This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement № 817991

Update on regulatory framework for BIPV

BIPVBOOST

"Bringing down costs of BIPV multifunctional solutions and processes along the value chain, enabling widespread nZEBs implementation"

Start date: October 2018. Duration: 4 Years

Coordinator: TECNALIA Grant Agreement No: 817991 www.bipvboost.eu

Summary

This document provides a complete overview of the current regulatory framework influencing building integrated photovoltaics (BIPV) in key European countries.

The first part focuses on the European-level regulation. The different definitions of BIPV are rapidly evoked, followed by a review of technical standards and building regulations influencing BIPV. Then, the main European Directives on the topic of energy, potentially impacting the development of BIPV, are reviewed. Their main features are highlighted as well as their possible influence on BIPV.

The second part consists in a detailed inventory of country-specific regulations existing in the European countries analyzed, namely Belgium, France, Germany, Italy, The Netherlands, Spain and Switzerland. These countries have been mainly selected because they are home markets of projects' partners, but also because, historically, they are important PV and/or BIPV markets in Europe. For each of these countries, the different support schemes applied to distributed PV installations are listed, as well as the building codes impacting BIPV installations. Information on costs, fees and grid access are also provided. Each sub-section ends with summarizing tables, to facilitate comprehension. They include information such as the logic of the support mechanisms, their duration or the exact level of remuneration provided.

Finally, the document is concluded with a brief discussion on the main regulatory trends identified across the analyzed countries and the points for improvement to be prioritized by policy-makers in order to stimulate the development of the BIPV market.

Document Information

Title	"Regulatory framework for BIPV"
Lead Author	ICARES (Becquerel Institute)
Contributors	CSTB, SUPSI, TECNALIA, TULiPPS
Date	April 2019

Acknowledgements

The work described in this publication has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 817991.

Disclaimer

This document only reflects the authors' view and not that of the European Commission. This work may rely on data from sources external to the members of the BIPVBOOST project Consortium. Members of the Consortium do not accept liability for loss or damage suffered by any third party as a result of errors or inaccuracies in such data. The information in this document is provided "as is" and no guarantee or warranty is given that the information is fit for any particular purpose. The user thereof uses the information at its sole risk and neither the European Commission nor any member of the BIPVBOOST Consortium is liable for any use that may be made of the information.

Contents

Tables

Figures

1 EXECUTIVE SUMMARY

1.1 Description of the deliverable content and purpose

This document provides a complete overview of the current regulatory framework influencing building integrated photovoltaics (BIPV) in key European countries.

The first part focuses on the European-level regulation. The different definitions of BIPV are rapidly evoked, followed by a review of technical standards and building regulations influencing BIPV. Then, the main European Directives on the topic of energy, potentially impacting the development of BIPV, are reviewed. Their main features are highlighted as well as their possible influence on BIPV.

The second part consists in a detailed inventory of country-specific regulations existing in the European countries analyzed, namely Belgium, France, Germany, Italy, The Netherlands, Spain and Switzerland. These countries have been mainly selected because they are home markets of projects' partners, but also because, historically, they are important PV and/or BIPV markets in Europe. For each of these countries, the different support schemes applied to distributed PV installations are listed, as well as the building codes impacting BIPV installations. Information on costs, fees and grid access are also provided. Each sub-section ends with summarizing tables, to facilitate comprehension. They include information such as the logic of the support mechanisms, their duration or the exact level of remuneration provided.

Finally, the document is concluded with a brief discussion on the main regulatory trends identified across the analyzed countries and the points for improvement to be prioritized by policy-makers in order to stimulate the development of the BIPV market.

1.2 Relation with other activities in the project

The regulatory details gathered in this document are crucial as they allow to estimate, for each country and system capacity range, the revenues and costs associated with BIPV solutions, as well as the rules these solutions must comply with. Hence, this document was used as a main source of information for activity 1.1 "Identification of current cost competitiveness of BIPV solutions and assessment methodology". It will also be used in Work Package 8, as support to the preparation of the demo sites and the development of business cases.

1.3 Abbreviation list

AC: alternating current

BAPV: building applied photovoltaics

DC: direct current

DSO: distribution system operator

EN: European standard

FiT: feed-in tariff

FiP: feed-in premium

IEC: International electrotechnical commission

kW: kilowatt, which indicates the nominal capacity of a PV system

PV: photovoltaic

TSO: transportation system operator

2 GENERAL OVERVIEW

2.1 BIPV products' definitions and requirements

Building integrated photovoltaics (BIPV) are defined as construction materials and building components including solar PV cells. According to the IEA PVPS Task 15 Report on "International definitions of BIPV" [1], 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. To be recognized as BIPV, as defined by various standards such as **EN 50583 or IEC 61730-1:2016**, the BIPV element must provide one or several additional function(s) to electricity generation. Among others, and mainly:

- 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.

This means that a BIPV element is part of the building envelope and, once installed, cannot be removed without modifying the integrity of the building's functionality. In such case, it would have to be replaced by another construction element fulfilling the same function. BIPV elements are assembled to create BIPV systems. It is worth noting that a BIPV system can potentially be made of usual solar PV modules. Indeed, the latter can fulfil the functions of building components such as water tightness and noise protection if appropriately installed and combined with specific accessories. Such cost-limited configuration would just require small technical adaptations, like the use of frameless PV modules or of a specific mounting system.

BIPV elements can be used to renovate existing buildings or build new ones. However, there are less constraints in the case of new buildings, or at least project's characteristics should be more flexible. Plus, by including the choice of BIPV from the initial stages of the project development process (i.e. the design phase) the integration of the system is facilitated.

2.1.1 Country-specific criteria for BIPV

The "International definitions of BIPV" report, published by IEA PVPS Task 15 [1], specifies how various national funding programs follow the same general criteria to define BIPV as in standards mentioned above and how some of them are more detailed and provide more examples. These definitions exist as some regulators have promoted or promote the installation of BIPV systems, through more favorable support scheme conditions than for regular PV installations. It should be kept in mind that, although these criteria exist, BIPV systems do not benefit anymore of special rules compared to other distributed PV systems.

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" to identify BIPV. 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.

Then, research programs and projects refer to “BIPV” definitions comparable to those of current standards, with some exceptions. The definition of IEA-SHC Task 41, for instance, explicitly introduces the concept of “formal (aesthetic) integration”, which is usually considered to be outside the scope of technical standards and guidelines providing the framework for specifications. The “dual functionality” of generating electricity and serving as a building component is common to almost all existing definitions.

2.1.2 General definition

Taking all the observations above into account, and referring to the IEA PVPS Task 15 report’s conclusions, the following definitions are recommended as a basis of common understanding 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.”

Thus, to date, there is no "standard" definition of building integrated photovoltaics modules and systems. European standard EN 50583 can be mentioned, but it does not imply a compulsory, internationally accepted definition. Therefore, ongoing discussions and work on this matter are taking place, for example, in the frame of IEC TC82. The resulting international standard for BIPV, which is expected to be finalized in the coming months, should bring answers to some of these pending questions. Finally, it should be noted that BIPV qualification procedures will be more detailed within the frame of WP5 “Cost reduction based on performance levels and advanced standardization schemes for BIPV”. The present report aims at providing an overview and comprehension of existing key regulatory aspects influencing BIPV installations.

2.2 Existing technical standards impacting BIPV products

As mentioned above, BIPV is defined in multiple official European and international standards and national building codes. Given their unique capability of simultaneously combining the characteristics of an electrical device and a building component, BIPV elements must comply with building-related codes and standards, including fire regulation, but also with electrotechnical requirements. The standards to respect can also be categorized as a function of their perimeter of influence: International, European or National.

Table 2-1 Technical standards impacting BIPV products

PV standards	Building standards
IEC International Electrotechnical Commission	**ISO** International Organization for Standardization
CENELEC European Commission for Electrotechnical Standardization	**CEN** European Committee for Standardization

Two other types of technical standards can be mentioned, though they are not listed in the table above because specifically related to Switzerland: CES (Comité Electrotechnique Suisse) among the PV standards, and SIA (Schweizerische Ingenieur- und Architekten-Verein) among the building standards.

Note that there are differences in requirements as a function of the final application area: roof or façade. Plus, there are in some cases significant variations between countries, even within the European Union. Nevertheless, most countries simply transpose into their national regulation the standards and rules defined at the European level (EN). The most important ones are presented here below.

2.2.1 PV modules and system standards

IEC/EN 61215:2016 is a qualification for PV modules, regardless of the technology. Officially, it "lays down requirements for the design qualification and type approval of terrestrial photovoltaic modules suitable for long-term operation in general open-air climates", as defined in **IEC 60721-2-1**. The objective of this standardized testing is to determine the electrical and thermal characteristics of the module and to show, as far as possible within reasonable constraints of cost and time, that "the module is capable of withstanding prolonged exposure in climates described in the scope." It covers the parameters which are typically responsible for the ageing of PV modules. This includes all forces of nature:

- Sunlight including UV
- Climate (changing of climate, coldness, warmth, humidity)
- Mechanical load (hail, wind suction, wind pressure, snow; parameters which are responsible for the ageing of PV modules).

IEC/EN 61646, which was highly identical to IEC/EN 61215 but specific to thin-film PV modules, has been withdrawn. Now only **IEC/EN 61215** exists anymore and **covers all PV technologies**, whereas it was used to be exclusively related to crystalline silicon modules.

IEC/EN 61730-1:2016 "specifies and describes the fundamental construction requirements for photovoltaic (PV) modules in order to provide safe electrical and mechanical operation. Specific topics are provided to

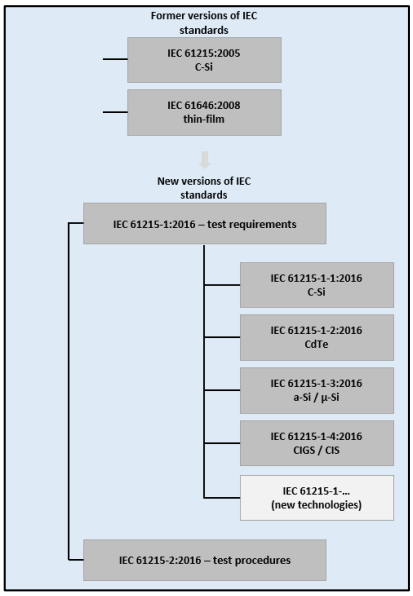
assess the prevention of electrical shock, fire hazards, and personal injury due to mechanical and environmental stresses. This part of IEC 61730 pertains to the particular requirements of construction, whereas IEC 61730-2 defines the requirements of testing. This standard is intended to apply to all terrestrial flat plate module materials such as crystalline silicon module types as well as thin-film modules." However, note that this standard includes a specific reference as well to BIPV, as mentioned previously, in its **"Part 1: Requirements for construction"**. 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.

The BIPV module is thus 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.

Multiple cross references exist within these standards, referring to multiple standards such as IEC 60364-4-41 relative to the protection against electric shock or others like IEC 60891, IEC 60904, IEC 61853 and IEC 61724, regarding qualification of PV modules and systems characteristics and performances, for example. These are not detailed here but must be of course fulfilled as well by (BI)PV modules manufacturers.

Figure 2.1: Former and new versions of IEC PV module (Source: Fraunhofer ISE)



2.2.2 Building standards and technical specifications

As already mentioned above, since photovoltaic modules are to be used as buildings' envelopes components or inserted into it, they must satisfy both the standards related to the electrical characteristics of photovoltaic modules and those related to buildings. Hence, as construction products, BIPV elements available on the European market must comply with the **European Construction Product Regulation CPR 305/2011** [2].

In function of the application area, the orientation, the design and the technical characteristics of the BIPV elements as well as of the system, required standards and regulations will vary. In the case of a façade solution, standards to comply with will not be the same if it is a curtain wall installation or a ventilated façade. In addition, it will vary according to the aimed functions or performance to be fulfilled as a building component (noise protection, thermal insulation, sound insulation, etc.). Then, when it comes to the type of standards for a construction installation, they can be of different nature, and consequently to this, the standards to comply with can differ widely and be numerous.

For example, for a façade curtain wall, a sample of the potential requirements is as follows:

- EN 14449 “Glass in building – Laminated glass and laminated safety glass”
- EN 12150 “Glass in building – Thermally toughened soda lime silicate safety glass”
- EN 1279 “Glass in building – Insulating glass units”
- EN 12154 “Curtain wall – Air permeability”
- EN 12155 “Curtain wall – Water tightness”
- EN 12179 “Curtain wall – Resistance to wind”
- EN 13947 “Thermo-technical behavior of curtain walls”
- EN 1364-3 “Fire resistance proof of non-supporting components”
- EN 14019 “Curtain wall – impact strength – performance requirements”
- EN 13830 “Curtain wall – product standard”.

Note that this list is not exhaustive, and all standards are not required. The same reasoning can be applied to roofing solutions.

For more examples, an exhaustive and schematic analysis of EN 50583 - parts 1 and 2 - has been provided by PVSITES project report on “Standardization needs for BIPV” [3], and is reported in Annex I. Moreover, as evoked, this matter will be discussed in further details in the frame of WP5 of BIPVBOOST project.

2.2.3 Standards specific to BIPV

In order to simplify compliance with standards for BIPV and avoid possible blurry areas, specific standards have been/are being developed. They combine techno-electrical requirements and building codes.

At the European level, a standard was finalized and published in 2016, after five years of work. It focuses mainly on mechanical features, as electrical features and test procedures are already stated in elder standards like **IEC 61215, 61646** or **61730**, among others. **EN 50583:2016** refers to photovoltaic modules used as construction products. It also 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 [4], the Electro-Magnetic Compatibility Directive [5], the Directive on Waste of Electrical and Electronic Equipment [6] or CENELEC standards.

EN 50583:2016 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 (BAPV) and building-integrated (BIPV), definitions of building-applied modules and systems are also provided.

EN 50583-1 "BIPV modules": Photovoltaic modules are considered to be building-integrated if the PV modules form a construction product providing a function 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 atmospheric agents 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.

EN 50583-2 "BIPV systems": 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 providing a function as defined in the European Construction Product Regulation CPR 305/2011.

In this standard, 5 categories of BIPV mounting systems are identified:

- A: Sloped (0° to 75°), roof-integrated, not accessible from within the building
- B: Sloped (0° to 75°), roof-integrated, accessible from within the building
- C: Non-sloped (75° to 90°) mounted not accessible from within the building
- D: Non-sloped (75° to 90°) mounted accessible from within the building
- E: Externally integrated, accessible or not from within the building (e.g. balconies, louvres, balustrades, shutters etc.).

This definition is a first step but still contains inaccuracies and neglects, mainly regarding the part related to construction product's characteristics. For example, BIPV as well as BAPV could be considered as construction products by the CPR. Indeed, this CPR does not define the functions of construction products. In addition, this standard does not consider the potential specific requirements necessary in certain countries for building components. These are only a few of the numerous remaining issues with this standard, which explains why it is not yet widely used. Updates are highly needed.

The IEC is also working on a specific definition of BIPV, through its Technical Committee 82. To date, the **IEC 63092 standard is still a draft** [7] and few information is available about the technical requirements included, though it closely follows the European standard. Thus, in this document, the definition of BIPV is coherent with the standards mentioned above. More specifically:
"Photovoltaic modules are building-integrated, if they have been designed following the basic requirements for construction works in order to form and/or replace a construction product. The basic requirements for construction works are:

- Mechanical resistance and stability
- Safety in case of fire

- Hygiene, health and the environment
- Safety and accessibility in use
- Protection against noise
- Energy economy and heat retention
- Sustainable use of natural resources.

Then, as already mentioned, 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.

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

Table 2-2: Summary of standards impacting BIPV systems

Standard	Topic
EN 50583-1	PV modules used as construction products
EN 50583-2	PV systems integrated into buildings (structural aspects)
IEC 63092-1 (draft)	BIPV modules. Based on EN 50583-1
IEC 63092-2 (draft)	BIPV systems. Based on EN 50583-2
ISO 52000-1 and other parts	Energy Performance of Buildings
EN 15316-4-3	Method for calculation of system energy requirements and system efficiencies
prEN 50331-1 (draft)	Safety requirements for PV in buildings

2.2.4 European Technical Approval Guidelines (ETAGs)

Generally, one or several building functions are realized by BIPV modules (like weather protection, thermal insulation, noise protection, etc.), ensuring that conventional building product can be omitted. BIPV elements can be used to build roofs, facades, overhead glazing, balustrades, semi-transparent windows or skylights.

In this context, **European Technical Approval Guidelines (ETAGs)** can serve as the basis for constructing the regulatory framework of BIPV products and provide relevant input for BIPV manufacturers [8].

Table 2-3: Main existing ETAGs applicable to BIPV (Source: PVSITES project)

ETAG impacting BIPV products	
ETAG 002	**Structural Sealant Glazing Systems** Part 1: Supported and Unsupported Systems Part 2: Coated Aluminum Systems Part 3: Systems incorporating profiles with thermal barrier

	This guideline relates to Structural Sealant Glazing Kits (SSGK) for use as facades and roofs, or parts thereof, with glazing at any angle between vertical and 7° above horizontal.
ETAG 034 (replaced by EAD 090062-00-0404)	**ETAG of kits for external wall claddings** Part 1: Ventilated cladding kits comprising cladding components and associated fixings. Part 2: Cladding kits comprising cladding components, associated fixings, sub-frame and possible insulation layer. This ETAG sets out: - The performance requirements for cladding kits - The verification methods used to examine the various aspects of performance - The assessment criteria used to judge the performance for the intended use - The presumed conditions for the design and execution.

Since 2014 and based on a specific agreement with the European Commission, the European Organisation for Technical Assessment (EOTA) develops the ETAGs into EADs following the requirements set up in the European Construction Products Regulation No 305/2011. This will lead to modifications of the structure as well as of the content. Unless otherwise noted, technical changes are not envisaged to be considered.

Thus, on 16 November 2018, the reference to the European Assessment Document **EAD 090062-00-0404 "Kits for external wall claddings mechanically fixed"** was published in the Official Journal of the European Union, through Communication 2018/C 417/07, to replace the ETAG 034 [9]. The **EAD 090062-00-0404** covers kits for ventilated and non-ventilated facades with mechanical cladding elements (as did ETAG 034). This EAD is the result of the conversion work of ETAG 034 to an EAD, considering the criteria of the Construction Products Regulation and some new features, introduced at the request of the European Commission [10]. More transformed ETAGs have been published in early 2019.

2.3 Main EU policies impacting BIPV

In November 2016, the European Commission published its "Clean Energy for All Europeans" initiative [11]. In this regard, the EU is in the process of updating its energy policy framework in a way that will facilitate the clean energy transition and make it fit for the 21st century. Negotiations have now been concluded on all aspects of the new energy legislative framework, and all the new rules will be formally adopted in the first few months of 2019, if not already.

The new policy framework brings regulatory certainty, through the introduction of the first national energy and climate plans and will encourage essential investments to take place in this important sector. It empowers European consumers to become fully active players in the energy transition and fixes two new targets for the EU for 2030: **a binding renewable energy target of at least 32% and an energy efficiency target of at least 32.5% - with a possible upward revision in 2023**. For the electricity market, it confirms the 2030 interconnection target of 15%, following on from the 10% target for 2020. These ambitious targets will stimulate Europe's industrial competitiveness, boost growth and jobs, reduce energy bills, help tackle energy poverty and improve air quality.

To strive towards a long-term greenhouse gas reduction objective, the framework also sets up a robust governance system for the Energy Union, and each Member State is now required to draft integrated national energy and climate plans for 2021 to 2030 outlining how they will achieve their respective targets.

The package also outlines specific measures for the building sector, the largest single energy consumer in Europe, with considerable potential for gains in energy performance.

These new targets also played an important part in the Commission's preparations for its long-term vision for a climate neutral Europe by 2050, published on 28th of November 2018.

A further part of the package seeks to establish a modern design for the EU electricity market, adapted to the new realities of the market – more flexible, more market-oriented, better placed to integrate a more significant share of renewables.

These new rules also aim to put **consumers at the heart of the transition** – in terms of giving them more choices, strengthening their rights, and enabling everyone to participate in the transition by producing their own renewable energy and feeding it into the grid at a fair price. By allowing electricity to move freely to where it is most needed and when it is most needed via undistorted price signals, consumers will eventually also benefit from cross-border competition. This will drive the investments necessary to provide security of supply, whilst decarbonising the European energy system.

The **Clean Energy for All Europeans Package** includes 8 different legislative acts:

- **Energy Performance in Buildings Directive (EPBD)**
- **Renewable Energy Directive (RED)**
- **Energy Efficiency Directive (EED)**
- Governance Regulation
- **Electricity Regulation**
- **Electricity Directive**
- Risk-Preparedness Regulation
- Regulation for the Agency for the Cooperation of Energy Regulators

The state of play for each of the eight proposals in the legislative circuit is available in the table below.

Table 2-4: Clean energy for All Europeans package - state of play as of 1st of April, 2019 (Source: EU Commission)

	European Commission Proposal	EU Inter-institutional Negotiations	European Parliament Adoption	Council Adoption	Official Journal Publication
Energy Performance in Buildings	30/11/2016	Political Agreement	17/04/2018	14/05/2018	19/06/2018 - Directive (EU) 2018/844
Renewable Energy	30/11/2016	Political Agreement	13/11/2018	04/12/2008	21/12/2018 - Directive (EU) 2018/2001
Energy Efficiency	30/11/2016	Political Agreement	13/11/2018	04/12/2018	21/12/2018 - Directive (EU) 2018/2002
Governance of the Energy Union	30/11/2016	Political Agreement	13/11/2018	04/12/2018	21/12/2018 - Regulation (EU) 2018/1999
Electricity Regulation	30/11/2016	Political Agreement	26/03/2019	Scheduled in May 2019	-
Electricity Directive	30/11/2016	Political Agreement	26/03/2019	Scheduled in May 2019	-
Risk Preparedness	30/11/2016	Political Agreement	26/03/2019	Scheduled in May 2019	-
ACER	30/11/2016	Political Agreement	26/03/2019	Scheduled in May 2019	-

Among all these legislative acts, EPBD, EED, RED and Electricity Regulation and Directive will be further analyzed in this document, as they impact BIPV solutions. The 2010 Energy Performance of Buildings Directive, the 2012 Energy Efficiency Directive and the 2009 Renewable Energy Directive are the EU's main legislative instruments promoting the improvement of the energy performance of buildings within the EU and providing a stable environment for investment decisions.

The adoption of these directives and regulations is an important step towards smarter and more sustainable buildings and their implementation will have a direct impact on the BIPV sector.

First, the **EPBD** requirement for all new buildings to be “nearly zero-energy” from the end of 2020 can represent an asset and contribute to stimulating the future market deployment of BIPV. Thanks to the large variety of products available, BIPV systems can adapt not only to specific customers’ needs but also to specific market requirements, which are driven by the regulatory framework. Moreover, the **EED** urges the EU countries and the public sector to make improve the energy efficiency of the building stock and develop only energy efficient buildings. Objectives that multifunctional BIPV solutions can contribute to fulfil.

Then, the **RED** aims at empowering consumers and strengthening their role in the energy transition, by enabling them to self-consume without undue restrictions and being fairly remunerated for the electricity they feed into the grid. This provides guarantees to investors willing to install distributed PV systems such as BIPV and reduces the risks by allowing to foresee future cashflows of the installations. Hence, this can contribute to the development of reliable and innovative business models based on self-consumption. Similarly, the requirements defined by the revised **Electricity Market Design Regulation and Directive** can help to limit the uncertainty linked with the market valuation of the electricity produced by distributed PV system such as BIPV. One can mention for example the recommendation that market rules shall correspond to the principles of non-discrimination, transparency and ensure access of all market participants, providing prices reflecting market fundamentals, including the real time value of energy.

2.3.1 Energy Performance of Buildings Directive (EPBD)

The 2010 Energy Performance of Buildings Directive has made it possible for consumers to make informed choices that will help them save energy and money. It has resulted in a positive change of trends in the energy performance of buildings. Following the introduction of energy requirements in national building codes in line with the Directive, new buildings today consume only half as much as typical buildings from the 1980s.

The **revised Energy Performance of Buildings Directive (2018/844/EU)** entered into force on 9 July 2018 [12]. The new Directive 2018/844/EU introduces targeted amendments to Directive 2010/31/EU, aimed at accelerating the cost-effective renovation of existing buildings, with the vision of a decarbonized building stock by 2050 and the mobilization of investments. The revision also supports electromobility infrastructure deployment in buildings' car parks and introduces new provisions to enhance smart technologies and technical building systems, including automation.

However, it is worth highlighting that in the EPBD, the focus is put on energy consumption of buildings. On-site energy production and the ability of buildings to become net producers of energy is not considered, which per definition limits the opportunity for BIPV that this text can trigger.

The main elements of the revised Energy Performance of Buildings Directive are summarized in the table below.

Table 2-5: The Revised Energy Performance of Building Directive

Under the Revised Energy Performance of Buildings Directive (EPBD)
• All new buildings must be **nearly zero-energy buildings** by 31 December 2020 (public buildings by 31 December 2018). • **Energy performance certificates** must be issued when a building is sold or rented, and they must also be included in all advertisements for the sale or rental of buildings. • EU countries must establish **inspection schemes** for heating and air conditioning systems or put in place measures with equivalent effect. • EU countries must set **cost-optimal minimum energy performance requirements** for new buildings, for the major renovation of existing buildings, and for the replacement or retrofit of building elements (heating and cooling systems, roofs, walls and so on). • EU countries must draw up **lists of national financial measures** to improve the energy efficiency of buildings. • EU countries will have to establish stronger long-term renovation strategies, aiming at decarbonising the national building stocks by 2050, and with a solid financial component. • A common European scheme for rating the smart readiness of buildings, optional for Member States, will be introduced. • Smart technologies will be further promoted, for instance through requirements on the installation of building automation and control systems and on devices that regulate temperature at room level.

- E-mobility will be supported by introducing minimum requirements for car parks over a certain size and other minimum infrastructure for smaller buildings.
- EU countries will have to express their national energy performance requirements in ways that allow cross-national comparisons.
- Health and well-being of building users will be promoted, for instance through an increased consideration of air quality and ventilation.

To help EU countries properly implement the Energy Performance of Buildings (Directive 2018/844) and to achieve energy efficiency targets, the European Commission has established practical support initiatives: the Energy Performance of Buildings standards (EPB standards). These include a set of standards for a common methodology calculating the integrated energy performance of buildings, in accordance with the Energy Performance of Buildings Directive. This topic will be further developed in D1.4 "*Potential contribution to BIPV systems to nearly Zero Energy Buildings and methodology for project outputs assessment*".

2.3.2 Energy Efficiency Directive (EED)

The 2012 Energy Efficiency Directive establishes a set of binding measures to help the EU reach its 20% energy efficiency target by 2020. Under the Directive, all EU countries are required to use energy more efficiently at all stages of the energy chain, from production to final consumption. On 30 November 2016, the European Commission proposed an update to the Energy Efficiency Directive, including a new 30% energy efficiency target for 2030, together with several measures to update the Directive to make sure the new target is met.

The revised **Energy Efficiency Directive (2018/2002)** entered into force 20 days after the Official Journal Publication (21/12/2018) [13].

The new regulatory framework includes an energy efficiency target for the EU for 2030 of 32.5% with an upwards revision clause by 2023. This new objective shows the EU's high level of ambition and demonstrates the remarkable pace of change of new technologies and reduced costs through economies of scale. Together with the recently agreed 32% renewable energy target (evoked in section 2.3.3) for the EU for 2030, Europe will be equipped to complete the clean energy transition and meet the goals set by the Paris Agreement.

Note that, in comparison to what was mentioned about EPBD, the direct opportunities for BIPV that this Directive can create are limited, as it focuses on energy efficiency and consumption, with no reference to production. Nevertheless, as multifunctional solutions, BIPV systems can also make buildings more energy efficient while producing renewable energy at the same time.

The main elements of the revised Energy Efficiency Directive are summarized in the next table:

Table 2-6: The Revised Energy Efficiency Directive

Under the Revised Energy Efficiency Directive (EED)
• New energy efficiency target for the EU for 2030 of 32.5%, with an upwards revision clause by 2023. • The annual energy saving obligation is extended beyond 2020, which will attract private investments and support the emergence of new market actors. • Real energy savings will be delivered in in the period 2021-2030 and beyond, coming from new energy efficiency renovations or other measures undertaken in the next decade. • Energy distributors or retail energy sales companies must achieve 1.5% energy savings per year through the implementation of energy efficiency measures. • EU countries can opt to achieve the same level of savings through other means (such as improving the efficiency of heating systems, installing double glazed windows or insulating roofs). • **EU countries must draw up long-term national building renovation strategies which can be included in their National Energy Efficiency Action Plans.** • **The public sector in EU countries should purchase energy efficient buildings, products and services.** • **EU countries must make energy efficient renovations to at least 3% of the total floor area of buildings owned and occupied by central government.** • Energy consumers should be empowered to better manage consumption. This includes easy and free access to data on consumption through individual metering. • National incentives for SMEs to undergo energy audits. • Large companies will make audits of their energy consumption to help them identify ways to reduce it.

2.3.3 Renewable Energy Directive (RED II)

The 2009 Renewable energy directive set a binding target of 20% of the final energy consumption to come from renewable sources by 2020. To achieve this, EU countries have defined and committed to reach their own national renewables targets. They are also required to source at least 10% of their transport fuels from renewable sources by 2020. In November 2016, as part of 'Clean Energy for all Europeans' package, the Commission adopted a legislative proposal for a **recast of the Renewable Energy Directive**.

In the context of the co-decision procedure, a final compromise text among the EU institutions was agreed in June 2018. The RED II Directive was officially published on December 2018 and entered into force 20 days after.

The main elements of the revised Renewable Energy Directive are summarized in table 2.7.

Table 2-7: The Revised Renewable Energy Directive

Under the Revised Renewable Energy Directive - Recast to 2030 (RED II)
• A new, binding, renewable energy target for the EU for 2030 of 32%, including a review clause by 2023 for an upward revision of the EU level target. • The design and stability of support schemes for renewables are improved. • Real streamlining and reduction of administrative procedures are delivered. • Long-term certainty for investors is provided and procedures to receive permits for projects are speeded up; • **Consumers are empowered by enabling them to self-consume without undue restrictions, being remunerated for the electricity they feed into the grid. (Art 23)** • Competition and market integration of renewable electricity are increased. • The uptake of renewables in the heating/cooling and transport sectors is accelerated. • The sustainability of bio-energy is strengthen and innovative technologies are promoted. The provision on active customers and citizen energy communities **respect the achievements of the Renewable Energy Directive regarding renewable self-consumers and renewable energy communities**: ○ Cost-reflective network charges, non-disproportionate, non-discriminatory technical and administrative requirements and procedures; ○ Entitlement to operate through aggregation, to develop power purchase agreements, third party management; ○ The Market Design acknowledges additional rights.

Today, many Member States remain behind their national 2020 target, as shown on Figure 2.2. Among them, Belgium, France, Germany, Netherlands or Spain can be cited. This demonstrates that the interest and investment in renewable energies still have large possibilities for improvement and growth. This fact can potentially benefit BIPV, as this technology can contribute to increase the penetration of renewable energy in urbanized environments.

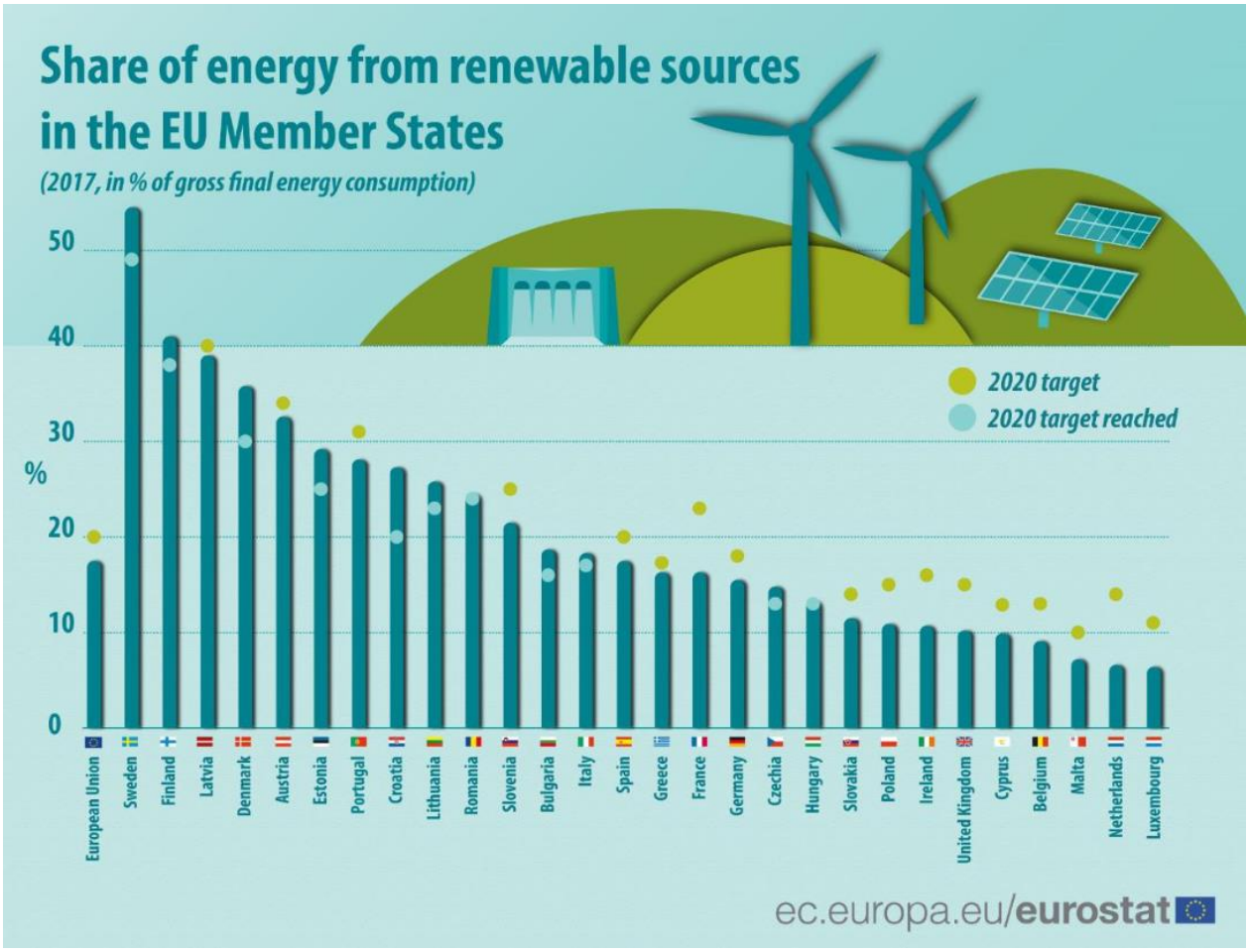


Figure 2.2 Share of energy from renewable sources in the EU, in 2017 (source Eurostat)

2.3.4 Electricity Market Design Regulation and Directive

On 30 November 2016, the Commission proposed new rules on the EU energy market design in order to help energy markets include more renewables, empower consumers, and better manage energy flows across the EU [14]. On 26 March 2019, the European Parliament has passed proposals for the new Electricity Market Regulation and Electricity Market Directive.

The new electricity market design proposals, which encompasses a Directive and a Regulation, aim to adapt the current market rules to new market realities. The new rules were designed to allow energy consumers to play an active role in the energy transition. The new market rules envision the free trade of energy, with more cross-border trade possibilities and flexible options to accommodate a higher share of variable renewable energy. Additionally, the new energy market will place a bigger focus on digitalization. It will also prioritize market competition to keep prices in check. Capacity subsidies to power plants emitting more than 550g CO_2/kWh will be phased out under the new rules.

Through the **revised Electricity Directive**, these new rules will put consumers at the heart of the transition – giving them more choice and greater protection. Consumers will be able to become active players in the market thanks to access to smart meters, price comparison tools, dynamic price contracts and citizens' energy communities. At the same time, energy poor and vulnerable consumers will enjoy better protection.

The **revised Electricity Regulation** brings stricter and harmonized rules for capacity mechanisms, reconciling thus the EU objectives of security of supply and emission reduction. Enhanced regional coordination will improve market functioning and thereby competitiveness while making the system more stable. [15].

The main elements of the revised Electricity Market Design Regulation and Directive are summarized in the table below.

Table 2-8: The Electricity Market regulation and Directive

Under the revised Electricity Market Design Regulation and Directive
• Market rules shall correspond to the principles of non-discrimination, transparency and ensure access of all market participants. They shall provide **prices reflecting market fundamentals**, including the real time value of Energy. • Balancing markets and prequalification processes should ensure effective **non-discrimination of market participants and transparent and technology-neutral definition of products**. • Power Purchase Agreement are enabled, as the text secures the consumer's right to have several supply contracts at the same time, provided the required connection and metering are established. • Direct line installations benefit from a protection from disproportionate administrative procedures and costs. • Energy communities can engage into electricity sharing, without prejudice to taxes and charges, subject to a cost benefit analysis. However, the wording on virtual net metering and distributed ledger technologies has been rejected.

3 COUNTRY-SPECIFIC REGULATIONS

This section analyses, country per country, the currently applicable regulations applicable to building integrated solar photovoltaic solutions. It is based on different references such as the "European regulatory framework for BIPV" report from the H2020 PVSITES project [8], the publications of the Task 1 and Task 15 from the IEA PVPS [16] [17] [18], as well as extensive research within national regulatory texts.

Note that country-specific energy in buildings regulatory aspects and environmental certifications will be developed in Deliverable D1.4: *"Potential contribution to BIPV systems to nearly Zero Energy Buildings and methodology for project outputs assessment".*

3.1 Belgium

3.1.1 Support schemes for distributed PV

Supports schemes are a regional competence in Belgium and are adapted in function of the capacity of the PV system. The distributed PV market can be split in two main categories: the residential on one hand, the commercial and industrial segments on the other hand.

For residential installations, the main support scheme allowed in all three regions of Belgium is the net-metering on annual base. This scheme offsets the consumption and PV production and reduces the electricity bill of the consumer accordingly. The limit for using this scheme is set at 10 kW (5 kW in Brussels) which covers most residential applications. This limit is arbitrary since residential customers with larger houses and electricity use for heating (with heat-pumps for instance) cannot benefit from the net-metering scheme if the capacity of the PV system installed is above these limits.

In addition to this scheme, Brussels is the only region still providing additional financial support to residential installations, through green certificates. This support has been calculated to integrate the end of the net-metering, planned to enter into force in 2020 in Brussels. Flanders is also planning to phase out of it from 2020 but allowing existing systems to benefit from it for 15 years. No date has been defined for Wallonia.

Since 2015, Flanders has implemented an additional annual prosumer grid tariff which reduces the benefits of the prosumer. Wallonia has planned to introduce this tariff in 2020.

For the commercial & industrial sector, plant operators are, like for the residential sector, allowed to self-consume and they get also a certain number of green certificates for every MWh produced, for 10 years. However, this number and the minimal price for green certificates vary between each region:

- The Flemish region looks yearly at all the costs related to development, construction and operation and at the average wholesale electricity price to calculate the support needed to achieve an IRR of 5%. For existing projects, this number of green certificates is revised every year to consider electricity price evolutions.
- The Walloon region considers the CO2 emission reduction, an economical coefficient and the average wholesale electricity price.
- In Brussels, plant operators receive a fixed number of green certificates.

For the excess electricity, the plant operator needs to sign a PPA with a utility to sell it at wholesale market price.

There are some yearly costs linked to DSO's control of the imposed equipment. In Flanders, the DSO also apply injection tariffs: 0,3 c€ to 1, 2 c€ /kWh depending on the size and the amount of energy injected into the grid.

There have been some modifications in the last years to consider price and technological evolutions, but the global framework has remained unchanged in the three regions. There are ongoing discussions in Wallonia to further decrease support for renewables, but no consensus has been achieved so far.

3.1.2 Grid access

For small systems (< 10 kW), there is no extra grid charges, unless the prosumer wants to go out of the net-metering scheme. If this is the case, a new meter, which is charged, must be installed. In Brussels, the installation of a "green meter" is compulsory for every prosumer.

For larger systems (>10 kW), there are extra charges depending on the size of the system and the DSO for administrative work (such as pre-connection study, possible detailed study) and for hardware (decoupling device). Note that for very large PV installations (>250 kW or >1.000 kW depending on the DSO), contracts between the DSO and the prosumer must be established. This includes, among others, flexibility clauses allowing the DSO to manage congestion issues with a remote monitoring equipment. In such case, the DSO can curtail injection of PV electricity to the grid.

3.1.3 Building codes and regulations

Different building codes and regulations are designed at regional level in Belgium and can have impacts on the procedures and requirements for BIPV. Table 3-1 below describes the most important ones

Table 3-1 : Building codes in Belgium

REGULATORY TEXT	REQUIREMENTS
Brussels Town Planning Code (CoBAT)	In the Brussels-Capital Region, the Brussels Town Planning Code lays down the following instruments and administrative procedures the Regional Urban Planning Regulation ("Règlement Régional d'Urbanisme" - RRU). The urbanism laws regarding building integration of solar modules are contained in the Government Decree of 13 November 2008. This Decree establishes the conditions that a solar installation must comply with in order to avoid the need of urbanism permission or the involvement of a government employee, the local authorities, the royal commission for monuments, or an architect. The permission is not needed if "the solar modules are not visible from the public space or located in roofs, parallel to the roof slope, not exceeding a 30 cm height or exceeding roof limits. Every type of roof is included."
Walloon code for town and country planning, urbanism,	According to the Walloon code for town and country planning, urbanism, heritage and Energy, the installation of photovoltaic solar modules does not need an

heritage and Energy (CWATUPE)	urbanism permission (Art. 262, paragraph 2), no matter their shape, surface or thickness. This is only valid if the installation: • Does not imply non-fulfilment of other legal requirements (sector plans, local urbanism legislations) • Is not located on a protected building • Does not need actions or works under the conditions of urbanism permissions
Flemish Code for Environmental Planning	Provides for a mixed system involving a duty to obtain a permit, a duty to notify, and certain exemptions. The exemption from planning permission for the placement of photovoltaic modules (except in certain protected areas or areas with special requirements) is thus contained in the Exemptions decree.
Energy performance	All three regions have specific legislations around the energy performance of new buildings or big refurbishments. Solar energy is one of the technologies that helps reaching this performance. In Flanders, the government introduced a measure that force all new buildings to have a minimum share of renewable energy. It can be produced by solar thermal, PV, heat pumps or other renewables systems. For PV, the minimum contribution is about 0.7 kW. This solution has been very effective and almost 90% of the new buildings have chosen to add PV systems.
Fire regulation	In Belgium, there are three levels with competence to establish regulations concerning fire security: • The federal authority is competent to establish the Basic Standards, which fix the minimum conditions that each building category must fulfil independently of its location. • Regions and Communities are competent to regulate particular aspects of security, complementing or adapting the federal legislation, improving the demands in terms of security (never reducing them). • Municipalities are responsible to enact regulations concerning fire prevention. The board of the Mayor and aldermen may attach conditions to building permits or environmental. The mayor is in charge of controlling the current legislation (Basic rules).
Acoustic regulation	Protection against noise essential requirement is regulated in Belgium through European standards for test and calculation methods and Belgian standards defining performance levels. For example, noise levels may not exceed the maximum laid down in standard NBN S0l-401, category 4

3.1.4 Specific requirements for integrated PV installations

There are no specific requirements for BIPV in Belgium, as no differentiation is made with BAPV.

3.1.5 Synthesis of key points

Table 3-2 : Synthesis of support schemes in Belgium

Parameters		Net-metering	Green certificates
PV Self-consumption	Right to self-consume	Yes	
	Collective self-consumption	Not yet but several legal documents in preparation	
	Revenues from self-consumed electricity	Savings on the electricity bill	
Excess PV electricity	Revenues from excess electricity	Full retail electricity price (net-metering)	None except if a PPA, e.g. with a utility, is signed
	Variability of retribution for excess electricity	Follows retail electricity price's variations	Possible – depend of PPA conditions
	Duration of the scheme	Unlimited	Unlimited
Investment and regulatory details	Third party ownership and/or PPA	Yes, both are allowed	
	Additional taxes/fees	Prosumer tariff in Flanders and probably soon in Wallonia	Injection tariff
	Direct incentive to invest in (BI)PV	Green certificates for 10 years in Brussels	Green certificates for 10 years Tax credit on investment: (20%)
	Indirect incentive to invest in (BI)PV	Obligation to have renewables energy in new buildings or deep renovation. In Flanders. As PV reduces the energy needs of the building, you can access the mandatory Energy level to get some capital incentives or reduction on cadastral income	
	Other enablers of self-consumption	No	
System-linked requirements	PV System size limitations	≤ 10 kW AC (5 kW for Brussels)	> 10 kW AC
	Additional features	None	

3.2 France

3.2.1 Support schemes for distributed PV

The generation of electricity is promoted through a feed-in tariff scheme for solar plants smaller than 100kW. Applicants can choose between two schemes:

- *Feed-in-Tariff (self-consumption not allowed)*: The entire production must be fed-back to the grid. The tariff for every kWh **produced** ranges between 11,19 and 18,72 c€/kWh depending on the size of the system;
- *Feed-in-Tariff (self-consumption allowed)*: The tariff for every kWh **injected** ranges between 10 or 6 c€/kWh depending on the size of the system. Once attributed, this tariff is fixed on system's lifetime. In addition, there is an investment premium ranging between 0,09 and 0,39 c€/Wp, which is spread over 5 years.

For the first scheme, requiring the injection of the total production, tariffs evolve in time:

- Quarterly indexation of feed-in tariffs and investment premium for new PV projects, based on various factors: indexation coefficient K based on the evolution of labor and production costs in the PV sector in France and degression coefficients based on market development.
- Once the project is granted, an annual indexation is applied to the feed-in tariff, based on indexation coefficient L. It is based on the evolution of labor cost in mechanical and electrical sectors, as well as production and services' prices index to industrial actors, in France.

For plants above 100 kW, applicants must compete in tender procedures for a compensation per MWh or, if plant is bigger than 500 kW, for a premium tariff on top of the sale price they get on the electricity market, so that the total value equals the value of the winning bid.

Specific tenders for self-consumption also exist, for installations ranging from 100 kW to 1000 kW. Participants bid for a feed-in premium, remunerating both injection and consumption. But a penalty is applied in function of the injection rate.

The French administration programmed a series of tenders up to 2020, the system will be evaluated and most probably reconducted if successful.

Collective self-consumption is allowed since April 2017, it consists in virtual self-consumption between one or more producers and one or more consumers. Splitting key of the PV production is pre-defined between actors which must share the same HV-LV sub-station. A 30-minute timestep is applied to follow what is the real production and consumption in order to identify exceeding electricity. All consumers and producers of the collective self-consumption process must form a common legal entity.

3.2.2 Grid access

For projects that wants to apply to the support scheme that allows self-consumption, a smart meter must be installed to allow DSO to make the calculations. Same for collective self-consumption operations.

3.2.3 Building codes and regulations

Different building codes and regulations are designed at national level in France and can have impacts on the procedures and requirements for solar. Table 3-3 below describes the most important ones

Table 3-3 : Building codes for France

REGULATORY TEXT	REQUIREMENTS
Code of Construction and Housing	Comprise legislative articles and regulatory articles. It defines the requirements in the field of safety, accessibility, acoustics and thermal insulation, and leaves the other performances to technical standards of a contractual nature. This code refers to main general regulatory texts for: • Energy control • Fire safety • Acoustic • Health • Seismic and structural • New EU Construction Products Regulation • Reach
Urban planning code	Including in French law legislative and regulatory provisions for town planning law. In France, the planning rules are codified in the town planning ode (Code de l'urbanisme). A 'Certificat d'Urbanisme (CDU) is required to get the right for building on land in a specific area. The CDU is not a building permit, but it is an 'approval in principal'. An architect is compulsory for applying the building permit for buildings larger than 170m². The building permit mostly deals with planning and architectural issues, based on an outline design of the architect. The contractor makes the detailed construction drawings. The project developer ("maître d'ouvrage") is responsible for conformity to the technical requirements of the Housing and Building code.
Consumer Code	Include the legal provisions relating to the consumer law, which is a subset of the business law. Identify the risks relating to use of the product and implement measures to prevent them. Compliance with this obligation may be presumed on the basis of standards or test protocols.
Insurance Code	Guarantee of product performances during for at least 10 years. Obligatory insurance of decennial guarantee implies a technical verification of the conformity of the works with technical standards by a controller contracted by the insurance company
Energy Code and RT2012	Official French legal code collecting various provisions relating to energy law. Since they were first introduced in 1975, the French Thermal Regulation (RT) has been developed and strengthened several times. The new RT 2012 thermal regulations aim to limit energy consumption in new residential and commercial buildings. It corresponds to the application of a part of the commitments defined under the Grenelle 2 environment forum concerning better management of our energy consumption.

	In actual thermal regulation RT2012, as a result the code includes mandatory renewable energy requirements (for individual house): solar thermal collectors, offered renewable energy is at least 5 kWh/m² in primary energy, thermodynamic water heaters, micro-cogeneration boiler. The next thermal regulation is scheduled for 2020 and should generalize energy-plus building (BEPOS).
Fire regulation	Many decrees and the Code of Construction and Housing describe the fire regulation. Fire behavior is judged on two criteria: • Fire reaction: represents the capability of a material to inflame and therefore to contribute to the development of a fire • Fire resistance: means the property of a material or assembly in a building to withstand fire or give protection from it. The NF EN 13501 February 2013 provides a harmonized procedure for the classification of reaction to fire of construction products, including products incorporated within building elements like BIPV.
Acoustic regulation	Code of Construction and Housing describe the fire regulation. Many decrees give minimal acoustic characteristic depending on building type. To follow different French regulation requirements, different class levels in terms of: • Airborne sound insulation global between rooms-DnT,A • Façade sound insulation- DnT,A,tr • Impact sound insulation between rooms L'nT,w • Service equipment noise global - LnAT in dB(A)

3.2.4 Specific requirements for integrated PV installations

France was one of the first countries to support BIPV with higher feed-in-tariffs than BAPV. Since 2018, these support schemes have been phased out.

3.2.5 Synthesis of key points

Table 3-4 : Synthesis of support schemes in France

Parameters		FiT without self-consumption	FiT with self-consumption	Self-consumption tender	Tender - PPA	Tender - FiP
PV Self-consumption	Right to self-consume	No	Yes	Yes	No	
	Right to self-consume (collective)	No	Yes	Yes	No	
	Revenues from self-consumed PV electricity	None	Savings on the bill	Savings on the bill + bonus per kWh	None	
Excess PV electricity	Revenues from excess electricity	Fixed depending on the size: 18,72c€/kWh ≤3kW 15,91c€/kWh ≤9kW 12,07c€/kWh ≤36kW 11,19c€/kWh ≤100kW	10c€/kWh (≤ 9kW) 6c€/kWh (> 9kW) 0 c€/kWh if collective self-consumption	Market price + Feed-in premium	Market price + bonus /kWh	Market price + Feed-in premium
	Variability of retribution for excess electricity	Yes – Yearly indexation (L coefficient)	No – constant once attributed	Relative – variation of wholesale market price BUT compensated by the FiP	No – constant once attributed	Relative – variation of wholesale market price BUT compensated by the FiP
	Duration of the scheme	20 years		10 years	20 years	
Investment and regulatory details	Third party ownership and/or PPA accepted	No		Yes	No	
	Additional taxes/fees	< 36 kW: 34,68 € /year >36 kW: 708,48 €/year		< 250 kW: 294,72 to 619,56 €/year > 250 kW: case by case		
	Other direct incentive to invest in (BI)PV	Reduced VAT (to 10 %) if < 3 kW	Investment premium: 400€/kW (≤3kW); 300€/kW (≤9kW); 190€/kW (≤36kW); 90€/kW (≤100kW) + reduced VAT (to 10 %) if < 3 kW	None		

	Other indirect incentive to invest in (BI)PV	None			
	Other enablers of self-consumption	None	Partial reduction of the FiP based on the electricity injected to the grid	None	
System-linked requirements	PV system size limitations	≤100 kW	100 ≤ 1000 kW	100 kW ≤ 500 kW	500 kW to 8 MW
	Additional features	None		Only on buildings, carports, warehouses, greenhouses	Only on buildings, warehouses, greenhouses

3.3 Germany

3.3.1 Support schemes for distributed PV

In Germany, electricity from renewable sources is mainly supported through a **feed-in tariff** and **market premium** scheme. The former will disappear soon, progressively replaced by the second one which was introduced in 2017.

For power plants up 100 kW, plant operators have the freedom to opt for one of the two systems mentioned above. When the support system is based on a **feed-in tariff,** the grid operator is in charge of paying it to the plant operator. The amount of tariff is set by law (Renewable Energy Sources Act - EEG) and is paid over a period of 20 years. Note that the level of FiT is rapidly decreasing, in order to incite operators of new PV systems to opt for the market premium scheme.

Installations above 100 kW are obliged to take part to the **market premium scheme**. This premium is calculated as the difference between a guaranteed value for the feed-in electricity and the monthly market value of the sold electricity (Annex I EEG 2017). The plant operator must sell his electricity directly, i.e. to a third party by a supply agreement or on the wholesale market and claim the so-called market premium from the grid operator. Nevertheless, the produced electricity is still prioritized in the power take-up, transport and distribution by the grid operator (§ 11 par. 1 EEG 2017).

Note that the regulator sets the value of the support measures based on market development, i.e. the capacity installed in the country in the previous year. The higher the total installed capacity, the lower the level of support and the higher the decreasing rate (feed-in tariff and market premium).

For installations above 750 kW, there is a compulsory **tender** procedure. The support mechanism applied is similar to the market premium scheme mentioned above, the main difference comes the attribution procedure. Projects must take part to a tender process to determine the guaranteed price they are entitled to receive over the period of 20 years from the commissioning of the plant, in case the bid turns out to be among the most competitive for that running session. The bidding procedure is 'pay as bid'. The scheme applies to the total electricity production of the plant, which cannot be self-consumed

Then, there is a specific financial support mechanism called "Tenant electricity surcharge" for property owners selling solar electricity to tenants living in their building. The electricity must be supplied and consumed within the building itself, there is no support for grid injection. The tariff for PV systems exceeding 40 kW should be lowered to 8 c€/kWh from January and further decreased to 1,90 c€/kWh in April 2019. For systems smaller than 40 kW, the tenant electricity deduction will continue at a level of 8,5 €c/kWh.

No major changes are planned in the support schemes in Germany for 2019. The feed-in tariff, as well as the market premium, will continue to decrease progressively. This implies that self-consumption will become increasingly important and PV installations will have to rely more and more on the intrinsic competitiveness of the technology.

Regarding collective self-consumption, the "Mieterstrom Model" is based on locally generated electricity from PV plants, typically within the same building or right next to it. Electricity is used directly by the tenants in multi-family houses (or in commercial buildings).

Finally, in terms of cost, the EEG levy is a tax on self-consumption for plants above 10 kW, it equals 2,7 c€/kWh on self-consumed electricity.

3.3.2 Grid access

In addition to the support schemes, the EEG also regulates the grid connection. DSOs are required by law to connect renewable energy systems as quickly as possible to the most economical grid access point. DSOs are also obliged - if necessary - to expand network capacities in order to integrate renewables.

For rooftop PV systems up to 30 kW, the building connection point is considered as the most economical grid access point; for systems larger than 30 kW, the distribution system operator must determine which grid access point is the most economical. The grid access point is therefore defined as the point where the connection and expansion of network capacities bring about the lowest possible overall costs. This might be the building connection point, for example, or the nearest local distribution transformer. The costs of connection of the photovoltaic system to the grid access point are carried by the PV system operator. The costs for the expansion of network capacity, if necessary, are carried by the DSO. [19]

3.3.3 Building codes and regulations

Different building codes and regulations are designed at national level in Germany and can have impacts on the procedures and requirements for solar. Table 3-5 below describes the most important ones.

Table 3-5 : Building codes for Germany

REGULATORY TEXT	REQUIREMENTS
European Construction Products Regulation (EU-CPR). Annex 1	Basic requirements for buildings are defined in Annex I of the European Construction Products Regulation (EU-CPR). From these basic requirements of Annex I, as well as on the basis of harmonized specifications entailed in the CE marking, requirements for building products and their labelling are determined. Apart from the safety of buildings and other structures, this also concerns health, durability, energy efficiency, environmental protection, economic aspects as well as other important matters of public interest. The Construction Products Regulation explains how a building product is described, taking the form of a harmonized technical specification. Technical specifications can either be harmonized European standards (hEN) or European Assessment Documents (EAD). Norms (or standards) count as harmonized when they are mandated by the European Commission and referenced in the published Official Journal of the European Union. European Assessments Documents are in turn the basis for the European Technical Assessment. The performances and properties of a building product are stated in a Declaration of Performance (DoP). Based on a harmonized technical specification, the

	Declaration of Performance explains performances for a specific product, which is in turn documented by the CE-marking. In case no harmonized norm is available for a construction product, or the performances described therein are not sufficient, one can apply for a European Technical Assessment (ETA), which is granted on the basis of an EAD by the responsible national representation, the Technical Assessment Body – the "DIBt" in Germany. If no Declaration of Performance relating to a harmonized norm or ETA has been submitted, no CE-marking can be issued.

3.3.4 Specific requirements for integrated PV installations

There is no specific distinction between BAPV and BIPV in Germany. Hence there is no specific requirements for BIPV.

3.3.5 Synthesis of key points

Table 3-6 : Synthesis of support schemes in Germany

Parameters		Feed-in-Tariff	Market premium model	Tenders
PV Self-consumption	Right to self-consume	Yes	Yes	No
	Right to self-consume (collective)	Yes	Yes	No
	Revenues from self-consumed PV electricity	Savings on the electricity bill		Not applicable
Excess PV electricity	Revenues from excess electricity	FiT	Market price + market premium (if applicable)	
	Variability of the revenue on duration of the scheme	No - constant once attributed	Relative – variation of the market price (monthly basis) compensated by the market premium to equal the guaranteed price/bid value initially defined	
	Duration of the scheme	20 years		
Investment and regulatory details	Third party ownership PPA accepted	Yes	Yes	Yes
	Additional taxes/fees	40 % EEG surcharge on the self-consumed electricity if bigger than 10 kW		No
	Other direct incentive to invest in (BI)PV	Higher FiT or Market Premium if applied on buildings or noise barriers		No
	Other indirect incentive to invest in (BI)PV	None		
	Other enablers of self-consumption	None		
System-linked requirements	PV system size limitations	≤ 100 kW	≤750 kW	> 750 kW
	Additional features	No		

3.4 Italy

3.4.1 Support schemes for distributed PV

For installations with a capacity below 500 kW, net-billing is applicable ("Scambio Sul Posto" or SSP). GSE, the administration in charge of energy, gives credit for the electricity fed in, which is remunerated through an "energy quota" based on electricity market prices and a "service quota" depending on grid services costs (transport, distribution, metering and other extra charges). The net-billing scheme is valid for one year and automatically renewed until end of life time. The average remuneration for injection in 2019 is around 0,15 €/kWh. The yearly fee charged by the GSE in the case of net-billing, required to cover the costs of management, verification and control, amounts to 30€. This is completed by a variable fee of 1€/kW for RES units with a capacity between 20 kW and 500 kW.

Alternatively, operators from plants up to 1 MW can opt for another scheme, based on direct selling of the electricity. In such case, they can decide between selling the injected energy on the free market themselves or sell it to the GSE, who then sells the energy on the free market on their behalf ("Ritiro Dedicato" or RID). Also, PV plants up to 100 kW may choose the guaranteed minimum price ("Prezzo Minimo Garantito"). The guaranteed minimum tariffs are reassessed every year, in 2019 the tariff is 39,8€/MWh. This support mechanism based on a guaranteed minimum tariff is applicable for a period of 20 years maximum. Under such scheme, the yearly GSE fee amounts to 0,65€/kW for units with a capacity between 20 kW and 200 kW and to 0,6€/kW for units with a capacity higher than 200kW.

Italy has recently adopted a new RES decree (FER decree) which introduces auctions for solar plants above 20 kW. Applicants must participate in public auctions, the first was published on January 31, 2019; six more will follow between 2019 and 2021.

- "Group A" dedicated to photovoltaic and wind power (separate tenders for plants up to 1 MW and above 1 MW).
- The "A2 Group", dedicated to photovoltaic systems installed in place of asbestos roofs (< 1 MW). If the plant is built together with the removal of asbestos roofs, there is a premium of 12€/MWh on all the energy produced, even the self-consumed.
- "Group C" for existing renewable energy power plants that will be partially or entirely retrofitted.

The incentive is attributed for a period of 20 years and can be seen as a Feed-in Premium. It remunerates the difference, for the electricity reinjected to the grid, between the wholesale market price at which this electricity is sold and the €/MWh level defined during the auction. It is not compatible with either the net-billing (SSP) or the "market based" (RID) schemes. For the 2018-2020 period, maximum prices for PV technology are as follows: €110/MWh for projects ranging in size from 20 kW to 100 kW; €90/MWh for projects between 100 kW and 1 MW; and €70/MWh for projects above 1 MW.

Finally, photovoltaic plants are eligible for a tax credit on investment (amortization of 130 % of the investment cost) and a reduced value-added tax rate (10 % instead of 22 %).

3.4.2 Grid access

Two different meters can be installed. First, all PV systems must be equipped with a "contatore di produzione", which records the production of energy of the system. In case the operator of the PV system opts for the net-billing scheme (SSP), it must install in addition a "contatore di scambio" which will track the electricity consumption and production; installed at the POD (Point of delivery) of the building.

There are some grid costs, subdivided in two parts. The first part depends on the capacity of the plant (from 100€ for plants up to 50 kW to 2500€ for plants above 1000 kW) and is due at project's installation. The second part depends on the distance between the point of connection (usually the POD of the building or the system) and the grid substation (medium/high voltage). It is calculated as shown below. The minimum value between **A** and **B** is selected, where **P** is the plant capacity, **DA** distance to the medium/low voltage substation, **DB** distance to the medium/high substation

A=35€*P + 90€*P*DA + 100€

B=4€*P + 7,5€*P*DB + 6000€

3.4.3 Building codes and regulations

Different building codes and regulations are designed at national level in Italy and can have impacts on the procedures and requirements for solar. Table 3-7 below describes the most important ones.

Table 3-7 : Building codes for Italy

REGULATORY TEXT	REQUIREMENTS
Construction code: d.P.R. 6 giugno 2001, n. 380 – «Testo unico delle disposizioni legislative e regolamentari in materia edilizia», update 2018	The first part defines the general recommendations. It defines urban and building parameters, building interventions, building function, procedures for building permission, height and density limits, distance between buildings. The second part gives accommodations to local regulators. It defines internal procedures, quality and sustainability regulations, technical requirements.
Construction code (regional): D.g.r. 24 ottobre 2018, n.11/695 – Adoption of «Testo unico tipo, d.P.R. 6 giugno 2001, n. 380»	Adoption of d.P.R. 6 giugno 2001, n. 380 in Lombardy region.
Urban planning code (local): Piano Regolatore Generale Comunale	It regulates the building construction according to the forecast of growth of the population and of the economic development. It contains different documents, as land mapping and regulatory reports.
Environmental regulation: Testo unico Ambiente (TUA), update 2018	Implementation of directives 2001/42/EC and 85/377/EEC (VAS) (VIA) regulates the procedures for strategic environmental assessment (sea), environmental impact assessment (EIA) and the integrated environmental authorization (IPPC); soil conservation and combating desertification, the protection of waters against

	pollution and water resources management; waste management and remediation of contaminated sites; the protection of the air and the reduction of atmospheric emissions; compensatory protection against environmental damage.
Fire regulation: D.M. 3 agosto 2015 – «Approvazione di norme tecniche di prevenzione incendi»	As code for fire prevention, it contains fire safety requirements for the design, the construction and the use of buildings. It defines terms, symbols and risk conditions, and provides rules for fire prevention, protection and risk reduction.
Energy regulation: D.Lgs. 3 marzo 2011, n. 28	Implementation of Directive 2009/28/EC. Defines the obligations of the use of renewable sources in new buildings and major renovations. Establishes the obligation for the PV panels on the roof
Energy regulation (regional): D.g.r. 18 aprile 2012, n. IX/3298	Guidelines for the authorization of electricity production plants from renewable energy sources through implementation of national legislation. Regulates the process of permits for construction, installation and operation of plants by bringing together in a single application procedure the various administrative procedures.
Structural regulation: D.M. 17 gennaio 2018 - Aggiornamento delle «Norme tecniche per le costruzioni»	The technical standards are inherent in the structural safety of the works. Themes like expected performance, actions on buildings, civil and industrial constructions, bridges. The structural design and calculation, the Geotechnical reports for earthquakes, the static test. Provides specifications on materials and products for structural use, and technical references.
Acoustic regulation: D.P.C.M. 5 dicembre 1997 - "Determinazione dei requisiti acustici passivi degli edifici"	Defines the performance that must own the buildings about noise isolation between different units, from outside noise, noise, noise of continuous and discontinuous and reverberation time.
Electrical plants in buildings: CEI 64-8	It defines the energy efficiency criteria for electrical system users of nominal voltage under 1000 V DC voltage under 1500 V AC. Contains requirements concerning the design, implementation and verification of electrical installations, with the aim of ensuring the safety of people, goods and an operation suitable for its intended use. Indicates minimum levels of plant equipment and functional performance. Contains provisions aimed at maximizing the energy efficiency of the system
Thermal installations in buildings: d.P.R. 16 aprile 2013, n. 74	Defines the general criteria concerning exercise, operation, inspection, maintenance and inspection of heating systems for winter heating and summer of buildings, and for the preparation of hot water for sanitary use.

3.4.4 Specific requirements for integrated PV installations

BIPV-specific policies existed until 2013 and contributed to stimulating the market as well as domestic industry.

3.4.5 Synthesis of key points

Table 3-8 : Synthesis of support schemes in Italy

Parameters		Scambio Sul Posto (SSP)	Ritiro Dedicato (RID)	Auctions (FER decree)
PV Self-consumption	Right to self-consume	Yes		
	Right to self-consume (collective)	Only in some cases		
	Revenues from self-consumed PV electricity	Savings on the electricity bill		
Excess PV electricity	Revenues from excess electricity	Net-billing (based on market prices and partial savings on grid costs and taxes)	Market price or "minimum guaranteed price" if <100 kW	Market price + feed-in premium (if applicable)
	Variability of the revenue on duration of the scheme	Partial variability as it is aligned, to a certain extent, on electricity market prices	Yes - aligned on market prices	Relative – variation of the market price (monthly basis) compensated by the feed-in premium to equal the price defined in the auction
	Duration of the scheme	1 year, renewable annually until end of system lifetime	No limitation, except in case of "minimum guaranteed price": 20 years	20 years
Investment and regulatory details	Third party ownership and/or PPA accepted	Yes		
	Additional taxes/fees	GSE fee and grid costs: Net-billing: fixed fee of € 30 and a variable fee of € 1 /kW for RES units with a capacity between 20 kW and 500 kW. Market price: 0.65 €/kW for units with a capacity between 20 and 200 kW; 0.6 €/kW for units with a capacity higher than 200 kW.		
	Other direct incentive to invest in (BI)PV	Tax credit 50 % investment cost if < 20 kW 130 % value of amortization for bigger systems		130 % value of amortization
	Other indirect incentive to invest in (BI)PV	10 % VAT		10 % VAT If installation is made in the frame of asbestos-including roof renovation, extra 12 €/MWh is given on each kWh produced (20 to 100 kW)
	Other enablers of self-consumption	No		
System-linked requirements	PV system size limitations	≤500 kW	≤1 MW	>20 kW to 1 MW
	Additional features	None		Not allowed in areas already saturated with renewable energies (grid)

3.5 The Netherlands

3.5.1 Support schemes for distributed PV

Solar installations below 15 kW fall into the “saldering” scheme which is a net-metering scheme, applied on an annual base. If extra electricity is produced compared to total annual consumption, this energy is compensated at a price that is proposed by the energy retailer (typically between 0,3 and 0,12 €/kWh). This scheme will probably evolve to a self-consumption scheme with a feed-in tariff for exceeding electricity. The level of feed-in will be calculated to get a 7-year payback time.

The SDE+ support scheme is meant for all systems with a capacity equal or higher than 15 kW. Applicants compete in tenders for an operating (feed-in) premium, granted for 15 years, which compensates for the difference between the price of renewable energy and the market value of the energy supplied. The amount can be recalculated every year to have a payback time of 7 years based on average assumptions. Self-consumption is allowed which allows savings on electricity bills.

There are some fiscal incentives applied at federal level to businesses and professionals and a 45% reduction is applied on the total taxable annual income. A VAT reduction applies for small systems.

The administration for companies (RVO) regularly opened rounds of subsidies to remove asbestos roofs. The ceiling for 2019 was already reached in 2018, so there will not be any new round in 2019.

The SDE++ is in preparation, it will probably introduce technology neutral tenders to reach a point where competition is based on the amounts of carbon dioxide (CO2) and other greenhouse gases that can be potentially avoided, rather than on price only.

Finally, collective self-consumption is already partially allowed, as part of the “postcoderoos” system. It allows collective community solar where citizens can invest in big installations and are exempted from the energy tax and VAT up to a maximum of 10.000kWh. Points of production and consumption must be located in contiguous municipalities. “Postcoderoos” cannot be combined with SDE support scheme.

3.5.2 Grid access

A smart meter is requested for solar operators below 15 kW who want to sell extra electricity (annual production must exceed annual consumption). For solar plants above 15 kW, a smart meter is always needed.

3.5.3 Building codes and regulations

Different building codes and regulations are designed at national level in the Netherlands and can have impacts on the procedures and requirements for solar. Table 3-9 below describes the most important ones

Table 3-9 : Building codes for The Netherlands

REGULATORY TEXT	REQUIREMENTS
Energy performance	Since 2015, the Energie Prestatie Coëfficiënt (EPC) norm for new buildings has been reinforced and it has led to an increase of small BAPV systems installations. In 2020, The BENG (translation of the European EPBD directive) will enter into force.
NEN 7250/A1: specific norm for solar energy systems	The Netherlands developed specific norm regarding the integration in roofs and facades of solar energy systems (thermal and PV). It concerns BAPV and BIPV applications and focus on building aspects (wind and water resistance, snow…)

3.5.4 Specific requirements for integrated PV installations

There is no specific distinction between PV and BIPV regulations.

3.5.5 Synthesis of key points

Table 3-10 : Synthesis of support schemes in The Netherlands

Parameters		"Saldering"	SDE+
PV Self-consumption	Right to self-consume	Yes	
	Right to self-consume (collective)	Yes	
	Revenues from self-consumed PV electricity	Net-metering	1. Savings on the electricity bill 2. SDE+ contribution
Excess PV electricity	Revenues from excess electricity	3 to 12 c€ for extra electricity (if annual production > annual consumption)	SDE+ contribution
	Variability of the revenue on duration of the scheme	Yes – in function of retail electricity price	Relative – Variation of the market price BUT correction amount is adapted every year to maintain a value equal to the "base" amount defined during tender
	Duration of the compensation scheme	Not fixed	15 years
Investment and regulatory details	Third party ownership accepted	No	Yes
	Additional taxes/fees	None	
	Other direct incentive to invest in (BI)PV	None	
	Other indirect incentive to invest in (BI)PV	VAT refund	45% reduction on taxable annual income
	Other enablers of self-consumption	None	
System-linked requirements	PV system size limitations	< 15 kW	≥ 15 kW
	Additional features		Differentiation between on buildings or on ground, the former benefitting from better conditions

3.6 Spain

3.6.1 Support schemes for distributed PV

Operators of solar plants below 100 kW can benefit from savings on their electricity bill thanks to self-consumption but are not allowed to sell the excess electricity they inject on the grid.

Operators of solar plants above 100 kW can decide to sell their electricity on the market or to self-consume, or both. In addition, premium tariffs are granted through punctual auctions, it is a complementary retribution to allow renewable technologies to compete with traditional technologies in the energy market. Only new mainland large scale PV and wind energy installations were eligible in the last auction which was held in 2017.

The recently enacted RDL 15/2018 introduces important measures supporting self-consumption such as the right to self-consume without charges, the right to implement collective self-consumption activities and the simplification of the administrative and technical procedures, especially for small-size installations. This decree has not entered into force yet as it is going through a consultation and revision process, with among other inputs expected from professionals of the sector.

Under this decree, a first scheme concerns self-consumption without excess electricity where the consumer can self-consume without charges and a physical device prevents injecting electricity to the grid.

Then, a second scheme concerns self-consumption with excess electricity; the producer can self-consume without charges and can sell its excess electricity to other consumers on the wholesale market (still to be defined in which conditions).

Also, as part of this new decree, Spain might enable collective consumption for producers connected to the internal network of the related consumers; producers and consumers linked through direct lines; as well as producers and consumers connected to the LV coming from the same transformation center. The details will be defined within the following months.

Finally, a tax credit up to 750 M€ will be activated. At the regional and local level, non-refundable grants are available, in most cases oriented to the promotion of self-consumption. The most common incentives are support to investment, soft credits, tax reductions (IBI, ICIO, etc.) and income tax reductions due to investments in renewable energies or energy efficiency in buildings.

Note that for installations with capacity above 10 kW, a grid tax is applied (0,5 €/MWh).

3.6.2 Grid access

The new royal decree law states that the procedures for the administrative and technical conditions for the grid connection will be established (still pending) and will be proportioned to the size and self-consumption modality.

The installations relying on self-consumption without excess electricity, with a capacity below 100 kW will be impacted by their respective technical regulation only (e.g. low-voltage installations will be executed in accordance with the Low Voltage Electrotechnical Regulation).

In addition, the technical configuration of measuring equipment will be established, significantly simplifying the precedent methodology. Only the strictly required meters for the correct invoicing will be needed (note that this statement needs further clarification in the decree, in order to define what exactly is 'strictly required').

Exemption for grid access and connection request are granted to installations under self-consumption without excess electricity schemes, if the consumer is already connected to the grid, as well as for installations below 15 kW in urban land (areas where it is authorized to build).

3.6.3 Building codes and regulations

Different building codes and regulations are designed at national level in the Spain and can have impacts on the procedures and requirements for solar. Table 3-11 below describes the most important ones

Table 3-11 : Building codes for Spain

REGULATORY TEXT	REQUIREMENTS
Law on Building Ordinances **Law 38/1999 of 5 November (LOE), and modifications.**	Establishment of the basic requirements to be met by buildings to ensure the safety of people, the welfare of society and environmental protection.
Technical Building Code **(Código Técnico de la Edificación - CTE)** **Real Decreto RD 314/2006** **Approved on 17th March 2006** **(BOE 28-03-2006) and modifications.**	It is the regulatory framework that establishes the requirements to be met by buildings in relation to the basic requirements of safety and habitability established by the LOE. One of the basic requirements of the CTE is energy saving and its objective is to achieve a rational use of the energy necessary for the use of the buildings, reducing consumption and achieving that the origin of part of the same is from renewable sources of energy. A part of the energy demand requirements, the "DB HE5 Minimum photovoltaics contribution of electrical energy" of the Spanish CTE introduces the obligation to supply a certain quantity of the electrical power by photovoltaics technologies. This is mandatory for certain buildings, such as new or fully retrofitted hypermarkets, hotels, medical clinics, sports centres, ferial pavilions or warehouses with a surface area greater than 5000 m2. In every case, the mandatory maximum amount of PV to be installed is set at 100 kW. Currently, there is a **Royal Decree modification proposal** of the CTE in order to update and revise the definition of nZEB in accordance with the European Directive 2010/31/UE. The **transposition of the latest recast of the EPBD**, in force since the 9th of July 2018, needs to be addressed within the following 20 months. Therefore, substantial modification of the Spanish CTE can be expected in the coming months.
Energy performance: **Royal Decree RD 235/2013**	Approving the basic procedure for the certification of the energy performance of buildings. Spanish transposition of the Directive 2010/31/UE, related to the establishment of the technical and administrative conditions for the certification of energy efficiency in buildings, and the methodology for calculating the energy efficiency rating.
Regulation of Thermal Installations in Buildings **(RITE)**	As a transposition of Directive 2002/91/EC, in 2007 the Spanish government enacted the Reglamento de Instalaciones Termicas en los Edificios [Regulation of Thermal Installations in Buildings]. According to this regulation, thermal installations should be designed, implemented, maintained and used so as to achieve a significant reduction of conventional energy consumption and, consequently, a parallel reduction of greenhouse gas emissions and other atmospheric pollutants

3.6.4 Specific requirements for integrated PV installations

In Spain, CE marking is the first “certification” asked and it is enough in most cases.
For construction product, three equivalent options exist to provide verified information:

- DAU (Document of Assessment for fitness of Use)
- DIT (Documento de Idoneidad Técnica)
- TC (Technical Conformity Report)

The DAU, Document of Assessment for fitness of Use, is the statement of a favorable opinion on the performances of an innovative product or system regarding its intended uses and defined constructive solutions, within the field of building and civil engineering construction.

A DAU assesses the fitness for the intended use of a constructive solution on the basis of objective levels or required limit values for building works and on functional requirements established case by case.

For new products and non-traditional construction, this type of information is strongly “recommended” by insurance companies.

3.6.5 Synthesis of key points

Table 3-12 : Synthesis of support schemes in Spain

Parameters		Type 1	Type 2
PV Self-consumption	Right to self-consume	Yes	
	Right to self-consume (collective)	Yes (still to be defined under what conditions)	
	Revenues from self-consumed PV electricity	Savings on the electricity bill	
Excess PV electricity	Revenues from excess electricity	No	Market price (to be defined in which conditions)
	Variability of the revenue on duration of the scheme	Not applicable	Yes, varies in function of the electricity market price
	Duration of the compensation scheme	Not applicable	
Investment and regulatory details	Third party ownership and/or PPA accepted	No	Yes
	Grid codes and additional taxes/fees	Yes: grid tax of 0,5€/MWh if system > 10 kW	
	Other direct incentive to invest in (BI)PV	No	
	Other indirect incentive to invest in (BI)PV	The Spanish building codes sets a minimum PV requirement to be fulfilled by new or fully retrofitted buildings with a surface >=5000 m2 falling under the defined appliance uses. Maximum required installation size 100 kW. The CTE is currently under revision and will be modified in the coming months.	
	Other enablers of self-consumption	No	
System-linked requirements	PV system size limitations	≤ 100 kW	>100 kW
	Additional features	Tax credits, support to investment, soft credits, tax reductions (IBI, ICIO, etc.), income tax reductions due to investments in renewable energies or energy efficiency in buildings.	

3.7 Switzerland

3.7.1 Support schemes for distributed PV

The main support measure in Switzerland was the feed-in tariff for installations larger than 30 kW. With the implementation of the new energy strategy 2050, this tariff will end in 2023. The tariff payment period for PV installations is 15 years and was equal to 0,11 CHF/kWh for projects connected in 2018. There are already 35.000 solar installations on the waiting list and there is no guarantee that they will get any financial support. Thus, this support scheme can be considered as irrelevant for new systems.

The investment premium, which was reserved for solar installation below 30 kW, is being extended to installations above 30 kW. It will exist until 2030 for new installations. This investment premium covers up to 30% of the investment costs of reference installations. As there are important waiting lists for the feed-in tariff, the investment premium is very likely the only support for new solar plants in Switzerland in the coming years. Payment delays for the premium of at least 2 years can be expected for new installations.

It is important to notice that both the feed-in tariff and the investment premium are higher if the installation is integrated to the building.

A new support scheme has been developed to replace the feed-in tariff support scheme. This scheme is partially based on or the electricity that is not self-consumed, there are two ways to valorize it for 15 years:

- Retribution with direct marketing: Mandatory for systems > 100 kW, producers will need to sell their electricity on the market, and they will get a feed-in-premium calculated as the difference between a fixed amount per kWh (remuneration rate) and the average market price. If the market price is higher than the remuneration rate, producer will be charged.
- Retribution without direct marketing: For systems < 100 kW, producers are not forced to sell their electricity on the market, and they can choose a fixed Feed-in premium.

The total retribution given for each kWh fed back to the grid varies from one DSO to another, but it often ranges around 0,10€/kWh (VAT included).

Collective self-consumption is allowed if applied in the same building or the same perimeter of land (neighbor but not crossing the street, one single grid connection). Different solutions exist depending on the DSO: either “virtual” metering by the DSO, or the DSO buys the entire production at 2 tariffs (excess and self-consumed). With the new legislation that has come into force on January 2018, the consumers that group together will be treated as one single consumer (internal metering will be under the responsibility of the group) and can have access to the free electricity market.

3.7.2 Grid access

In Switzerland every grid operator has the possibility to define the safety prescription for the grid connection of a PV system. Generally, it is always possible to install a PV system in self-consumption without special measures apart from a electricity meter that counts the energy flows. For an

installation with a power greater than 30 kVA, the installation of a central protection of the network is prescribed, namely an overall monitoring system of the network (including the frequency of the network). The switching device of the coupling circuit breaker must be electrically triggered instantaneously in the event of failure.

3.7.3 Building codes and regulations

Buildings in Switzerland are regulated by federal laws as well as by laws and ordinances of the Cantons. Since Switzerland is a federal state made of 26 Cantons, there are 26 different Building Laws. Building permits are usually obtained from the local authority where the construction work is to be performed. The local authority coordinates with the authorities of the Canton and all other instances involved in issuing the building permit. Switzerland is not a member of the EU, but a member of the European Free Trade Association (EFTA). To facilitate free trade with Member States of the EU, Swiss legislation is adapted to EU law in several areas. The authority which controls the Construction Product market in Switzerland is the Bundesamt für Bauten und Logistik (BBL). It is responsible for the application of the CE mark on building products. In Switzerland, the requirements for construction works are defined by a company of private law named SIA (Swiss society of engineers and architects), and are typically considered as state of the art. Some of the standards or part of their content are referenced by the law and are therefore mandatory.

Different building codes and regulations are designed at national level in Switzerland and can have impacts on the procedures and requirements for solar. Table 3-13Table 3-3 below describes the most important ones.

Table 3-13 : Building codes for Switzerland

REGULATORY TEXT	REQUIREMENTS
Swiss Civil Code of 1907	It is the codified law ruling in Switzerland and regulating relationship between individuals. It contains rules that apply to the abatement of nuisances such as water or air pollution, as well as noise.
Swiss federal Land Use Planning Law	Stipulates the ground rules for all planning on all levels, namely the economic use of land in general and the use of agricultural land in particular.
Energy performance and thermal regulation	Under the existing law, there are no national targets or legal requirements for increasing the use of renewable energy, but some cantons have set regional targets The Federal Council has proposed the Energy Strategy 2050, with the aim of restructuring the Swiss energy system and withdrawing from nuclear energy. Minergie® is the Swiss energy label launched in 1998. It is a private organisation owned by the non- profit Minergie® Association and sets benchmarks and tools to combine energy efficiency in building with improved comfort. Minergie® is a registered trademark and a labelling system. It is not just about accrediting energy efficient buildings. Minergie, a leading building standard organization, supported by the cantons as well as the Swiss Federal Office of Energy and the building industry, revised its building standards in 2016. PV has become quasi-mandatory to fulfil the requirements for the nearly zero energy standards. Since for a Minergy labelled building, only 40% of the grid-injected electricity can be counted for the overall energy requirements, there is an additional incentive to optimize self-consumption (DSM, battery)….

Construction product regulation (Bauproduktenverordnung, BauPV)	If a construction product is manufactured according to a technical specification, its conformity to the latter must be examined as part of a conformity assessment. Depending on the technical specification should preferably apply one of the following conformity assessment procedures: • assessment of conformity by the manufacturer; • conformity assessment by a conformity assessment body accredited The official body authorized for approval is the Swiss Federal Laboratories for Materials Testing and Research (EMPA). The Federal Council may designate other private bodies authorized for this purpose.

3.7.4 Specific requirement for integrated PV installations

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

Similar 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 glazing system so the construction rules of constructive glass building must be met. Since concrete Swiss glazing rules do not exist, often German standards are used.

3.7.5 Synthesis of key points

Table 3-14 : Synthesis of support schemes for Switzerland

Parameters		Retribution without direct marketing	Retribution with direct marketing
PV Self-consumption	Right to self-consume	Yes	
	Right to self-consume (collective)	Yes	
	Revenues from self-consumed PV electricity	Savings on the electricity bill	
Excess PV electricity	Revenues from excess electricity	Feed-in tariff	PPA + feed-in premium to equal the defined amount
	Variability of the revenue on duration of the scheme	Yes – can be revised on a yearly basis	Yes – can be revised on a yearly basis. Also, market price varies, although these variations are compensated by the FiP to equal the defined amount
	Duration of the compensation scheme	15 years	
Investment and regulatory details	Third party ownership and/or PPA accepted	Yes, both	
	Grid codes and additional taxes/fees	None	
	Other direct incentive to invest in (BI)PV	Investment premium of approximatively 30 % Higher premium for BIPV (~ + 10 %)	
	Other indirect incentive to invest in (BI)PV	None	
	Other enablers of self-consumption	None	
System-linked requirements	PV system size limitations	≤ 100 kW	>100 kW
	Additional feature	None	

4 CLOSING REMARKS

Due to the rapid decline of the prices of PV systems' components this last decade, national PV markets developed quickly, and support schemes had to be adapted on a regular basis. Each country has followed its own logic and objectives, but some trends can be identified:

- Self-consumption is becoming a major driver of distributed PV installations, often completed with a feed-in tariff (or a feed-in premium offered as a complement to the electricity market spot price) for the excess PV electricity fed back to the grid;
- BIPV-specific support schemes have disappeared. They remain only in Switzerland, while in other countries such as France or Germany, support to BAPV is more advantageous and can apply as well to BIPV;
- The collective use of self-consumption, within buildings or between different buildings, is not widespread yet. Although it already exists in some countries and is expected to develop in the short-term in others.

While the two first points could be perceived as unfavourable, they are part of the natural evolution of PV, which becomes an increasingly mature technology, able to rely on its sole intrinsic competitiveness to compete with other technologies on electricity markets. In addition, the last point on collective self-consumption allows mitigating the first two by creating new business opportunities. Indeed, it widens the range of possibilities to value the production of distributed PV systems.

Concerning the weaknesses of these regulatory frameworks, experts from each analyzed country have been asked to evaluate the remaining regulatory challenges to the expansion of the BIPV market. The main challenges that have been identified are listed below:

- Instability of the regulation, most importantly the support schemes of PV;
- Too many restrictions limiting the possibilities to value the PV production;
- Complexity of administrative procedures;
- Building codes restrictions.

It comes out that on average, none of these 4 challenges is considered by itself as a major obstacle. Nevertheless, for 3 countries (Italy, Netherlands and Switzerland), lack in stability of the regulation and difficulties to value the PV production are still major issues which must be solved before any wide deployment of BIPV on the market can be envisaged.

Globally, these elements remain a major point of attention as they can have significantly negative effects on the attractiveness of BIPV solutions, especially when they combine. Indeed, even if new business models can be developed thanks, for example, to new possibilities to value PV production such as collective self-consumption, these new business models will not spread if the administrative procedures are too complex or if risk perception is too high due to instable regulatory framework. For that reason, these four challenges should be treated in parallel and become the priority areas of improvement for policy-makers.

REFERENCES

[1] IEA PVPS T15, "International definitions of “BIPV”," IEA PVPS, 2018.

[2] "Regulation (EU) No 305/2011 of the European PArliament and of the Council," 4 April 2011. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011R0305&from=EN.

[3] CEA, Tecnalia and CTCV, "Standardization needs for BIPV," PVSITES, 2016.

[4] "Euroepan Commission | The Low Voltage Directive (LVD)," [Online]. Available: http://ec.europa.eu/growth/sectors/electrical-engineering/lvd-directive_en.

[5] "European Commission | Electromagnetic Compatibility (EMC) Directive," [Online]. Available: https://ec.europa.eu/growth/sectors/electrical-engineering/emc-directive_en.

[6] "European Commission | Waste Electrical & Electronic Equipment (WEEE)," [Online]. Available: http://ec.europa.eu/environment/waste/weee/index_en.htm.

[7] "IEC | TC 82 Dashboard," [Online]. Available: https://www.iec.ch/dyn/www/f?p=103:38:8299336743964::::FSP_ORG_ID,FSP_APEX_PAGE,FSP_PROJECT_ID:1276,23,23167.

[8] ACCIONA, NOBATEK and CEA, "European regulatory framework for BIPV," PVSITES, 2016.

[9] "EOTA | New EADs published," 2018. [Online]. Available: https://www.eota.eu/en-GB/content/new-eads-published/37/599/.

[10] EOTA, "European Assesment Document - EAD 090062-00-0404," 2018.

[11] "Clean Energy for All Europeans | Energy," [Online]. Available: https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans.

[12] "The revised Energy Performance of Buildings Directive (EU) 2018/44," [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2018.156.01.0075.01.ENG.

[13] "The revised Energy Efficiency Directive (EU) 2018/2022," 2018. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0210.01.ENG&toc=OJ:L:2018:328:TOC.

[14] "European Commission - Press release: Electricity Market Design DIrective and Regulation," 18 December 2018. [Online]. Available: http://europa.eu/rapid/press-release_IP-18-6870_en.htm.

[15] M. WILLUHN, "European Parliament approves electricity market design proposal," *pv magazine,* 27 March 2019.

[16] P. Macé, D. Larsson and J. Benson, Inventory of Existing Business Models, Opportunities and Issues for BIPV, IEA PVPS Task 15 - Subtask B Report, April 2018.

[17] G. Masson and I. Kaizuka, "Trends 2018 in Photovoltaic Applications," International Energy Agency Photovoltaic Power Systems Programme, 2018.

[18] G. Masson, "Review and analysis of PV self-consumption policies," International Energy Agency Photovoltaic Power Systems Programme, 2016.

[19] B. Bayer, P. Matschoss, T. Heiko and A. Marian, "The German experience with integrating photovoltaic systems intothe low-voltage grids," *Renewable Energy,* no. 119, pp. 129-141, 2018.

[20] "The revised Renewable Energy Directive (EU) 2018/2022," [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG&toc=OJ:L:2018:328:TOC.

[21] "Construction Products Regulation (CPR)," European Commission, [Online]. Available: https://ec.europa.eu/growth/sectors/construction/product-regulation_en.

[22] "List of new EADs published on 2017.12.15," EOTA, 2017.

[23] "European Commission - Press release: Clean Energy for All Europeans," 18 December 2018. [Online]. Available: http://europa.eu/rapid/press-release_IP-18-6870_en.htm.

[24] IEA Photovoltaic Power Systems Programme (PVPS), "http://www.iea-pvps.org/," [Online].

APPENDIXES

ANNEX I: Analysis of EN50583 “PV in Buildings” (Source: PVSITES, 2016) [3]

Product		System for demonstration	Relevant standards according with EN 50583:2016	
X1/ X3	CIGS roofing shingle on metal substrate	Roofing shingles	IEC 61646 a-Si	TF modules - Design qualification and type approval
			EN 61730	PV module safety qualification
			50583-2 Annex A	PV in buildings. Rain penetration test
			EN 13501 - 1	Fire - Classification from reaction to fire tests
X2	CIGS large area flexible roofing membrane and bendable elements	Roofing membrane	IEC 61646 a-Si	TF modules - Design qualification and type approval
			EN 61730	PV module safety qualification
			**EN 13363-1	Solar protection devices - Light & Solar
			50583-2 Annex A	PV in buildings. Rain penetration test
			EN 13956	Flexible sheet for waterproofing
			EN 13501 - 1	Fire - Classification from reaction to fire tests
			EN 16002	Flexible sheets for waterproofing - Resistance to wind load
X4	CIGS large area elements on metal substrate	Large area tiles façade	IEC 61646 a-Si	TF modules - Design qualification and type approval
			EN 61730	PV module safety qualification
		Roof tiles on metal	EN ISO 6946	Construction - Thermal transmittance
			EN 14782-3	Self-supporting metal sheet (roofing, cladding, lining)
			EN 14783	Supported metal sheet and strip for roofing, cladding, lining
		Large area roofing shingles	EN 13501 - 1,2,5	Fire - Classification from reaction to fire tests
			**EN 13116	Curtain walling - Resistance to wind load - Requirements
			**EN 12179	Curtain walling - Resistance to wind load - Test
X5	C-Si glazed products with hidden bus bars and L interconnections	Ventilated façade	EN ISO 12543 1-6	Glass in building - Laminated glass and laminated safety glass
			EN 14449	Laminated glass
			IEC 61215 c-Si	c-Si modules - Design qualification and type approval
			EN 61730	PV module safety qualification
			EN 13501 - 1,2	Fire - Classification from reaction to fire tests
			**EN 13116	Curtain walling - Resistance to wind load - Requirements
			**EN 12179	Curtain walling - Resistance to wind load - Test
X6	Glass-glass products with back contact c-Si cells	Ventilated façade	IEC 61215 c-Si	c-Si modules - Design qualification and type approval
			EN 61730	PV module safety qualification
			*EN 410	Glass - Light & Solar
			*EN ISO 12543 1-6	Glass in building - Laminated glass and laminated safety glass
			*EN 12758	Glass in building - Sound insulation
			*EN 12600	Glass in building - Pendulum test
			*EN 13501 - 1,1	Fire - Classification from reaction to fire tests
			**EN 13116	Curtain walling - Resistance to wind load - Requirements
			**EN 12179	Curtain walling - Resistance to wind load - Test
X7	Curved glass-glass, CIGS technology	TBD	EN ISO 12543 1-6	Glass in building - Laminated glass and laminated safety glass
			EN 14449	Laminated glass
			EN 61730	PV module safety qualification
			EN 673/674/675	Glass in building - U Value

			EN 12758	Glass in building - Sound insulation
			EN 13501 - 1	Fire - Classification from reaction to fire tests
X8	C-Si framing for large area glass	TBD	EN 61730	PV module safety qualification
			EN ISO 12631	Curtain walling - Calculation of thermal transmittance
			EN 13022-1	Glass in building - Structural sealant glazing (SSG)
			**EN 13116	Curtain walling - Resistance to wind load - Requirements
			**EN 12179	Curtain walling - Resistance to wind load - Test
X9 to X11	C-Si semi-transparent low concentration and solar control BIPV system	Skylight	EN 1279-5	Glass in building - Insulating glass units - Conformity
			**EN 13830	Curtain walling - Product standard
			IEC 62108	CPV - Design qualification and type approval
			EN 410	Glass - Light & Solar
			**EN 13363-1	Solar protection devices - Light & Solar
			EN 673/674/675	Glass in building - U Value
		Façade	EN 12758	Glass in building - Sound insulation
			EN 13501 - 1	Fire - Classification from reaction to fire tests
			**EN 13116	Curtain walling - Resistance to wind load - Requirements
			**EN 12179	Curtain walling - Resistance to wind load - Test
X12	Glazed modules treated for improved passive properties	TBD	***EN ISO 12543 1-6	Glass in building - Laminated glass and laminated safety glass
			***EN 14449	Laminated glass
			EN 410	Glass - Light & Solar
			EN 673/674/675	Glass in building - U Value
			IEC 61215 c-Si	Design qualification and type approval
			EN 61730	PV module safety qualification