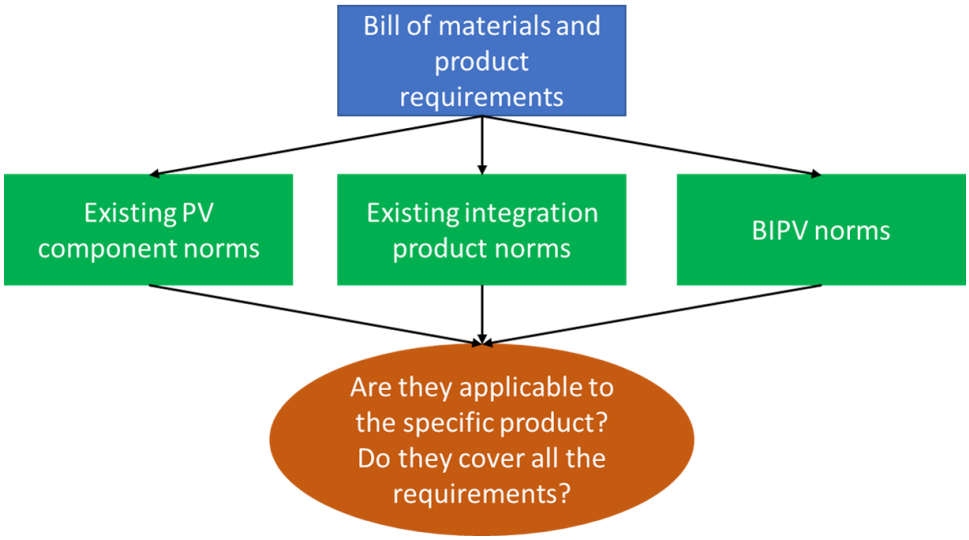

Figure 1 Diagram representing the methodology applied for the selection of the applicable standards and the identification of the gaps.

In addition to giving a specific overview of regulations applicable to each product, the current document will also form an important link to a future deliverable on possible routes to semi-fabricate and full product certification (D4.4). We will be able to use the standards listed in this deliverable to identify what type of testing, currently carried out on the end-product, could be transferred to semi-fabricate testing, and to what degree this testing can be translated into certification norms.

This deliverable includes four sections that are dedicated to each of the products separately, with each section including a brief description of the product, the target markets/countries, the applicable norms and the most relevant bottlenecks. The key take-away message is then summarized in the conclusions.

2 Applicable and reference documents

Report IEA-PVPS T15-04:2018, https://iea-pvps.org/key-topics/international-definitions-of-bipv/

SEAMLESS-PV D2.2 – Analysis of regulatory frameworks, https://www.seamlesspv.eu/sdm_downloads/d2-2-analysis-of-regulatory-frameworks-for-ipv/

MC2.0: D1.1 - requirements specification document

BIPV boost: Update on regulatory framework for BIPV, https://bipvboost.eu/public-reports/download/update-on-regulatory-framework-for-bipv

3 Definitions, abbreviations and acronyms

3.1 Definitions

PV semi-fabricate	Semi-finished PV module, part of the full product, may or may not include components such as backsheet or junction box
Full product	Includes both the PV semi-fabricate and the building integrated element, which in this deliverable can be either the metal cassette or the IGU

3.2 Abbreviations and acronyms

IPV	Integrated Photovoltaics
BIPV	Building Integrated Photovoltaics
IIPV	Infrastructure Integrated Photovoltaics
VIPV	Vehicle Integrated Photovoltaics
CIGS	Copper Indium Gallium Selenide
c-Si	Crystalline silicon
NZEBs	Near Zero Energy Buildings
IGU	Insulated Glass Unit
QD-LSC	Quantum Dot-Luminescent Solar Concentrator technology

4 BIPV certification relevant to the mc2.0 products

4.1 Schweizer - Façade

4.1.1 Description of product

Ernst Schweizer AG has started an internal innovation project in 2021 with the aim of combining a lightweight and easy-to-install façade cladding with lightweight, glass-free PV modules. The system is intended to be used as a building envelope component which produces electricity, in order to improve the energy efficiency of the building. At the same time, it fulfils all functions of a regular façade. The system consists of aluminium cassettes with glass-free PV modules attached to them by an adhesive. Different cell technologies (CIGS and c-Si) and dimensions (length: 1150-1950 mm, width: 480 mm) will be attempted in this project. Moreover, the colour may be another variation by colouring the cassette with a colour powder and adding a coloured foil in the semi-fabricate. Figure 2 shows a pilot installation of the product.

Figure 2 Demonstrator of Schweizer façade.

4.1.2 Region of interest

As explained in the introduction, the region of interest is a significant parameter regarding certification, since the certification approach of some aspects of the product may vary according to it. The priority market region for Ernst Schweizer AG is Switzerland with a large market potential, while they are currently expanding their activities to Germany and Austria.

4.1.3 Applicable norms

There is a large variety of applicable norms for this product due to the diverse components and use. Although the general BIPV standards mentioned in the introduction are applicable, certain requirements should be covered by other European and national standards. From the electrical production perspective, the requirements include electrical safety, mechanical safety and reliability against external stressors such as high temperature, temperature gradients, humidity etc. Regarding the electrical and mechanical safety, the relevant norms include the IEC 61730 family on PV module safety qualification. This family of norms is divided in two parts, one on the requirements for construction and one on the requirements for testing. Regarding

the reliability of the product, the applicable norms include the IEC 61215 family on design qualification and type approval. The norm family consists of two parts, one for test requirements and one for test procedures. At market launch, the minimum requirement is, that the PV module must be certified according to the standards IEC 61730 and IEC 61215, while the complete end product is additionally tested for hail and fire resistance. In the second stage, the complete façade product must undergo complete retesting according to the retesting requirements of IEC, included in IEC 62915.

The properties required for the product as a façade element include durability against mechanical loads (wind, snow, self-weight). The applicable norms are SIA 261-1,2 for Switzerland, which are equivalent to the Eurocode EN 1991. For Switzerland, there is an advanced hail resistance requirement, HW4, which the product will be tested for.

Additionally, there are relevant norms that should be considered regarding the integration part and the application of the product. DIN 18516-1 is the German norm applicable for ventilated external wall claddings (applicable also in Switzerland and Austria) and DIN / EN 62305-2 is the norm ensuring safety against lightning flashes. It is important to distinguish this façade system from curtain walling and external thermal insulation composite systems, which are not applicable. Finally, the current classification regarding fire is B2, meaning that the system can be installed on buildings up to 11 meters tall (Switzerland). All the discussed standards are summarised in Figure 3 and Table 2, which includes additional potentially applicable standards part of the BIPV norms which were not discussed above.

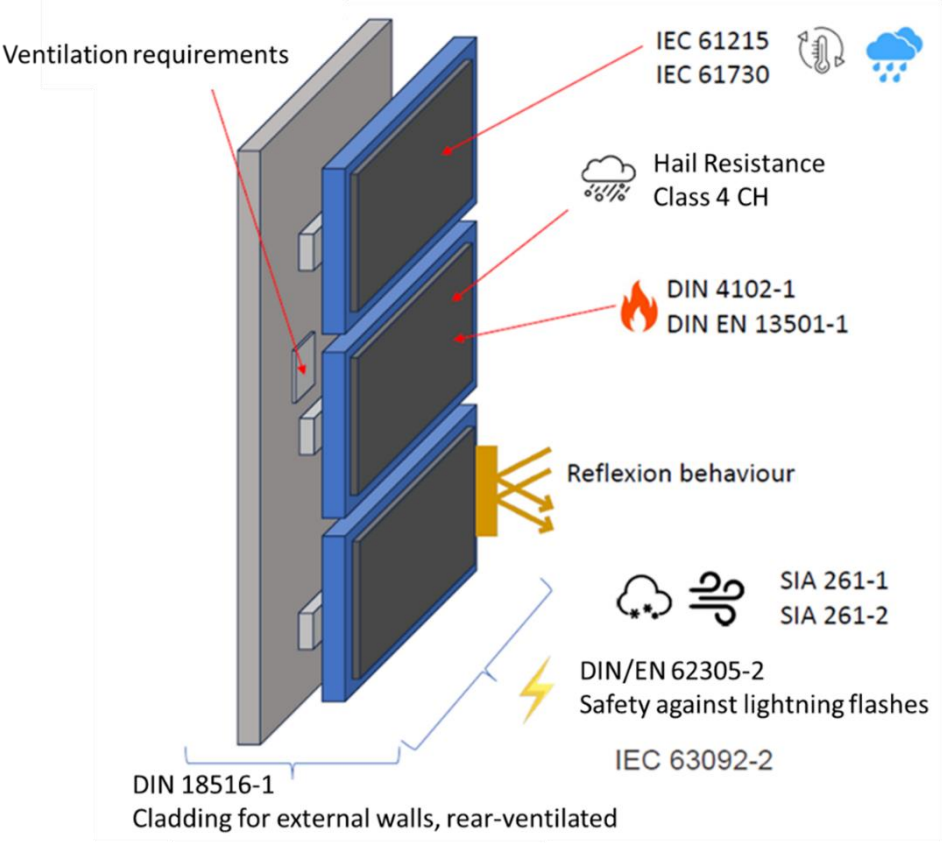

Figure 3 Overview of applicable norms for Schweizer façade.

Table 2 Summary of mandatory and applicable standards for Schweizer façade.

Category	Norm	Scope	Cited in BIPV norms (Y/N)	Certification?
Construction General	CPR-305/2011	European Construction Products Regulation (EU-CPR).	N	No, design guidelines
	EN 1990	Eurocode: Basis of structural design	Y	No, design guidelines
	SIA 261-1,2 / EN 1991	Eurocode 1: Actions on structures	Y	No, design guidelines
Construction-Sustainability	EN 15804	Sustainability of construction works: Environmental product declarations; core rules for the product category of construction products	Y	No, product classification
	CEN/TR 15941	Sustainability of construction works: Environmental product declarations; methodology for selection and use of generic data	Y	No, documentation
	EN 15942	Sustainability of construction works: Environmental product declarations; Communication format business-to-business	Y	No, documentation
	EN 15978	Sustainability of construction works: Environmental product declarations; Calculation method	Y	No, documentation
Construction-Cassette	DIN 18516-1	Cladding for External Walls, Rear-Ventilated	N	Yes
	DIN / EN 62305-2	Protection against lightning	N	Yes
Construction-Fire Safety	EN 13501-1,2&5	Fire classification of construction products and building elements	Y	Yes

PV Norms	IEC 61730-1&2	Photovoltaic (PV) module safety qualification	Y	Yes
	EN 61215-1&2	Terrestrial photovoltaic (PV) modules	Y	Yes
	IEC 62915	PV Retesting guidelines[1]	N	Yes
	EN 50380	Datasheet and nameplate information for photovoltaic modules	Y	No, documentation
Electrotechnical	LVD-35/2014	Low Voltage Directive	N	No, design guidelines
Instruction and documentation	EN 61082-1	Preparation of documents used in electrotechnology Part 1: Rules	Y	No, documentation

[1]Retesting guidelines are relevant in the case the design of the product needs to be adapted, so it depends on the case of the producer.

4.1.4 Identified gaps/issues in current norms and standards

One of the identified gaps for the Schweizer façade is the certification of the reliability of the adhesive between the PV semi-fabricate and the cassette, since the available standards only certify the PV and the integration components separately. Moreover, according to the standard IEC 63092, if a BIPV product includes fully flexible PV modules, only regional/national norms apply, which may not cover all the requirements.

4.2 Glass to Power - Insulating glass unit

4.2.1 Description of the product

Glass to Power is a company that aims at contributing to the energy efficiency of buildings, according to the decarbonization objective foreseen by the EU Green Deal. Glass to Power is currently developing a proprietary and innovative solution for integration into the building envelopes to ultimately achieve the energy standards of Near Zero Energy Buildings (NZEBs).

The current product portfolio of Glass to Power consists of two different PV-based technologies integrated within conventional IGU, therefore combining the roles of building envelope element with electrical power generation (Figure 4).

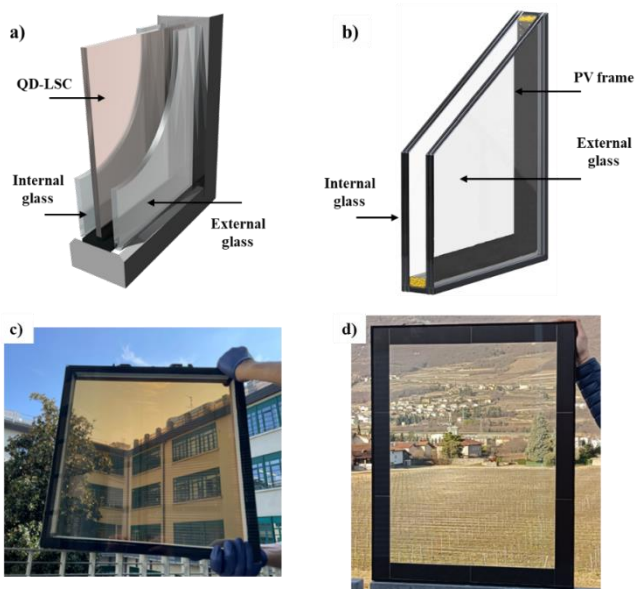

Figure 4 Schematic and front view of the first-generation QD-LSC triple-pane PV-IGU (a) and (c), and the second-generation fully transparent double-pane PV-IGU (b) and (d).

In detail, the first-generation product is a triple pane IGU based on the Quantum Dot-Luminescent Solar Concentrator technology (QD-LSC), while the second one is a double pain IGU endowed photovoltaic frame in a sandwich-like configuration.

4.2.2 Region of interest

The main market region of interest for Glass to Power is Italy, although a potential expansion towards other countries is currently under evaluation according to the business development strategy.

4.2.3 Applicable norms

On the IGU side, both products are regulated by the Construction Product Regulation (CPR-305/2011), while on the PV side, the Low Voltage Directive (LVD-35/2014) is the reference. Therefore, the relevant harmonised standards to be followed are:

1) EN 1279 - Glass in building - Insulating glass unit, with particular care to
    a. EN 1279-2 - Moisture penetration Test
    b. EN 1279-3 - Gas leakage test
    c. EN 1279-4 - Fogging test and Volatile content
2) IEC 61730-1 (2) - Safety qualification of photovoltaic modules.

However, for the PV scenario, another voluntary standard requested by customers is IEC 61215-1 (2) - Terrestrial photovoltaic modules - Design qualification and type approval, since the safety of the product is obligatory, but the reliability adds to the customer's confidence. Those standards, as well as other applicable ones from the BIPV norms, are summarised in Table 3.

Table 3 Summary of mandatory and applicable standards for Glass to Power window.

Category	Norm	Scope	Cited in BIPV norms (Y/N)	Certification?
Construction General	CPR-305/2011	European Construction Products Regulation (EU-CPR)	N	No, design guidelines
	EN 1990	Eurocode: Basis of structural design	Y	No, design guidelines
Construction-Sustainability	CEN/TR 15941	Sustainability of construction works: Environmental product declarations; methodology for selection and use of generic data	Y	No, design guidelines
	EN 15804	Sustainability of construction works: Environmental product declarations; core rules for the product category of construction products	Y	No, product classification
	EN 15942	Sustainability of construction works: Environmental product declarations; Communication format business-to-business	Y	No, documentation
	EN 15978	Sustainability of construction works: Environmental product declarations; Calculation method	Y	No, documentation
Construction-Glass Unit	EN 1279 series (1-5)	Glass in building - Insulating glass unit	Y	Mixed
	EN ISO 12543-series	Glass in building - Laminated glass and laminated safety glass	Y	Mixed
	EN 356, EN 410, EN 673, EN 674, EN 675	Various glass-related performance specifications	Y	Mixed

	prEN 12488, EN 12600, EN 12758, EN 13022	Various glass-related performance specifications	Y	Mixed
	EN ISO 10077-1:2017	Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 1: General (ISO 10077-1:2017)	Y	No, calculation methods
Construction-Fire Safety	EN 13501-1,2,5	Fire classification of construction products and building elements	Y	Yes
PV Norms	IEC 61730-1-2	Photovoltaic (PV) module safety qualification	Y	Yes
			Y	Yes
	IEC 62915	PV Retesting guidelines	N	Yes
	EN 50380	Datasheet and nameplate information for photovoltaic modules	Y	No, documentation
Electrotechnical	LVD-35/2014	Low Voltage Directive	N	No, design guidelines
Instruction and documentation	EN 61082-1	Preparation of documents used in electrotechnology Part 1: Rules	Y	No, documentation

4.2.4 Identified gaps/issues in current norms and standards

The first identified gap for the Glass to Power product is that the applicability of the PV related standards is questionable, since the voltage generated by the product may fall below the Low Voltage Directive. However, the standards remain applicable when more than one product are connected in series. Moreover, the size variability of the product may be an issue, since technically there might be limited availability of very large equipment that could test an IGU of big dimensions.

4.3 iWIN – Blinds integrated in insulating glass units

4.3.1 Description of product

The product developed by iWIN is an innovative multifunctional photovoltaic blind shading device, integrated within an insulating glazing unit. This solution combines several key functionalities, including:

- Energy production: Utilizing integrated photovoltaic technology, the device generates renewable energy, contributing to the energy efficiency of buildings.
- Light and solar radiation control: Adjustable slats allow for dynamic control over incoming sunlight and thermal radiation, optimizing indoor comfort.
- Glare protection: The design provides effective shading, reducing visual discomfort caused by direct sunlight.

The system is intended as a solar window that produces electricity. The product's technical specifications have been outlined in detail in the MC2.0: D1.1 - requirements specification document. Figure 5 and Figure 6 show the window design concept and final integration into building façades system.

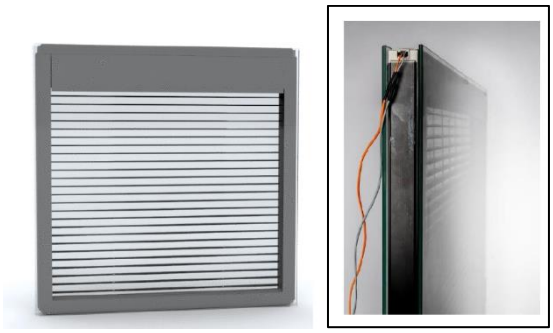

Figure 5 Design of iWIN solar window.

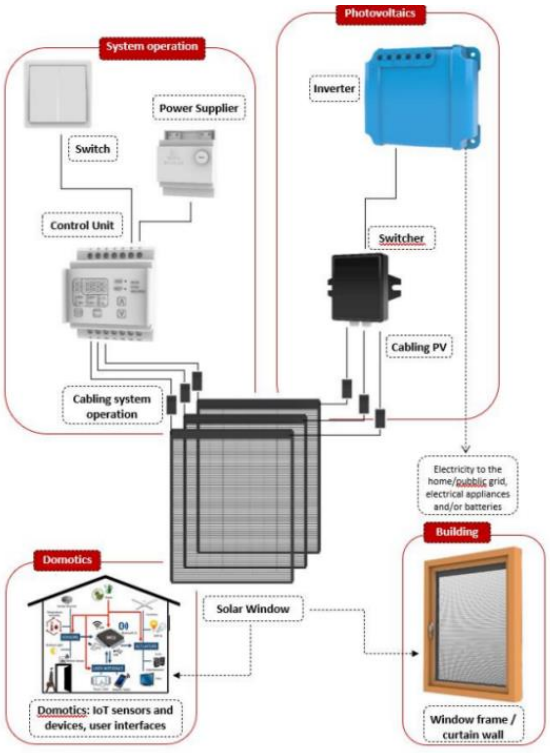

Figure 6 iWIN solar window complete solution design.

4.3.2 Region of interest

The iWIN photovoltaic blind shading device is developed in Manno, Switzerland, which is also its primary market. Switzerland is a European leader in BIPV, making it a strategic choice for both product development and certification.

Switzerland's BIPV industry puts a strong emphasis on sustainability and energy efficiency, driven by building regulations and energy policies, such as the Swiss Energy Strategy 2050. The BIPV sector in Switzerland is mature, with a high penetration rate in residential, commercial, and institutional buildings.

In Switzerland, regulatory and certification processes often operate at the cantonal level rather than being uniformly standardized at the federal level. This decentralized approach can present implementation challenges. However, navigating and succeeding in Switzerland's rigorous and diverse cantonal certification processes, the iWIN device gains a strong foundation for entry into other markets with varied regulatory environments, such as Germany, France, or Italy.

4.3.3 Applicable norms

The table listing applicable international standards for iWIN product, has been adapted from the MC2.0: D1.1 - requirements specification document. These standards are the reference to a harmonized international certification approach. The product standards of Table 4 can be considered as guidelines for the selection of technical specifications applicable to the product.

Table 4 Summary of mandatory and applicable standards for iWIN venetian blinds.

Category	Norm	Scope	Cited in BIPV norms (Y/N)	Certification?
Construction General	CPR-305/2011	European Construction Products Regulation (EU-CPR)	N	No, design guidelines
	EN 1990	Eurocode: Basis of structural design	Y	No, design guidelines
Construction-Sustainability	CEN/TR 15941	Sustainability of construction works: Environmental product declarations; methodology for selection and use of generic data	Y	No, design guidelines
	EN 15804	Sustainability of construction works: Environmental product declarations; core rules for the product	Y	No, product classification

		category of construction products		
	EN 15942	Sustainability of construction works: Environmental product declarations; Communication format business-to-business	Y	No, documentation
	EN 15978	Sustainability of construction works: Environmental product declarations; Calculation method	Y	No, documentation
Construction-Glass Unit	EN 1279 series (1-5)	Glass in building - Insulating glass unit	Y	Mixed
	EN ISO 12543-series	Glass in building - Laminated glass and laminated safety glass	Y	Mixed
	EN 356, EN 410, EN 673, EN 674, EN 675	Various glass-related performance specifications	Y	Mixed
	prEN 12488, EN 12600, EN 12758, EN 13022	Various glass-related performance specifications	Y	Mixed
	EN ISO 10077-1:2017	Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 1: General (ISO 10077-1:2017)	Y	No, calculation methods
Construction-Blinds and shutters	EN 14501:2021	Blinds and shutters – Thermal and visual comfort – Performance characteristics and classification	N	No, definitions
	EN 14500	Blinds and shutters - Thermal and visual comfort - Test and calculation methods	N	Yes

	EN 14201	Blinds and shutters - Resistance to repeated operations (mechanical endurance) - Methods of testing	N	Yes
	EN 13527	Shutters and blinds - Measurement of operating force - Test methods	N	Yes
	EN 16433	Internal blinds - Protection against strangulation risks - test methodologies.	N	Yes
	EN 16434	Internal blinds - Protection from strangulation hazards - Requirements and test methods for safety devices	N	Yes
Construction-Fire Safety	EN 13501-1,2,5	Fire classification of construction products and building elements	Y	Yes
PV Norms	IEC 61730-1-2	Photovoltaic (PV) module safety qualification	Y	Yes
	EN 61215-1-2	Terrestrial photovoltaic (PV) modules	Y	Yes
	IEC 62915	PV Retesting guidelines	N	Yes
Electrotechnical	LVD-35/2014	Low Voltage Directive	N	No, design guidelines
Instruction and documentation	EN 61082-1	Preparation of documents used in electrotechnology Part 1: Rules	Y	No, documentation

To date, as also analysed in BIPV boost project, photovoltaic modules are not explicitly addressed as building components in the Swiss construction standards (99% of the installations in Switzerland are roof installations, in particular PV systems added on flat or sloped roofs and PV systems integrated on the roof as multifunctional components like solar tiles), except for some requirements considering the under construction roofs or fire safety issues. Since this situation leaves too much room for uncertainty, guidelines for how to use PV in buildings are in preparation.

Similarly to Germany, the CE mark has no legal building regulation relevance. Construction products can be classified differently depending on the construction and use. Standards such as EN 61215 or DIN 61646 and EN 61730 are used as codes of technique for the photovoltaic part.

According to the type of installation (façades or roof, for example), PV modules can be treated as a glazing system, so the construction rules of constructive glass building must be met. Since concrete Swiss glazing

rules do not exist, German standards are often used (see BIPV boost, Update on regulatory framework for BIPV).

4.3.4 Identified gaps/issues in current norms and standards

The PV windows product features integrated, movable blinds within a sealed double-glazed unit. Existing standards for blinds and insulating glass units provide a foundation for the product testing methodology, however they do not fully address the specific conditions introduced by the enclosed environment. The type of sealing gas (e.g., vacuum, argon) within the double-glazed unit can influence the thermal behaviour of the PV blinds, potentially affecting their operational lifespan and performance. Current testing methodologies for blinds focus primarily on open-air operation and do not account for the altered thermal dynamics and environmental stresses of a sealed enclosure. This highlights a need for an innovative testing sequence that combines operational lifetime testing of the blinds (e.g., repeated motion of lifting, lowering, and tilt adjustment) with temperature monitoring and performance evaluation under varying thermal conditions inside the double-glazed unit.

4.4 Wienerberger - PV rooftiles

4.4.1 Description of the product

Wienerberger AG is an Austrian company providing building solutions for the entire building envelope. They are the leading producer of rooftiles and have joined the MC2.0 project to develop a corrugated rooftile with integrated flexible PV module or semi-fabricate. The semi-fabricate consists of PV cells packaged between a flexible polymer backsheet and flexible polymer front sheet that should be producible with the Mass Customization line of TNO. To achieve the corrugated rooftile shape required for the Wienerberger product, the semi-fabricate will be shaped in a thermal process using a mould for the rooftile. After shaping, the semi-fabricate will either be glued or mechanically attached to the supporting rooftile. A single PV rooftile would consist of multiple classic rooftiles, most likely of the VHV Vario design (see Figure 7). Some draft drawings of the semi-fabricate and final product are shown in Figure 8. The material of the rooftile will most likely be a type of plastic or ceramic. The type and material of the rooftile, as well as the number of rooftiles in a single product and its electrical output and design, are still being decided.

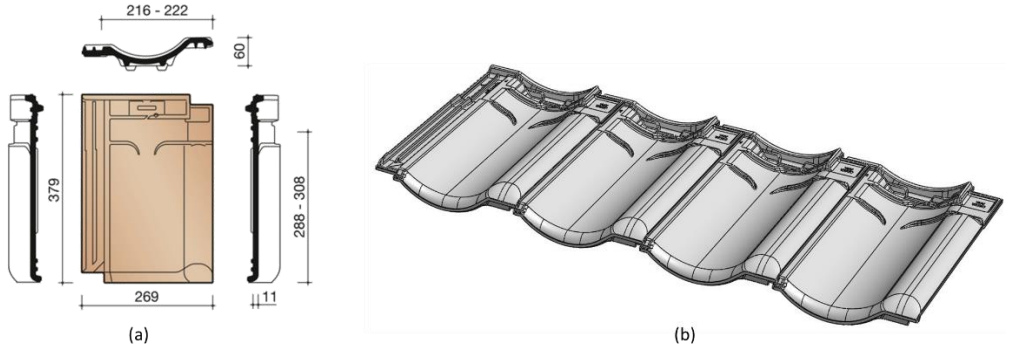

Figure 7 (a) Technical drawing of VHV Vario rooftile currently considered as base for the Wienerberger PV rooftile. Dimensions in the image are in millimetres. (b) Rendering of four connected VHV Vario tiles for the Wienerberger product.

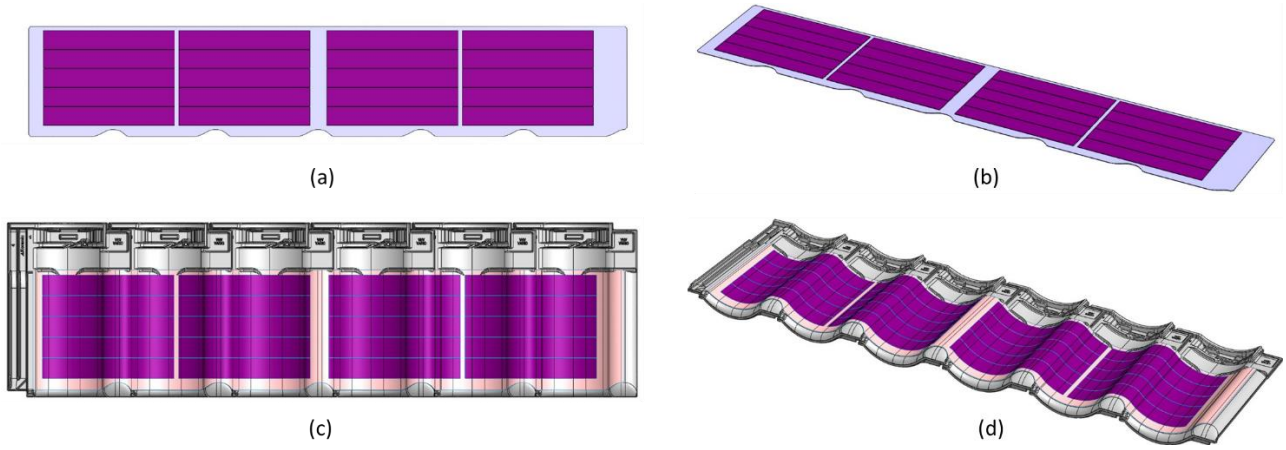

Figure 8 Top: Draft of a PV semi-fabricate before shaping for a Wienerberger rooftile (a, b). Bottom: Draft of a final roof tile with shaped PV semi-fabricate glued or fixed to the supporting rooftile (c, d).

The Wienerberger rooftile is designed to be easily installable onto a standard roof and combine the functionalities of a rooftile and a PV module. Hence, the Wienerberger tile replaces a conventional rooftile and meets the description of BIPV element as given by IEA PVPS Task 15 (see IEA-PVPS T15-04:2018).

There are specs in IEC 63092-1 (p16 & 20) for BIPV with polymer, steel sheet ("BIPV modules based on polymer waterproofing sheet or metal sheet") or glass sheet ("with at least one glass pane").

4.4.2 Region of interest

The Wienerberger product is very suitable for houses with standard corrugated rooftiles that will require replacement in the coming years. With this concept, Wienerberger is targeting the market of buildings to be renovated in The Netherlands. An estimated 1.5-2.5 million m^2 of rooftiles are replaced in The Netherlands yearly. If 50% of these roofs is suitable for rooftiles with integrated PV, this would be a market potential of 0.75-1.3 million m^2 in PV rooftiles in The Netherlands alone.

4.4.3 Applicable norms

As mentioned in the introduction, EN 50583 is considered to be the most relevant norm for any BIPV product to be marketed in Europe, and also largely overlaps with the international equivalent IEC 63092. The latest version of EN 50583 is from 2016, and as of end 2024, a new draft is in progress. It is possible that the Wienerberger rooftile will no longer fall within the scope of the updated EN 50583-1 norm, depending on possible changes to the scope.

A large number of the norms cited in EN 50583 are not applicable to the current design of the Wienerberger product, since they refer to glass in buildings, doors and windows, curtain walling or metal roofings. In total, 17 of the norms listed in EN 50583 are applicable to the Wienerberger product (see Table 5). These can be categorized into norms on the construction, PV, general electrical safety and product instruction and documentation. Other relevant European and national standards that are applicable to the Wienerberger product are also shown in Table 5.

The European norm EN 1304 lists the requirements for clay rooftiles. However, no unified norms or standards were found for the case where polymer/plastic rooftiles are used.

In addition to the European norms, there are Dutch National standards for integration of PV systems (NEN 7250), safe installation and assessment of low voltage electrical systems (NEN 1010 and NEN 3140) and calculation and fixation methods of roofing systems (NEN 6707 and NEN 6708). NEN 7250 prescribes structural requirements to roofing systems on which PV systems are installed. Since the Wienerberger rooftile would mechanically be installed as a classical tile, this norm might not be of much-added value in addition to NEN 6707 and NEN 6708. It is listed here nevertheless, since currently a PV rooftile would be within its scope.

The NEN 1010 is the national norm in The Netherlands that describes the requirements for any low voltage (< 1000 V AC or < 1500 V DC) electrical installation in the built environment. This national norm is based on a combination of the European low voltage directive and international IEC 60364 framework. NEN 3410 is a similar framework which is only applicable in professional environments. Within the intended scope of the Wienerberger PV tile described in section 4.4.2, NEN 1010 would likely be the most appropriate.

The NEN 6707 and NEN 6708 are complementary to each other. NEN 6707 gives requirements for mounting on existing roofs, while NEN 6708 gives practical calculation methods for different roofing systems that can be used in the design stage to meet the requirements given in NEN 6707.

Table 5 Summary of mandatory and applicable standards for Wienerberger PV rooftiles.

Category	Norm	Scope	Cited in BIPV norms (Y/N)	Certification?
Construction General	EN 1990	Eurocode Basis for structural design	Y	No, design guidelines
	EN 1991	Eurocode 1 Actions and structures	Y	No, design guidelines
Construction-Sustainability	EN 15804	Sustainability of construction works: Environmental product declarations; core rules for the product category of construction products	Y	No, design guidelines
	CEN/TR 15941	Sustainability of construction works: Environmental product declarations; methodology for selection and use of generic data	Y	No, product classification
	EN 15942	Sustainability of construction works: Environmental product declarations; Communication format business-to-business	Y	No, documentation

	EN 15978	Sustainability of construction works: Environmental product declarations; Calculation method	Y	No, documentation
Construction – Roofing	NEN 7250/A2	Solar system integration into roofs and façades	N	Yes
	EN 1304	Clay rooftiles	N	Yes
	NEN 6707	Structural requirements and testing for mounting of roofing systems	N	Yes
	NEN 6708	Methodology for calculation of suitability of mounting of roofing systems	N	No, calculation methods
Construction Fire classification	IEC 13501-1,2,3	Fire classification of construction products and building elements	Y	Yes
PV norms	IEC 61215-1,2	PV qualification testing (for thin film modules)	Y	Yes
	IEC 61730-1,2	PV safety testing	Y	Yes
	IEC 62915	PV Retesting guidelines	N	Yes
	EN 62446	Grid connected photovoltaic systems: minimum requirements for system documentation,	Y	No, documentation

		commissioning tests and inspection		
Electrotechnical	NEN 1010	Low Voltage regulation General	N	No, regulation
	NEN 3140	Low Voltage regulation Work environment	N	No, regulation
Instruction and documentation	EN 61082-1	Preparation of documents used in electrotechnology Part 1: Rules	Y	No, documentation
	EN 82079-1	Preparation and instruction of use: Structuring content and presentation Part 1, general principles and detailed requirements.	Y	No, documentation

4.4.4 Identified gaps/issues in current norms and standards

As with the other products described in this deliverable, the main issue is that the rooftile size, shape and even bill of materials can vary for different versions of the product. Consequently, the current range of certification standards would imply having to carry out extensive testing for each new variation, which clearly threatens the economic viability of such mass customized products. Additionally, the case of a PV rooftile with polymer front- and backsheet does not seem to be covered by the standards we reviewed, as they mainly cover PV modules with at least one glass pane (similarly to the Schweizer façade).

5 Conclusions

The work in this deliverable summarizes the applicable standards for each of the investigated products. This review shows that, using the existing certification standards and regulations, extensive certification (e.g. EN 50583) would have to be repeated for each modification (e.g. of size or shape) to a BIPV product. This is a major obstacle, in terms of cost and time-to-market, to the rollout of mass-customized BIPV products, where the design might vary between projects. Moreover, the current umbrella BIPV standards do not cover some aspects of the products (e.g., fully flexible PV modules), meaning the current standards need adaptations to cover more innovative solutions. Additionally, a new certification strategy needs to be developed (D4.4), applicable to the products mentioned in this document, in the form of family certification. This could include a pre-certification approach for the different semi-fabricate families (semi-fabricates with a similar bill of materials), to simplify the certification of the final products. Finally, fire safety is a critical issue, as some of the products include fully-flexible semi-fabricates with polymer frontsheets, which are more flammable than glass panes and should be investigated in the future.