IEA INTERNATIONAL ENERGY AGENCY

International definitions of “BIPV”

PVPS

PHOTOVOLTAIC
POWER SYSTEMS
PROGRAMME

Report IEA-PVPS T15-04: 2018

INTERNATIONAL ENERGY AGENCY
PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

International definitions of “BIPV”

IEA PVPS Task 15
Subtask C – International framework for BIPV specifications
Report IEA-PVPS T15-04: 2018
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23rd August, 2018

Helen Rose Wilson
Editor of this report

Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organization for Economic Co-operation and Development (OECD) which carries out a comprehensive programme of energy co-operation among its member countries.

The IEA Photovoltaic Power Systems Programme (PVPS) is one of the technological collaboration programmes (TCP's) on research and development within the International Energy Agency (IEA). IEA PVPS has been established in 1993, and participants in the programme have been conducting a variety of joint projects regarding applications of photovoltaic (PV) conversion of solar energy into electricity.
The mission of the PVPS is "…to enhance the international collaboration efforts which accelerate the development and deployment of photovoltaic solar energy as a significant and sustainable renewable energy option…". The underlying assumption is that the market for PV systems is gradually expanding from the niche-markets of remote applications and consumer products to rapidly growing ones for building-integrated and centralised PV generation systems.

Building Integrated PV (BIPV) is seen as one of the five major tracks for large market penetration of PV, besides price decrease, efficiency improvement, lifespan, and electricity storage, and IEA PVPS Task 15 is an international collaboration to create an enabling framework to accelerate the penetration of BIPV products in the global market of renewables and building envelope components, resulting in an equal playing field for BIPV products, Building Added PV (BAPV) products and regular building envelope components, respecting mandatory, aesthetic, reliability and financial issues.
To reach this objective, an approach based on 5 key developments has been developed, focussed on growth from prototypes to large-scale producible and applicable products. The key developments are dissemination, business modelling, regulatory issues, environmental aspects, and research and development sites.

This Task contributes to the ambition of realizing zero energy buildings and built environments. The scope of this Task covers new and existing buildings, different PV technologies, different applications, as well as scale difference from 1-family dwellings to large-scale BIPV application in offices and utility buildings.

The current members of IEA PVPS Task 15 include: Austria, China, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Korea, Norway, The Netherlands, Spain, Sweden and Switzerland.

Further information on the activities and results of the Task can be found at www.iea-pvps.org.

Michiel Ritzen, operating agent IEA PVPS Task 15

May 2018

1. Introduction

This report provides an overview of current building-integrated photovoltaic (BIPV) definitions. The definitions have been used in standards to specify their scope, by funding programmes to differentiate between classes of photovoltaic systems that were eligible for different subsidies, and in collaborative research projects and programmes to achieve a common working understanding of the topic.

Based on the overview of existing standards provided in Section 2, the authors of the report provide definitions for BIPV products and BIPV systems for use within IEA-PVPS Task 15.

2. Existing definitions

2.1 From current standards and building code

2.1.1 EN 50583, Parts 1 and 2, Photovoltaics in buildings

EN 50583 distinguishes between modules (part 1) and systems (part 2) by providing a definition for BIPV modules used as construction products and a definition for BIPV systems (e.g., BIPV curtain wall systems) that are integrated into buildings. To clearly distinguish between building-applied[1] and building-integrated, definitions of building-applied modules and systems are also provided.

Building-integrated photovoltaic modules - BIPV modules
Photovoltaic modules are considered to be building-integrated, if the PV modules form a construction product providing a function[2] as defined in the European Construction Product Regulation CPR 305/2011. Thus, the BIPV module is a prerequisite for the integrity of the building's functionality. If the integrated PV module is dismounted (in the case of structurally bonded modules, dismounting includes the adjacent construction product), the PV module would have to be replaced by an appropriate construction product.

The building's functions in the context of BIPV are one or more of the following:

- mechanical rigidity or structural integrity
- primary weather impact protection: rain, snow, wind, hail
- energy economy, such as shading, daylighting, thermal insulation
- fire protection
- noise protection
- separation between indoor and outdoor environments
- security, shelter or safety

Inherent electro-technical properties of PV such as antenna function, power generation and electromagnetic shielding etc. alone do not qualify PV modules to be building-integrated.

Building-attached photovoltaic modules - BAPV modules
Photovoltaic modules are considered to be building-attached, if the PV modules are mounted on a building envelope and do not fulfil the above criteria for building integration.
(Negation: The integrity of the building functionality is independent of the existence of a building-attached photovoltaic module.)

Building-integrated photovoltaic system - BIPV system
Photovoltaic systems are considered to be building-integrated if the PV modules they utilize fulfil the criteria for BIPV- modules as defined in EN 50583 Part 1 and thus form a construction product pro-

[1] *Also known as building-attached or building-added. All terms are used interchangeably within this report.*
[2] *It is noted that this wording (from EN 50583) does not quote CPR 305/2011 accurately. An alternative proposal from Subtask C is provided in the Annex in Section 4.*

viding a function as defined in the European Construction Product Regulation CPR 305/2011.

Building-attached photovoltaic system - BAPV systems
Photovoltaic systems are considered to be building-attached, if the PV modules they utilize do not fulfil the criteria for BIPV- modules as defined in EN 50583 Part 1.

2.1.2 ISO/FDIS 18178 Glass in building - Laminated solar photovoltaic glass for use in buildings

Building-integrated photovoltaics (BIPV):
Photovoltaic materials that are used to replace conventional building materials in parts of the building envelope.
EXAMPLE: The building envelope would comprise the roof, skylights, or facades.

Building-attached photovoltaics (BAPV):
Photovoltaic materials that are not used to replace conventional building materials in parts of the building but simply attached to the building.

Laminated solar PV glass:
Laminated glass that integrates the function of photovoltaic power generation.

2.1.3 IEC 61730-1:2016 Photovoltaic (PV) module safety qualification

Part 1: Requirements for construction

Building integrated PV (BIPV)
PV modules are considered to be building integrated if the PV modules form a building component providing additional functions such as:

- mechanical rigidity or structural integrity
- primary weather impact protection: rain, snow, wind, hail
- energy economy such as shading, daylighting or thermal insulation
- fire protection
- noise protection

Thus, the BIPV module is a prerequisite for the integrity of the building's functionality. If the integrated BIPV module is dismounted, the PV module would have to be replaced by an appropriate building component.

2.1.4 IEC TS 61836:2016 Solar photovoltaic energy systems

Terms, definitions and symbols

Building-attached photovoltaics (Abbreviation: BAPV)
relates to photovoltaic modules fastened onto building construction materials

Building-integrated photovoltaics (Abbreviation: BIPV)
relates to photovoltaic modules providing one or more functions of the building envelope

2.1.5 Korean Standard (KS) C 8577:2016 Building integrated photovoltaics (BIPV) Modules

The requirement of performance evaluation

Building-integrated photovoltaic modules are considered to be building components installed as part of the building envelope, such as glazing, curtain wall and roof, which are simultaneously photovoltaic electricity generators. The BIPV modules in the standard are limited to crystalline silicon photovoltaic modules, and thin-film photovoltaic modules of amorphous silicon or CIS/CIGS solar cells. The definition only applies to glass-glass and glass-backsheet modules.

The requirements for BIPV modules include the following two aspects:

1) Structural requirements:

- mechanical rigidity or structural strength
- primary weather impact protection: rain, snow, wind, hail
- function as building components and considering aesthetic appearance

2) Electrical requirements in relation to performance and safety:

- satisfying some parts of existing standards, such as KS C IEC 61215 (Crystalline silicon terrestrial photovoltaic (PV) modules—Design qualification and type approval), KS C IEC 61646 (Thin-film terrestrial photovoltaic (PV) modules -Design qualification and type approval) and KS C IEC 61730 (Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction and Part 2: Requirements for testing).

2.1.6 Spanish Technical Building Code

Order FOM/1635/2013, 10th of September 2013

The Spanish Technical Building Code (Código Técnico de la Edificación, CTE) is the normative framework that establishes the safety and habitability requirements of buildings. Approved in 2006 and updated in 2013, it also addresses energy savings and partially transposes the European Directives 2002/91/EC, 2010/31/EU and 2009/28/EC to the Spanish legal order.

The Basic Document of the CTE includes a section named HE.5, which establishes a minimum installed photovoltaic power. This affects new building and retrofit actions of hypermarkets, multi-store and leisure centres, storage and distribution warehouses, covered sports facilities, hospitals, clinics and assisted residences, and exhibition hall pavilions.

The minimum required installed power is a function of the built-up area of the building and the climatic conditions. The PV modules shall be arranged such that the losses due to orientation, inclination and shading are lower than the limits indicated in Table 1. The limits depend on the "integration type": general (no integration at all), superposition (BAPV) or integration (BIPV).

Losses are expressed as a percentage of the annual solar irradiation which the PV modules would have received if they were facing south at the optimal tilt angle and were not shaded (maximum reference yield). The optimal tilt angle is latitude minus 10° in this case. If, due to exceptional architectural circumstances, after all feasible possibilities have been analysed, not all the power required can meet

the loss limits of the table, the solution shall be the option which comes closest to the maximum generation conditions.

Table 1 Maximum annual losses permitted by the Spanish CTE

Case	Irradiation losses (tilt angle and azimuth)	Shadow losses	Total
General	10 %	10 %	15 %
BAPV	20 %	15 %	30 %
BIPV	40 %	20 %	50 %

Definitions related to BAPV and BIPV are included in the glossary of the document:

Architectural integration of photovoltaic modules: photovoltaic modules that play a dual role as energy converters and architectural elements (cladding, enclosure, or shading) and additionally replace conventional building elements or are constituent elements of the architectural composition.

Superposition of photovoltaic modules: photovoltaic modules that are placed in parallel to the envelope of the building without the dual function defined in the architectural integration. Horizontal installation is not accepted, to favour self-cleaning.

A fundamental rule to follow in order to achieve integration or superposition of solar installations is to keep, as much as possible, the alignment with the main axes of the building.

2.1.7 Committee Draft of IEC 63092-1 ED1 (status as of 05.07.2018)

Building-integrated photovoltaics - BIPV

"BIPV modules" relates to photovoltaic modules providing one or more functions of the building envelope.

Moreover, the BIPV functions should be electricity generation and, depending on the application, one or more of the following:

- mechanical rigidity or structural integrity
- primary weather impact protection: rain, snow, wind, hail
- shading, daylighting, thermal insulation
- fire protection
- noise protection
- separation between indoor and outdoor environments
- security, shelter or safety

If a BIPV module is dismounted, it would have to be replaced by an appropriate construction product.

NOTE: The above definition is part of the draft version and the final published version may differ from this.

2.2 From cancelled or deleted standards

2.2.1 IEC 62980 ED1 Photovoltaic modules for building curtain wall applications (cancelled)

Photovoltaic (PV) on curtain wall:
It is defined as a PV module applied on a curtain wall of a building façade that has non-load bearing characteristics, but complies with the following functions: power generation, construction material and aesthetic performance.

2.2.2 IEC 63092 ED1 Photovoltaics (PV) on roof (status before October 2017)

The definitions quoted below were used in the version of IEC 63092 ED1 before October 2017. The IEC number is still active but the title and intended scope were changed in October 2017. See Section 0 for status as of 11.12.2017.

Photovoltaic module for roof materials
Glass-to-Tedlar (GtoT) type and Glass-to-Glass (GtoG) type modules using a backsheet made by bonding glass to glass together with a photovoltaic module.

Roof material system for photovoltaic power generation
A system enabling photovoltaic modules for roof material to replace original roof materials and generate electricity by changing part of the function of the roof's exterior materials.

2.3 From Funding Programmes

"Funding programmes" refers to publicly supported programmes to promote the installation and use of BIPV. This may be in the form of subsidised investments, advantageous loan conditions or special feed-in tariffs for electricity from a BIPV installation.

2.3.1 French Funding Programme

French Ministry of the Environment, Energy and the Sea, responsible for international relations concerning the climate.
Decree of 9th May 2017 specifying the conditions for purchase of electricity generated by solar photovoltaic installations on buildings with an installed peak power of 100 kW or less.

Criteria for Integration into Buildings

1. A photovoltaic system fulfils BIPV criteria if it meets the following four conditions:
    - 1.1 The photovoltaic system is installed on the roof of an enclosed building (on all vertical surfaces) and roofed to protect people, animals, property or activities. The photovoltaic system is installed in the same plane of inclination as the roof (defined below *).
    - 1.2 The photovoltaic system substitutes elements of the building which ensure that it is windproof and watertight. After installation, the photovoltaic module or film cannot be dismantled without damaging the sealing function provided by the PV system or making the building unsuitable for use.
    - 1.3 For photovoltaic systems composed of standard rigid modules, modules are the main sealing element of the system.
    - 1.4 For photovoltaic systems composed of flexible films, assembly is carried out at the factory or on site. On-site assembly is carried out under a single work contract.

2. As an exception to the provisions of the preceding paragraph, a photovoltaic installation meets the criteria for integration into the building when it fulfils all of the following conditions:
    - 2.1 The photovoltaic system is installed on an enclosed building (on all vertical surfaces) and roofed.
    - 2.2 The photovoltaic system fulfils at least one of the following functions:
        - 2.2.1 aprons/sills
        - 2.2.2 cladding
        - 2.2.3 sunshade
        - 2.2.4 curtain wall

*) Conditions fulfilled by a photovoltaic installation on the roof to be considered as being installed in the plane of the roof:

1. A photovoltaic installation covering an entire single-plane segment of a sloping roof or the entire area of a flat roof is considered as being installed in the plane of the roof.
2. A photovoltaic installation that does not cover an entire single-plane segment of a sloping roof or the entire area of a flat roof is considered to be installed in the plane of the roof if both of the following conditions are fulfilled:
    - 2.1 The plane of the photovoltaic system is parallel to the plane of the surrounding covering elements.
    - 2.2 The projection height of the photovoltaic system with respect to the plane of the surrounding covering elements is less than or equal to 20 mm.

2.3.2 Italian Funding Programme

4th FiT scheme "Conto Energia"

The Italian feed-in tariff (FiT) system, so-called "Conto Energia", was first introduced in July 2005 with four successive ministerial decrees.

The Decree sets new rules to support the production of electricity from PV plants and for the development of new technologies. It continues within the general framework already defined with the previous decrees of August 6, 2010 (Third FiT), February 19, 2007 (Second FiT) and July 28, 2005 (First FiT). These decrees were all implementing article 7 of Decree 387/2003.

The new decree is valid for PV plants commissioned after May 31, 2011 and before December 31, 2016, regardless of whether they are the result of new projects, total refurbishments or increase in capacity.

The concept of PV integration into buildings was introduced with the Second FiT, which set different tariffs according to the "integration level". It specifically defined the levels of building integration according to three different degrees of implementation (not integrated, partially integrated and integrated).

Partially integrated systems refers to PV modules installed both horizontally and inclined over flat roofing or with the same tilt of an underlying sloping roof. This category was addressed to the vast majority of the existing building stock, located in historical towns where only retrofit installations are allowed (so-called BAPV, Building-Attached Photovoltaics).

With the "**totally integrated plants**" category, rewarded with a higher tariff, the decree introduced the concept of substitution of a building component, however without specifying the functions that the PV element should have.

The subsequent decrees (third, fourth and fifth FiT) were issued to overcome this lack of specification, introducing the concept of "innovative BIPV" through the definition of two principles: first, product categories (according to specific construction features) and, second, the installation criteria.

According to Title III of the Decree (**integrated PV plants with innovative characteristics, BIPV**), PV plants using innovative modules and innovative components, developed specifically in order to be integrated and replace architectural elements of buildings, are eligible for a premium tariff. The plants shall have a minimum capacity of 1 kW and a maximum capacity of 5 MW.

The **PV module** can be considered **building integrated** if its use is possible and effective only for architectural applications. The solar module consists of a special building product, a single and indivisible unit, which is commercially identified and certified in accordance with technical standards specified in Annex 1 to the Decree (both electrical and construction standards are listed in this annex). This class includes all flexible PV modules certified together, their support and all rigid PV modules that, without further components, replace building elements, such as photovoltaic tiles and transparent modules for facades, roofs and windows installed in order to admit light into the building.

The innovative PV module or the PV surface (in the case of innovative components) ensures electricity generation as well as the typical functions of building envelope such as:

- the watertight seal of the building structure
- a mechanical seal equivalent to the replaced element of the building
- a thermal barrier not reducing the energy performance of the building

The meaning of "**Architectural integration of photovoltaics**" is that the removal of the photovoltaic modules damages the functionality of the building, making it unfit for its use.

2.3.3 Swiss Funding Programme

In order to encourage the use and promote the social acceptance of solar technology (reducing also the return on investment, ROI), with special attention to integration into buildings, various incentives have been introduced by the Swiss Federal Office of Energy, utilities and various cantons. This is also the case of the incentive systems that since 2014 provide favourable conditions for investment in building-integrated PV applications. The Federal incentive system recognizes two types of contributions for buildings: building-attached PV (BAPV) and building-integrated PV (BIPV). Another category recognized is that of isolated (ground-mounted) PV.

The Directive defining the criteria for feed-in remuneration of Building Integrated Photovoltaics was published on 03/04/2014 by the Federal Office of Energy.

As stated by EnEV N.2.3, **PV systems** are considered to be "**Building-Integrated**" when they provide thermal insulation, security or protection against the weather, in addition to generating electricity. More specifically, photovoltaic systems are considered to be building-integrated if the PV modules replace a building component providing a function as defined for example in the European Construction Product Regulation CPR 305/2011 (or by the 933.0 Bauproduktegesetz, BauPG). Thus, the building function of PV is a prerequisite for the integrity of the building's functionality. If the integrated PV module is dismounted (e.g. in the case of structurally fixed modules, dismounting includes the adjacent building component), the PV module has to be replaced by an equivalent building component that is able to satisfy the same technological requirements (e.g. water-tightness, mechanical resistance, etc.). This means that the BIPV installation cannot be simply mounted onto a traditional building envelope (e.g. roof or façade) as an added layer only satisfying some secondary building requirements (linked to the passive role of the superposed PV modules). In other words, the PV layer cannot be separately removed from the building envelope without compromising a technological/structural primary requirement of the layer underneath or of the whole building envelope (which is, by definition, incomplete without the BIPV component).

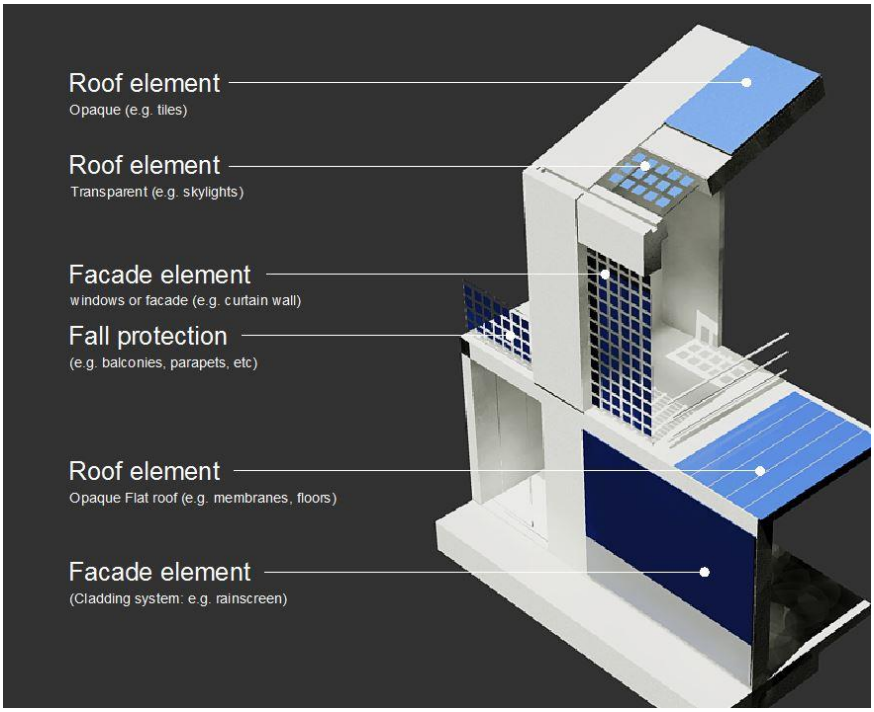

Figure 1: Examples for integration of PV elements as part of the building skin. (Source: SUPSI)

The building functions that a BIPV system has to satisfy are one or more of the following:

- primary protection against weather (such as rain, snow, etc.)
- thermal and solar protection: (such as insulation, sun-shading, daylighting)
- protection against falling (such as balconies, parapets, etc.)

All other cases are not considered to be covered by the building-integration criteria of the EnEV N.2.3 PV.

Furthermore, a BIPV system, as a normal construction work, must be generally designed and built in such a way that it does not present unacceptable risks to people of accidents or damage in service or in operation as a whole and in its separate parts, throughout the entire lifecycle of the building. Therefore, the BIPV system, depending on the specific context, has to satisfy basic requirements for building components such as mechanical resistance and stability, safety in case of fire, hygiene and health of people, safety and accessibility in use, protection against noise as well as energy economy and sustainable use of natural resources. Inherent electro-technical properties of PV alone, such as power generation, yield, electromagnetic shielding etc., do not qualify PV elements to be classified as building-integrated.

To summarise, in general, a BIPV system must always fulfil another function/requirement in addition to electricity generation, as stated in the aforementioned list (multifunctionality or double function criteria), for specific building envelope units.

More detailed information, including schematic diagrams and drawings, can be found in chapters 2.2, 2.3 and 2.4 of the Swiss Directive.

Official source: Swiss Federal Office of Energy (SFOE)
http://www.bfe.admin.ch/themen/00612/02073/index.html?lang=it&dossier_id=02168 (latest access: November 2017)

2.3.4 Chinese Funding Programme

Source: IEA PVPS National Survey Report of PV Power Applications in China 2012

According to the China National Photovoltaic Status Report 2012 II of 16 July 2013, the following definition of BIPV has applied to the various funding programmes described in Table 2: “BIPV is defined as building-integrated PV, which requires that the building team along the entire supply chain - including architects, building designers, engineers, building owners and utility companies - works together to design and install the specially designed PV modules into the building’s "skin" as an element, from the inception of the project onwards. This applies particularly to the usage of solar building material, such as solar tiles, solar façades and solar shingles.”

Table 2 Overview of Chinese funding programmes for renewable energy, including BIPV

Utility-scale PV		
Phases	Approved Capacity	Feed-in Tariff (RMB)
2011 FIT	2000MW	FIT = 1.15 Yuan/kWh
2012 FIT	2000MW	FIT = 1.0 Yuan/kWh
Total（2009 - 2012）	4300MW	800MW waiting for grid connection
Financial Source	**Renewable Energy Surcharge**	
PV Building Project		
Phases	Approved Capacity	Subsidy to Capital（Yuan/W）
3rd phase, 2011	106 projects，120MW	BIPV 12 Yuan /W
4th phase, 2012	250MW	BIPV 9 Yuan /W, BAPV 7.5 Yuan /W
Total（2009 - 2012）	500MW	
Financial Source	**Special Fund for Renewable Energy**	
Golden Sun Demonstration		
Phases	Approved Capacity	Subsidy to Capital（Yuan/W）
3rd Phase 2011	140 projects，690MW	C-Si 9.0 Yuan /W, a-Si 8.5 Yuan /W
4th Phase 2012	167 projects, 1709MW	PV Building 5.5 Yuan /W， off-grid >7.0 Yuan /W
Total（2009 - 2012）	2870MW	
Financial Source	**Special Fund for Renewable Energy**	
Additional PV Building Project and Golden-Sun Demonstration		
Nov. 2012	2830MW	BIPV 7 Yuan /W, BAPV 5.5 Yuan /W
Financial Source	**Special Fund for Renewable Energy**	
Total Installed and Approved PV by the end of 2012 is 10500MW		

2.3.5 Information on BIPV Definitions by Funding Programmes in Other Countries

Canada does not have specific funding programmes for BIPV or programmes that differentiate BIPV from BAPV.

Norway does not have specific funding programmes for BIPV or programmes that differentiate BIPV from BAPV.

The Netherlands do not have specific funding programmes for BIPV or programmes that differentiate BIPV from BAPV.

2.4 From IEA Tasks and Research Projects

2.4.1 IEA SHC Task 41 Solar Energy and Architecture

Within the framework of the IEA SHC Task 41, "Solar Energy and Architecture", the **architectural integration quality** of a solar energy system (either photovoltaic or solar thermal) is defined as the result of a controlled and coherent integration of the solar collectors simultaneously from all points of view. In particular, the integration has to consider three aspects:

1. Functional integration
2. Constructive integration
3. Formal (aesthetic) integration

In particular, the first two sets of criteria refer to the multifunctionality of the solar system taking over one or more envelope functions. Taking over this building function is important to ensure that the multifunctional envelope system meets all building construction standards, such as:

- The collector load should be correctly transferred to the load-bearing structure through appropriate fixtures.
- The collector should withstand fire and weather wear and tear.
- It should resist wind load and impact, and should be safe in case of damage.
- Risks of theft and/or damage related to vandalism should be evaluated and appropriate measures taken.
- The fixing should avoid creating thermal bridges and the global U value of the wall should not be negatively affected.
- Vapour transfer through the wall should not encounter condensation layers, so that the wall can dry correctly.

Besides these standard building construction constraints, the integration of solar systems implies other issues resulting from specific solar technology attributes, i.e. the presence of a hydraulic system (for solar thermal) or electric cabling (for PV) and the high temperatures of some modules.

The third criterion (formal) refers to all the system characteristics affecting building appearance (i.e. system formal characteristics) that should be coherent with the overall building design:

- position of the modules
- module size and shape
- jointing types

The formal characteristics of the system are strongly dependent on the specific solar technology, which imposes the core components of the solar modules, with their specific shapes and materials.
For more information please consider Report T.41.A.2: Solar energy systems in architecture: integration criteria and guidelines available here: http://task41.iea-shc.org/publications (accessed May 2017)

2.4.2 European Research Programme Horizon 2020

Work programme 2018-2020 of the Horizon 2020, Part 10 "Secure, clean and efficient energy" (27 October 2017)

Within the specific call *LC-SC3-RES-6-2018: Demonstrate significant cost reduction for building-integrated PV (BIPV) solutions"*, BIPV is given the following definition:

"BIPV need to satisfy multiple building functions such as mechanical rigidity and structural integrity; primary weather impact protection including rain, snow, wind, etc.; energy economy, such as shading, daylighting, thermal insulation; fire protection, noise protection, in addition to architectural and aesthetic considerations, so as to replace roofs, facades and shading devices."

2.4.3 EU-funded Construct-PV project

"A photovoltaic or solar thermal component on a building is defined to be 'building-integrated' if it is required to meet one or more specifications according to the European Construction Product Regulation (EU) No.305/2011 (CPR) or national standards for construction products, which go beyond the requirements of product standards for photovoltaic or solar-thermal components, respectively."
By the definition, the building's functions that apply for the BIPV products are the following:

- mechanical rigidity and structural integrity
- primary weather impact protection: rain, snow, wind and hail
- energy economy, such as shading, daylighting, thermal insulation
- fire protection
- noise protection

2.4.4 EU-funded Dem4BIPV project "Development of innovative educational material for Building-integrated PV" (November 2016)

While the field of application of BIPV has been defined in various ways, as a general rule these specific products always serve a dual and full function as construction and electricity-producing components. "Building-Integrated Photovoltaic modules are considered to be building-integrated, if the PV modules form a construction product providing a function as defined in the European Product Regulation CPR 305/2011. Thus the BIPV module is a pre-requisite for the integrity of the building's functionality. If the integrated PV module is dismounted (in the case of structurally bonded modules, dis-mounting includes the adjacent construction product), the PV module would have to be replaced by an appropriate construction product" (ÖVE/ÖNORM 2015). BIPV modules could be considered as "integral" elements of the building contributing not only as a technical unit by generating electricity, but also as functional units by being essential parts of the building skin and replacing conventional building materials.

2.4.5. Architectural Solar Association

Source: https://www.archsolar.org/what-is-bipv

BIPV is defined as "a photovoltaic generating component which forms an integral and essential part of a permanent building structure without which a non-BIPV building material or component would be required to replace it. The performance of power generation by a BIPV component is deemed to be secondary to the role of being a building material or structural component.

BIPV occupies a space in the building design such that, if removed from that space, its absence will be distinct and noticeable."

3. Conclusions and Recommendations for IEA-PVPS Task 15

The reviewed current standards agree in requiring a PV module or system to have (at least) dual functionality as an electricity generator and a building component to qualify as building-integrated photovoltaics. Typical functions of building components that can be fulfilled by BIPV elements are specified. Removal of the BIPV element would require its replacement by an equivalent conventional building component.

Most of the reported national funding programmes, which often promote the installation of BIPV systems with more favourable conditions than for other PV installations, follow the same general criteria to define BIPV as in current standards, but specify them in more detail and provide more examples. The French definition includes specific geometric criteria for building integration of PV systems. Referring to a BIPV module, the Italian definition limits its possible and effective use to architectural applications. The Italian definition also introduces the concept of "a special building product, a single and indivisible unit, which is commercially identified and certified in accordance with technical standards". In Spain, in addition to dual-functionality criteria, permissible relative losses in annual electricity yield due to incident radiation level and shading are used to differentiate expectations on BIPV, BAPV and "general" PV installations. The Chinese criterion for BIPV differs from the others in that it regards "integration" as being evidenced by close collaboration along the whole supply chain of the building team that implements a BIPV installation.

Most of the definitions used by research programmes and projects are similar to those of current standards. An exception is the definition of IEA-SHC Task 41, which explicitly introduces the concept of "formal (aesthetic) integration". This is a concept which is usually considered to be outside the scope of technical standards and guidelines that provide the framework for specifications. The "dual functionality" of generating electricity and serving a specific and integral purpose as a building component is common to almost all reviewed definitions. To serve a useful purpose in technical standards, it is beneficial to recognise the widespread division of responsibility for products, usually taken by the manufacturer or a single on-site assembler, and systems, usually assumed by the system provider/installer.

Taking the observations above into account, the following definitions are recommended as a basis of common understanding within IEA-PVPS Task 15 for use within Subtask C for proposals concerning BIPV standards:

A BIPV module is a PV module and a construction product together, designed to be a component of the building. A BIPV product is the smallest (electrically and mechanically) non-divisible photovoltaic unit in a BIPV system which retains building-related functionality. If the BIPV product is dismounted, it would have to be replaced by an appropriate construction product.

A BIPV system is a photovoltaic system in which the PV modules satisfy the definition above for BIPV products. It includes the electrical components needed to connect the PV modules to external AC or DC circuits and the mechanical mounting systems needed to integrate the BIPV products into the building.

The motivation behind providing separate definitions for BIPV products and BIPV systems is to separate spheres of liability, as the product manufacturer is usually not identical with the system designer/installer. This is also the reason for the (admittedly wordy) attempt to define the boundary of a BIPV product.

4. Annex: Comments on EN 50583 definitions

4.1 Comment A

The IEA-PVPS Task 15, Subtask C recommends that in future revisions of EN 50583, the first sentence of the definition be replaced by:

'*Photovoltaic modules are considered to be building-integrated, if the PV modules form a construction product* ***meeting a "basic requirement for construction works" or their parts*** *as defined in the European Construction Product Regulation CPR 305/2011.'*

The sentence introducing the bullet points should be reformulated as:

'The basic requirements for construction works or their parts, that are to be met in the context of BIPV*, are one or more of the following:'*

4.2 Comment B

The EN 50583 has the great advantage of trying to combine technical standards from the electric 'Photovoltaic World' with those from the "Building World". This is expressed in the scope:

1 Scope
This document applies to photovoltaic modules used as construction products. It focuses on the properties of these photovoltaic modules relevant to essential building requirements as specified in the European Construction Product Regulation CPR 305/2011, and the applicable electro-technical requirements as stated in the Low Voltage Directive 2006/95/EC / or CENELEC standards. This document references international standards, technical reports and guidelines. For some applications, in addition, national standards (or regulations) for building products may apply in individual countries, which are not explicitly referenced here and for which harmonized European Standards are not yet available.

In the further details of the standard and especially in the BIPV definition, the Construction Product Regulation CPR 305/2011 has been referenced in a way which is open to misinterpretation.

The problems occurring with this definition of BIPV in EN 50583 can be summed up as follows:

- A distinction between BIPV, BAPV and roof top PV cannot be made by quoting the CPR 305/2011 as all three are Construction Products according to the Construction Product Regulation.
- The CPR 305/2011 does not define construction product functions.
- The CPR 305/2011 lists basic requirements, which are mainly meaning that a construction product must be safe and not do any harm (it must not emit noise, shall not emit poisonous gases or liquids, should not fall down, shall not be easy inflammable etc.). This is not to be misinterpreted as meaning that a construction product needs to be noise-insulating, fire-protecting, etc.
- All products incorporated in a permanent manner in construction works are defined as construction products by the CPR 305/2011 and need to fulfil basic requirements as well as the mandatory standards and regulations of construction.
- In the CPR 305/2011, 'incorporated' does not mean the same as the so-called 'integration' quoted for BIPV. 'Incorporated' just means to be 'a part of' a construction work. This is what BAPV and roof-top PV are as well.
- Roof-top PV and BAPV, just like BIPV, have to meet the basic requirements for construction works and to comply with the applicable and relevant mandatory technical standards and regulations for construction works and buildings.
- BIPV, BAPV and roof-top PV systems all have an effect on the performance of the construction works.

The 'Construction Product Regulation EU No 305/2011' defines a Building Product as the following (direct quote from EU No 305/2011, Article 2. Definitions):

For the purposes of this Regulation the following definitions shall apply:

1. 'construction product' means any product or kit which is produced and placed on the market for incorporation in a permanent manner in construction works or parts thereof and the performance of which has an effect on the performance of the construction works with respect to the basic requirements for construction works;
2. 'kit' means a construction product placed on the market by a single manufacturer as a set of at least two separate components that need to be put together to be incorporated in the construction works;
3. 'construction works' means buildings and civil engineering works.

The definition means that any device which is incorporated in a permanent manner in a construction work is defined by the 'Construction Product Regulation EU No 305/2011' to be a construction product.

Whenever a PV/BIPV-module is attached in a permanent manner to a construction work, besides the Low Voltage Directive and their related harmonized standards, the applicable harmonized standards of the EU Construction Product Regulation apply as well.

This means that the differentiation between BAPV and BIPV cannot be drawn from the CPR and the Low Voltage Directive as the applicable harmonized standards of the EU Construction Product Regulation apply to both BAPV and BIPV.

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