Technology Collaboration Programme
by IEA

International Energy Agency
Photovoltaic Power Systems Programme

Task 1 Strategic PV Analysis and Outreach

PVPS

Building Integrated Photovoltaic Policies in Italy

2021

Report IEA-PVPS T1-40:2021

What is IEA PVPS TCP?

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD). The Technology Collaboration Programme (TCP) was created with a belief that the future of energy security and sustainability starts with global collaboration. The programme is made up of 6.000 experts across government, academia, and industry dedicated to advancing common research and the application of specific energy technologies.

The IEA Photovoltaic Power Systems Programme (IEA PVPS) is one of the TCP's within the IEA and was established in 1993. The mission of the programme is to "enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems." In order to achieve this, the Programme's participants have undertaken a variety of joint research projects in PV power systems applications. The overall programme is headed by an Executive Committee, comprised of one delegate from each country or organisation member, which designates distinct 'Tasks,' that may be research projects or activity areas.

The IEA PVPS participating countries are Australia, Austria, Belgium, Canada, Chile, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Malaysia, Mexico, Morocco, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, and the United States of America. The European Commission, Solar Power Europe, the Smart Electric Power Alliance (SEPA), the Solar Energy Industries Association and the Cop- per Alliance are also members.

Visit us at: www.iea-pvps.org

What is IEA PVPS Task 1?

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation.

Authors

- **Main Content: Task 1 participants:** Francesca Tilli (Gestore dei Servizi Energetici S.p.A - GSE). Other contributors: Matteo Giannì (GSE)
- **Data:** GSE
- **Analysis:** Luca Benedetti (GSE), Francesca Tilli (GSE)
- **Editor:** Oliver Ashby (APVI, Solinno Pty Ltd)

COVER PICTURE

GSE, *Catalogue of Photovoltaic Plants Integrated with Innovative Characteristics*, as well as all other pictures in this report

ISBN 978-3-907281-22-2, Task 1 Report T1-40:2021

INTERNATIONAL ENERGY AGENCY

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

IEA PVPS Task 1

Strategic PV Analysis & Outreach

Building Integrated Photovoltaic Policies in Italy

Report IEA-PVPS T1-40:2021

December 2021

ISBN 978-3-907281-22-2

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

This report received valuable contributions from Mr. Francesco Trezza, former Head of the Feed-in Tariff Unit of Gestore dei Servizi Energetici (GSE), and from other actors of this important process and of BIPV market. Many thanks to all of them.

EXECUTIVE SUMMARY

Building Integrated Photovoltaics (hereafter, BIPV), plays an important role in achieving the ambitious decarbonization targets of the European Union. In 2021, BIPV plants are installed all over the world, even in countries without defined goals in terms of capacity installed and/or a structured regulation scheme, that might aim to manage and drive the growth of the market.

A key element, to support the review of laws, regulations, and incentives, is the dissemination of best practice and the sharing of principles with stakeholders and all the market players including industry, public administrations, utilities, associations, regulators, certification bodies, architects, engineers, and citizens.

This knowledge sharing is a two-way process: on the one hand there is dissemination, on the other there is feedback and input from stakeholders and market operators.

Dissemination of best practice and the sharing of outcomes is the main objectives of this report. In addition, we report results achieved in Italy, where out of the 21,6 GW of total PV capacity installed at the end of 2020, around 2,5 GW are BIPV plants. This 2,5 GW has been incentivized under the feed in tariff (FiT) law managed by Gestore dei Servizi Energetici (hereafter, GSE). GSE is a stock company, owned by the state, charged with implementing energy policies concerning renewable energy systems (RES) and energy efficiency through incentives. GSE supports sustainability among public administrations, industries, and private citizens.

The path towards BIPV in Italy started in 2005 with the introduction of the FiT law. The process is ongoing, with feedback from stakeholders in the BIPV industry (Italian and foreign) received through to the beginning of 2021. These stakeholders, with whom GSE keeps long-lasting relationships, contributed to defining the successes and the critical issues related to the FiT law in Italy, that are analysed in this report. This is a learning process of innovation on topics, technologies, and European patents, which did not stop at the end of the FiT Law.

The scope of this report is to provide a review of the implementation and outcomes of a BIPV incentive policy in terms of capacity installed, and in terms of progress in establishing a new culture among all stakeholders of the BIPV market, an approach that might be extended to other countries.

In this sense, success can also be found both in the significant uptake of BIPV and in the cultural change that has meant the BIPV market continues to thrive in Italy, even after the FiT era, with stakeholders willing to invest in BIPV projects.

Success is a common and shared path.

After highlighting the policies concerning FiT implementation, this report provides the definitions of the requirements to access incentives. Briefly highlighted, these are:

- Total integrated plant, a first step towards BIPV, with modules that simply replace part of the roof, the façade, or shelter.
- BIPV plants with innovative characteristics, where the BIPV system substitutes the traditional building element and involves ensuring waterproofing and thermal regulation. At the same time, the building has its energy needs met from the building structure and becomes an integrated system in which BIPV takes part in the energy flows.

Chapter 4 reviews the data relating to BIPV plants accessing the incentives of the FiT Law with details of the different typology of components, the related costs and the particular incentives

granted. In this chapter, the difficulties faced by the GSE on several topics (including dissemination) is discussed, with the two-way process implemented throughout. Results from publications, focus groups and meetings with operators are included. Chapter 4 emphasizes the results (innovations) obtained, the performance of components, the new designs that consider integrations with the entire building envelope, and the new attitude and confidence of operators in sharing new BIPV solutions, often backed by the FiT incentives.

Chapter 5 reports critical issues, as highlighted by the operators; one among them is the claimed cost of certification for PV modules, which is still relevant today.

In Chapter 6, answers to the surveys of industry stakeholders, interviewed over the years following the FiT Law between 2013 to 2020, are discussed. These reveal a BIPV market showing ongoing cost reductions that contracted immediately after the FiT law ended and has seen a recovery since 2017. In the questionnaires, BIPV producers presented their existing products and their vision on the possible future for BIPV in Italy.

Answers from the industry make clear that a new culture has emerged, despite the existence of some critical issues. This is confirmed by the fact that some regions in Italy, even after the incentive period, continued to apply the GSE BIPV guidelines in order to access regional incentives or request funding. Moreover, in the same period, many Innovative BIPV plants have been installed to access the net-billing scheme and tax deductions. As a result, a BIPV market, together with knowledge and culture, still exists in Italy.

The report ends with chapter 7, where some suggestions for future policies are given.

This report is mainly intended for policy makers. The analysis of the effectiveness of the Italian FiT policy was conducted over a few years after the end of the FiT Law in order to understand if a BIPV market and a cultural shift towards the integration of PV in buildings still exists in Italy.

Barriers to a full deployment of BIPV still exist, but with a shared process involving all the stakeholders, these barriers can, over time, be solved. This report shows a possible way to build this process and the main topics and challenges to be faced.

1 INTRODUCTION

In a country where architecture is one of the main roots of its cultural heritage, how can photovoltaics become a part of the buildings? This question framed the implementation of the Italian feed-in-tariff law (FiT law) introduced in Italy in 2005, known as the 'Conto Energia'.

Since then, over 2 GW of Building Integrated Photovoltaic (BIPV) plants have been installed in Italy, including plants built beyond all the possible definitions of BIPV.

The path to success for BIPV has been built on a number of requirements, for PV modules, buildings, and installation criteria, with a long-term vision. At times these were considered too strict by stakeholders, however, these requirements have defined the dignity and value of photovoltaics as a building element, leading to Building Integrated Photovoltaics as we know it.

We have defended and enhanced this approach, worthy of a building culture that identifies the place of human institutions in architecture.

Beginning with the first retrofit installations of last decade, followed by the five 'Conto Energia' decrees, finally photovoltaics meets architecture.

2 ENERGY POLICIES IN FAVOUR OF BIPV

2.1 The Path of PV Along Five Decrees

The Italian feed-in-tariff (FiT) law was introduced in Italy in 2005, with four successive ministerial decrees (all named “Conto Energia”). The first FiT scheme was designed by the decree of July 2005, proceeded by the legislative decree n.387 of December 29th ,2003, which endorsed the European directive on renewable sources.

GSE was appointed as the implementing body in charge of allocating the incentives.

The mechanism established by this decree was a FiT premium (up to mid 2012). The responsible party of the PV plant received, from GSE, the applicable tariff on the PV production plus the revenues from the net-billing scheme or other specified schemes. From mid 2012, the fourth decree oversaw a switch to a FiT scheme, with a specific tariff for the self-consumed quota.

In addition to the FiT system, in 2009 Italy switched from the net-metering mechanism to the so-called “Scambio Sul Posto” (SSP) for plants below 500 kW. The SSP is a net-billing scheme, in which electricity fed into the grid 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 charges). In the case where the producer does not want to apply for the SSP, electricity market prices are applied for the electricity injected into the grid.

The cost of the incentive is covered by a component of the electricity tariff structure paid by all final consumers, with the financial cap set by the decree at 6,7 BEUR per year.

Due to these generous incentives and bonuses, Italy has seen a booming PV market, especially between 2009 and 2011. Among them was a bonus for plants whose investment capital was sourced for components produced within the European Union, the building energy efficiency bonus (see chapter 2.2) and a bonus for PV plants replacing asbestos.

As a result of this boom, the cumulative PV power installed in Italy at the end of 2020 was 21,6 GW.

2.2 Total Integrated Plants, the First Step Towards BIPV

The first revision of the FIT law in February 2006 envisaged a generic 10% increase to the incentive for building integrated systems, but it was the second Conto Energia of 2007 that redefined the tariffs and introduced new rules.

Tariffs were designed to promote small plants (distributed generation) and architectural integration according to three different degrees of implementation: not integrated, partially integrated and integrated, each with their own tariffs.

As far as building integration is concerned, the incentive scheme dealt with partially and totally integrated systems. The partial integration case was designed to consider the vast majority of existing buildings, often in historical towns where retrofitting technologies using Building Applied Photovoltaic (BAPV) was the only possibility. Partially integrated systems consisted of PV modules installed horizontally and inclined over flat roofing or with the same tilt of an underlying sloped roof.

Architectural integration was rewarded with a higher incentive for the implementation of PV modules as a component of the building envelope. The second FiT law was the first step for

PV along the path towards architectural integration, with the request for the PV module to substitute a component of the facade of the roof, or of the shelter.

This definition of the difference between partially and totally integrated requirements was quite controversial and the introduction of PV at a design stage of the building or in a whole building renovation project was uncommon.

Partially Integrated Plant

Totally Integrated Plant

Another important innovation of the second FiT scheme was to consider the energy efficiency aspect. This was globally quite unique and followed the guidelines of the Decree 192/05 and the implementation of the European Directive 2002/91/EC on the energy performance of the building. A further increase in tariffs (up to 30%) was granted for plants under the net-billing scheme, improving energy efficiency of the annexed building and for PV plants installed on a new building. In this second case, the primary energy consumption index of the building had to be at least 50% lower than the standard thresholds set by the law.

The energy integration aspect was an important but little-considered aspect of the Italian FiT. The idea of including the building in a wider energy project, and that BIPV is not only a power generation plant to be installed on the surface of the roof, can be seen to be the seed on which the following decrees concerning BIPV were implemented.

2.3 Innovative Characteristics, the Full Achievements of BIPV

More than 30% of the plants of the second Conto Energia decree accessed the totally integrated tariff (both in number and in capacity), regardless of their actual function in the building.

The subsequent decrees (third, fourth and fifth FiT) set new rules to support the production of electricity from PV plants. They defined a specific role for photovoltaic architecture through the introduction of ‘Innovative BIPV’ and emphasized the link between the BIPV plant and the building. Furthermore, according to the decree, BIPV Modules and Components (two product categories explained below) must preserve the building energy needs and have a thermal transmittance equivalent to that of the building element replaced. Thus, there must be a physically measurable building energy need, according to existing technical specifications. In this sense, the building transforms, from a mere structure, and becomes an integrated entity with a focus on sustainability.

Concerning Innovative Modules and Components, a distinction for products coming from two different markets was necessary. On one side, historical PV producers of standard modules

with Special Components; on the other side, new entrants from the construction industry attracted by this booming market where they would be able to experiment with their Innovative Modules on new PV building products.

Standard module producers and new entrants both had to address the concept of innovation requested by the decree. For the PV module, specifically designed as a building structure (Innovative Module), this innovation was clear. For the traditional modules however, typically used only for electricity production, the innovative aspect was less obvious. The key element in this case became the mounting system, which needed to have "innovative features" to justify the access to higher tariffs. At the suggestion of the National PV Associations, during the public consultation phase of the GSE Technical Rules and the BIPV Guide for the Third FiT, the innovative features were identified in a European patent (see the GSE *Catalogue of Photovoltaic Plants Integrated with Innovative Characteristics*).

Special Components are standard laminated (frameless) PV modules, certified in accordance with technical standards set by the decree. For these products, innovation required a European patented mounting system specifically designed to guarantee a waterproof building structure. Products with a European Patent pending were also eligible if all claims regarding Novelty, Inventive step and Industrial applicability of the preliminary opinion were positively evaluated by the European Patent Office.

Detail of a Special Component; the PV modules (laminates) together with the patented mounting system ensure the waterproofing of the building structure

The subject of the patent (or patent application) must be related to the PV architectural integration, so that the PV laminates, together with the mounting system, are enough to ensure the water-tight seal of the building structure without any other element.

Innovative Modules consist of a special building product, unique and indivisible, commercially identified and certified in accordance with technical standards set in the decree. This class includes all flexible PV modules certified along with their support and all rigid PV modules, that can replace building elements without additional components. These might include photovoltaic tiles and transparent modules for facades, roofs and windows installed so as to allow light into the building envelope. Examples are described below;

2.3.1 Flexible PV modules certified along with their support substrate

Substitution of the waterproofing membrane with a PV module comprising a thin film layer on a flexible support substrate. The waterproofing is carried out over the entire covering

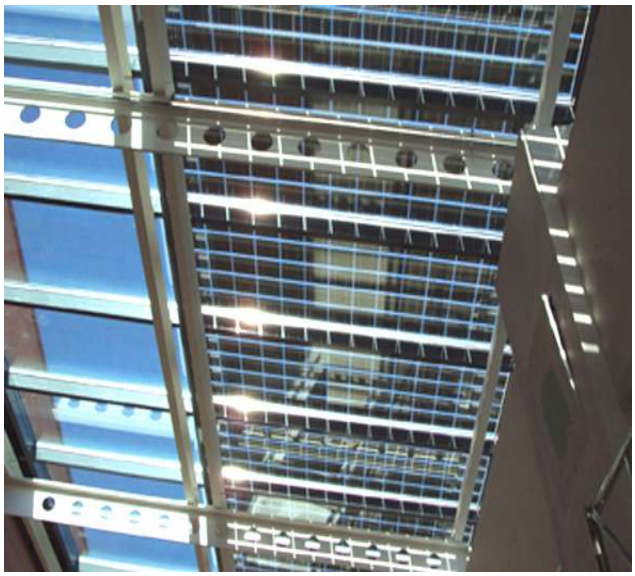
2.3.2 Rigid PV modules - Tiles

PV Tile installations had to fulfil certain requirements on the size and the continuity of the entire surface on which the plant is installed. In particular, the BIPV tile had to respect a dimension similar to that of a traditional building element and the PV plant could substitute a part of the traditional tiles of the roof (not a requirement) but in this case it also had to complement elements of similar size in order to guarantee the continuity of the surface of the roof (see pictures).

2.3.3 Thin film layer on rigid support substrate

The PV module is commercially identified and certified in accordance with technical standards set in the decree.

2.3.4 Transparent modules



The custom-made modules are double glass with spaced PV cells in order to let the light pass through into the building

Facades, if ventilated, were considered as a special case, which did not require the EU patent for the mounting system.

PV module certification has played an important role, since it was developed in parallel with architectural integration, and it became an important factor regarding the economic sustainability of some categories of BIPV modules.

With the second and the third FiT law, certifications like IEC 61215 (for crystalline modules) and IEC 61646 (thin film modules) were sufficient to meet the requirements requested by the decree.

The fourth decree required further certification for plants commissioned after June 30th, 2012 to access the PV and BIPV tariffs. PV module producers had to obtain additional certifications including ISO 9001:2008 (Quality management systems), OHSAS 18001 (Occupational Health and Safety), and ISO 14001 (Environmental Management System).

Moreover, with the bonus for components produced in European Union/European Economic Area, together with the Factory Inspection Certificate, an Attestation was needed to show the European origin of the product. The Attestation showed, in the case of a silicon crystalline module, the production site of cell stringing, assembly, lamination, and testing in the EU. For BIPV plants, the Attestation had to provide detail on the innovation as a building element.

Belonging to the Innovative Modules or to Special Components category was necessary but not a sufficient condition to access the Innovative BIPV tariffs; additional principles that needed to be considered were installation criteria and the link between the PV and the building.

The decrees specify that PV modules must guarantee both the energy production and architectural functions (e.g., protection or thermal regulation) of the building. The photovoltaic technology then becomes part of the building structure, replacing traditional elements and guaranteeing their functions. As a result, the installation of BIPV involves the whole building and not only the surface that it is being mounted on.

PV elements, thus, become a structural matter for the architect, to study, fold, and mould according to a building's life. They must become a part of the architecture since building performance is influenced by the innovative modules and components. Integration and innovation are two separated concepts but, with the new FiT law, integration became innovation aimed at stimulating the industry.

With the Italian FiT scheme, BIPV elements become a means of communication and of demonstration of new architectural materials, delivering a real representation to those sensitive to new architectural and urban design. Success with the Italian FiT scheme is just the beginning of a cultural process concerning sustainability in architecture.

PV — quoting the renowned words of Louis Kahn, the famous American architect — will always say 'I like Architecture'.

You say to a brick, 'What do you want, brick?' And brick says to you, 'I like an arch.' And you say to brick, 'Look, I want one, too, but arches are expensive and I can use a concrete lintel.' And then you say: 'What do you think of that, brick?' Brick says: 'I like an arch.'

Louis Kahn

3 DEFINITION AND RELEVANCE OF INNOVATIVE BIPV

The second FiT law was an initial step towards the definition of BIPV, specifying the requirement of the substitution of building elements by PV without further detail. At that stage, BIPV was more a general concept that was not specifically focused on building. This second law also included PV modules on shelters or installed on lighting elements exposed to solar radiation.

With the introduction of "Innovative BIPV", photovoltaics is designed to play two (or more) functions in the building's life, aligned with current international standard and building codes.

We moved forward with definitions and relative requirements – considering also the existing Italian building stock – for Innovative BIPV related to how they involved the building, its thermal transmittance and, for Special Components, a mounting system with a European patent.

As a result, the three definitions listed below became the structure for Innovative BIPV. They identify "*what*", "*where*", and, more important, "*how*":

- *what* – Innovative Modules definition, Special Components definition (see chapter 2.3)
- *where* – building definition (see chapter 2.3)
- *how* - Innovative BIPV definition (see below, from GSE Guide of Photovoltaic Plants Integrated with Innovative Characteristic)

The Innovative PV module or the PV surface, in the case of Special Components, ensures the energy production as well as the typical functions of building envelope such as:

- the water-tight seal of the building structure
- mechanical seal equivalent to the element replaced of the building
- thermal resistance not reducing the energy performance of the building

"Architectural integration of photovoltaics" is integration such that the removal of the photovoltaic modules would damage the functionality of the building, making it unfit for its use.

4 THE ITALIAN ACHIEVEMENTS

As a result of the 'Conto Energia' and of the related BIPV initiatives, Italy has the largest BIPV capacity in the world. By the end of 2013 Italy had nearly 2,3 GW of totally integrated plants plus an additional 300 MW of Innovative BIPV. Since 2013, after the FiT era, new MW of additional BIPV have been installed, with renewed growth since 2017 in terms of installed capacity.

The achievements went beyond the world-class installed capacity but also the experience that GSE shared with stakeholders and in developing a positive culture that enabled GSE to establish and sustain a central role.

The analysis was conducted over the years 2006-2020 exploiting the following documents owned by GSE:

- Requests for incentives for BIPV and building energy efficiency, installed capacity, type of installations/building/costs, etc. (GSE data)
- Discussions on regulation issues with government institutions (ministries) and the Italian Energy Authority
- Contacts with stakeholders/requests for information from different stakeholders/focus group with stakeholders
- Patents and relative issues related to requests to GSE (European Patent Office)
- Legal litigations
- Issues with procurement's offices
- Press releases/publications
- Regional regulations about BIPV before and after the Feed-in Tariff scheme
- Meetings with Public Administrations
- Certifications issues emerged with certification bodies
- Interviews with industry stakeholders

4.1 BIPV Data

We analysed and summarised data owned by GSE (data retrieved 31.12.2016), such as:

1. Data declared by Responsible Parties to GSE in order to request to incentives like, i.e.,

- Site (Region, Province).
- Type of Responsible Party (or PV owner).
- Type of installation (rooftop, facade, etc).
- Type of building (residential, commercial, etc).
- Module PV technology and support system (patented mounting system, if any).
- PV module, inverter and total plant cost.

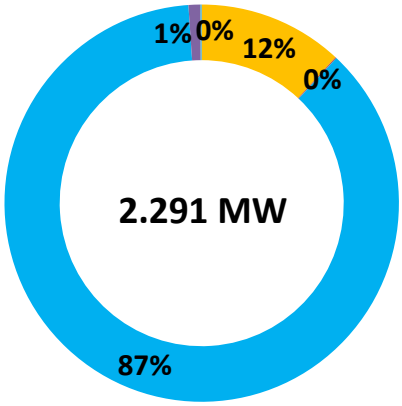
2. Data available from GSE database:

- Date of commissioning.

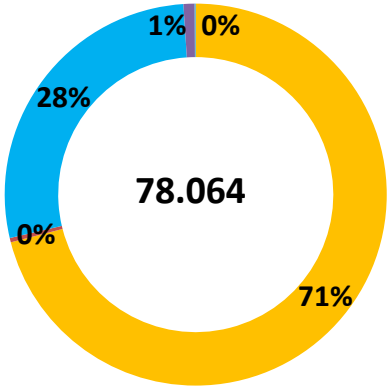
- Electricity produced/delivered to the grid.
- Incentives granted (including bonuses for removing asbestos and/or building energy efficiency, etc.).

The following figures contain the structure of the BIPV sector in Italy according to number, capacity, definitions, costs and characteristics of components installed. Data is grouped according to the two above mentioned steps/categories of BIPV: totally integrated plants and Innovative BIPV plants.

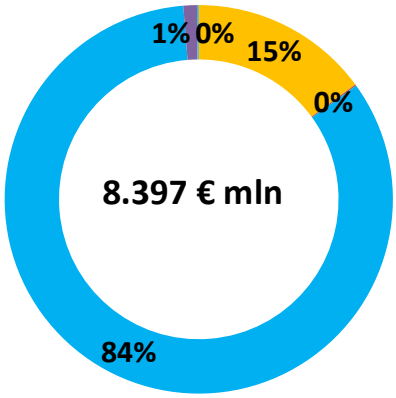
4.1.1 Second FIT: Totally Integrated Plant



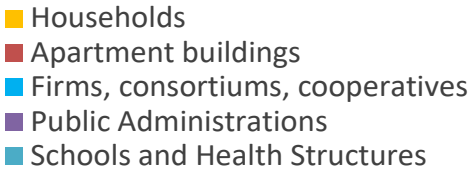
Plant capacity



Number of plants

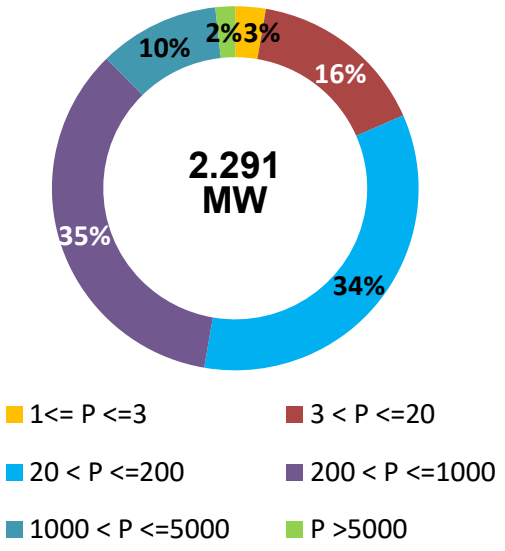


Investment cost

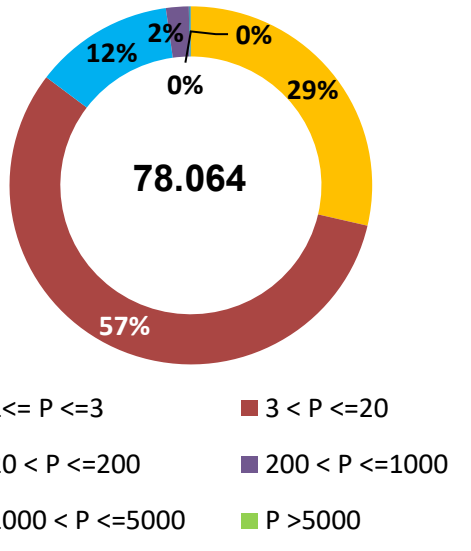


Categories of PV owner

The average cost of the plant is 4.629 €/kW and the yearly incentives granted are around 1,15 billion €.

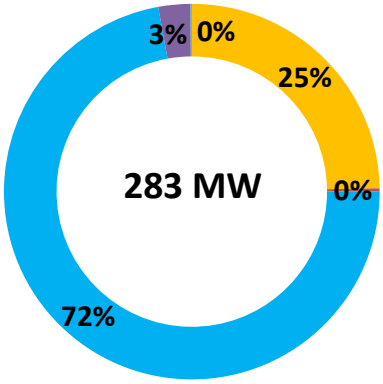


Percentage by capacity range

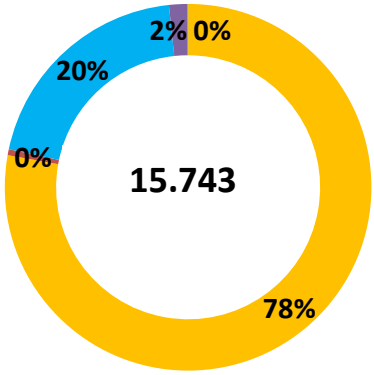


Percentage number of plants by capacity range

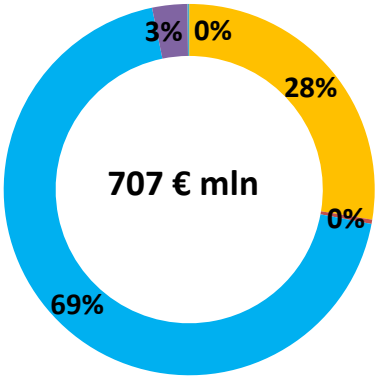
4.1.2 Third, Fourth and Fifth FiT: Innovative BIPV



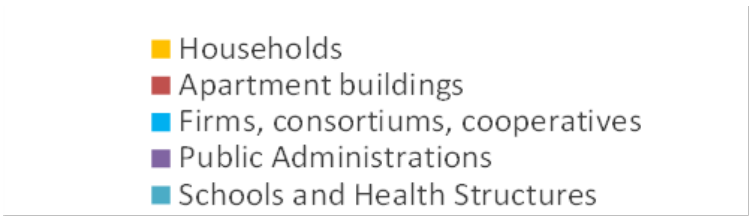
Plant capacity



Number of plants

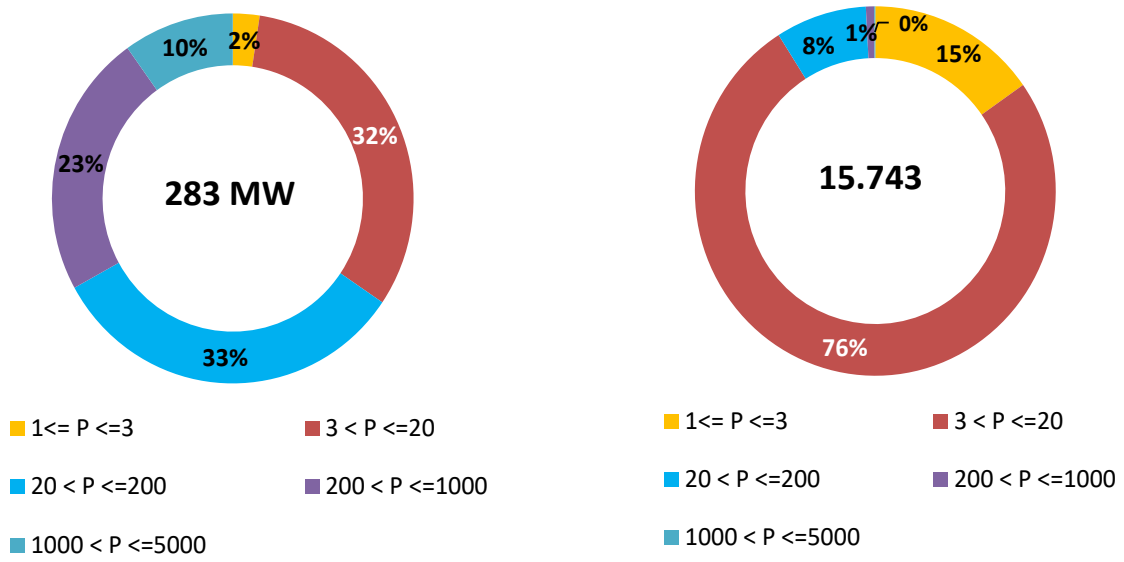


Investment cost



Categories of PV Owner

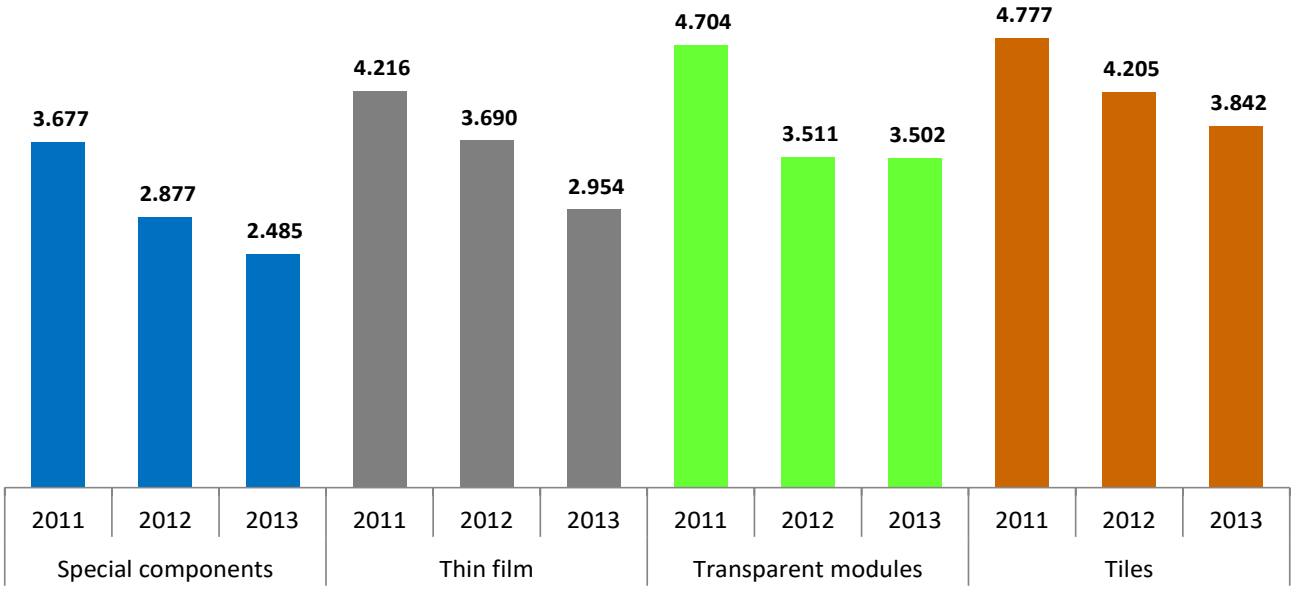
The average cost of the plant is 2.862 €/kW, the average granted tariff is 0,353 €/kWh and the yearly incentives granted are almost 98 million €.



Percentage by capacity range **Percentage number of plants by capacity range**

The percentage distribution of innovative plants of the third, fourth and fifth FiT system follows that of those totally integrated of the second FiT. It does not apply to those plants with a capacity between 3 and 20 kW, with 32% of capacity (in the second they were 16%) and 76% of number (in the second FiT it was 57%).

With the data available from the GSE database, the brand of the products (modules) and the mounting system (in case of installation of Special Component) were associated with each incentivized plant. This was done to determine the BIPV categories and the related costs, by year of plant commissioning, as indicated below.



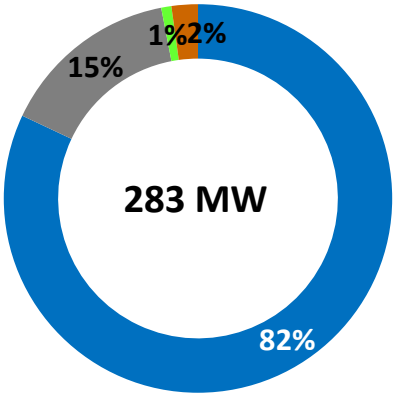
Innovative BIPV plant costs (€/kW) according to different module categories: Special Components and Innovative Modules (Thin film, Transparent modules and Tiles)

As outlined above, the Special Components, consisting of standard laminate and a frame (a patented mounting system), are those with a lower cost. They are the only category decreasing

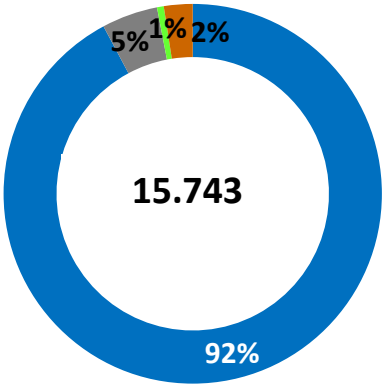
in costs and increasing in capacity. New requirements for production sites (ISO, OHSAS) made the reduction costs for other categories more complex (especially for Tiles).

Several plants with transparent modules with spaced cells – sometimes custom made – did not see a reduction cost in 2012 and 2013.

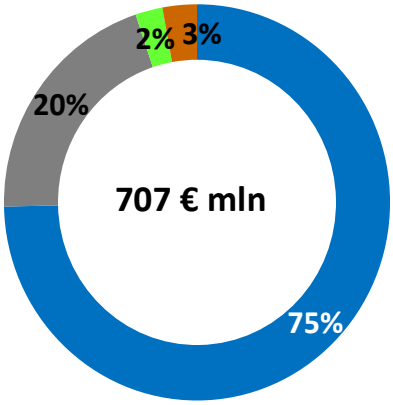
The category that had the highest costs is BIPV Tiles. This niche sector in Italy was developed to seek solutions for an existing urban context, and this particular product suffered, more than others, from restrictive criteria, concerning certifications and installation.



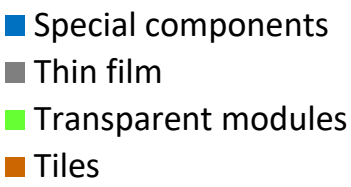
Percentage capacity by category of product



Percentage number by category of product



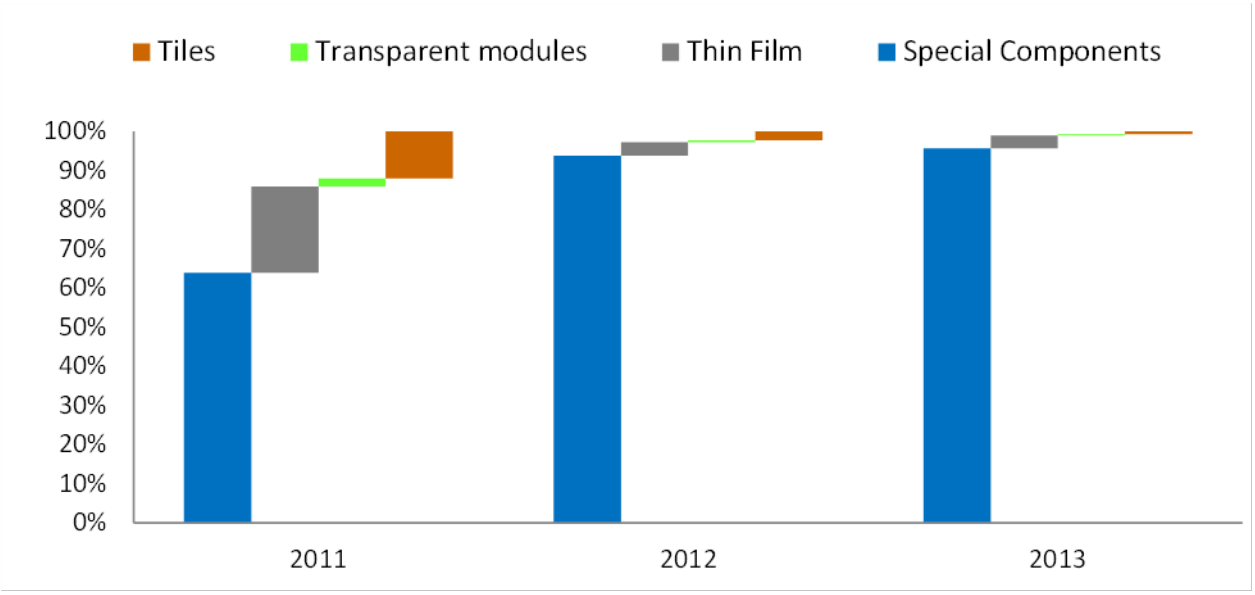
Investment cost by category of product



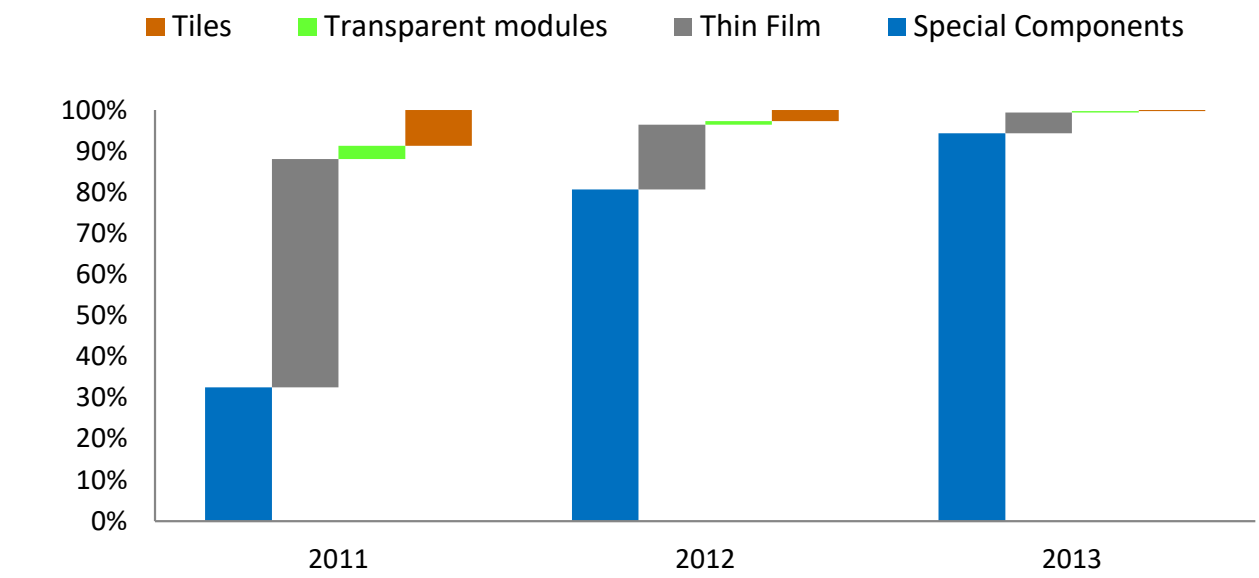
Category of product

As evident from the above data, the result is that most of the Innovative BIPV plants are built with Special Components, given the costs, maintenance and the relative ease of installation. Thin films were installed on large industrial roofs, and tiles were installed on small domestic systems.

The evolution of installations over the 2011–2013 years is more towards Special Components and less towards Tiles. Producers of modules and mounting systems benefitted from more standardized products once the European Patent Office granted patent on the mounting system. Conversely, from mid 2012 Tiles producers suffered, due to new, stricter rules on certification.

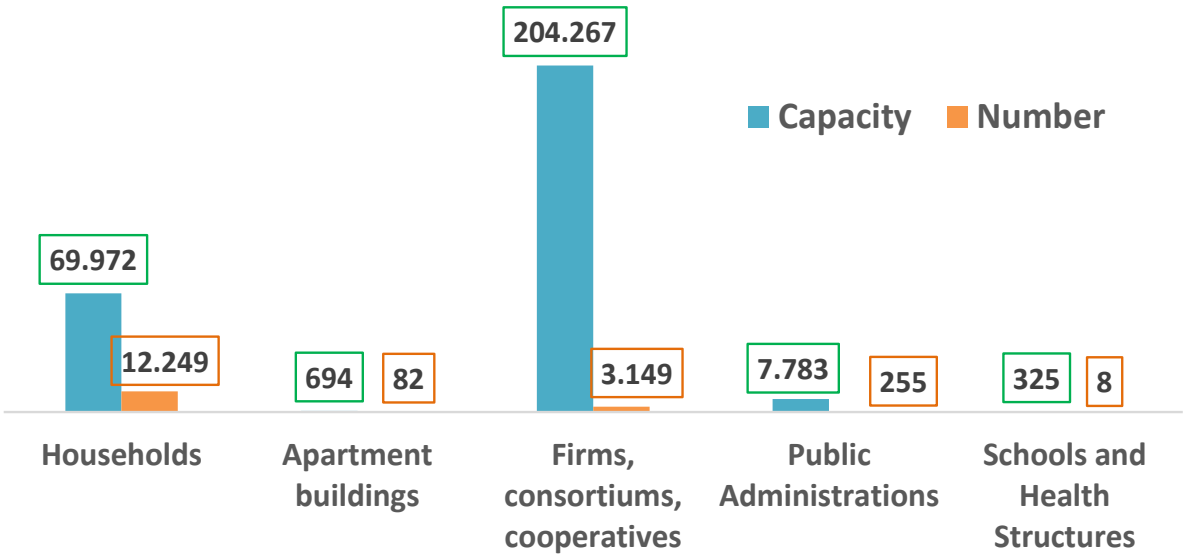


Percentage number by category of products

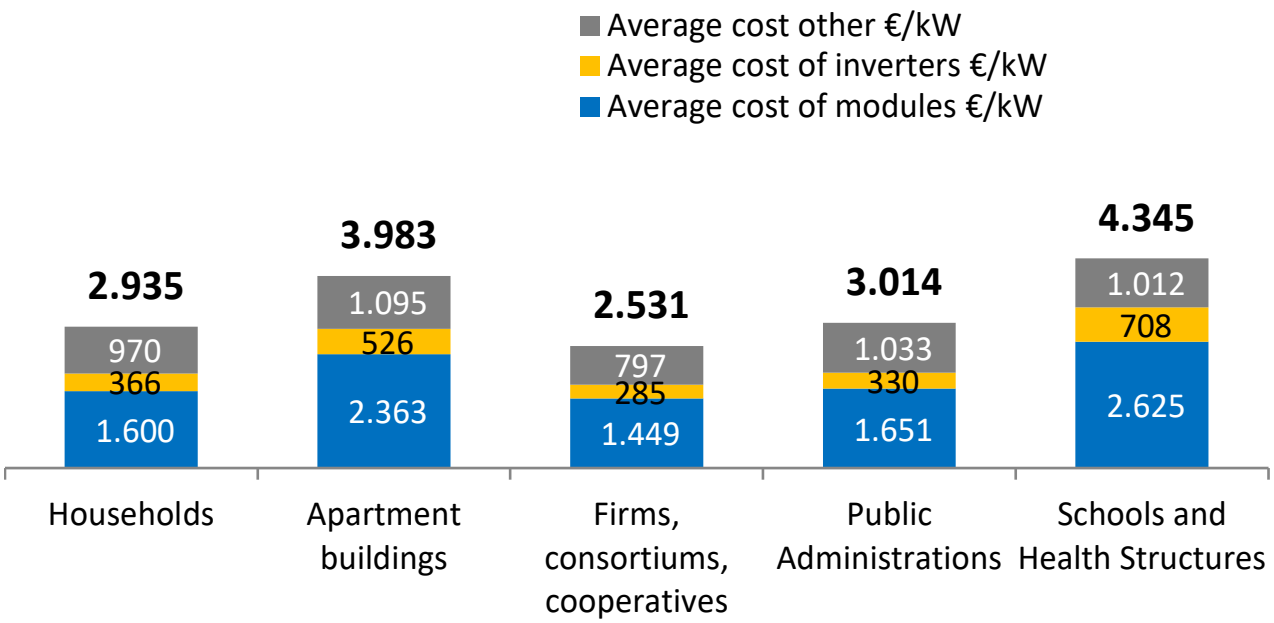


Percentage capacity by category of products

The following graphs show that most BIPV plants are domestic plants and bigger plants owned by firms, cooperatives and consortiums, each with different investment costs.



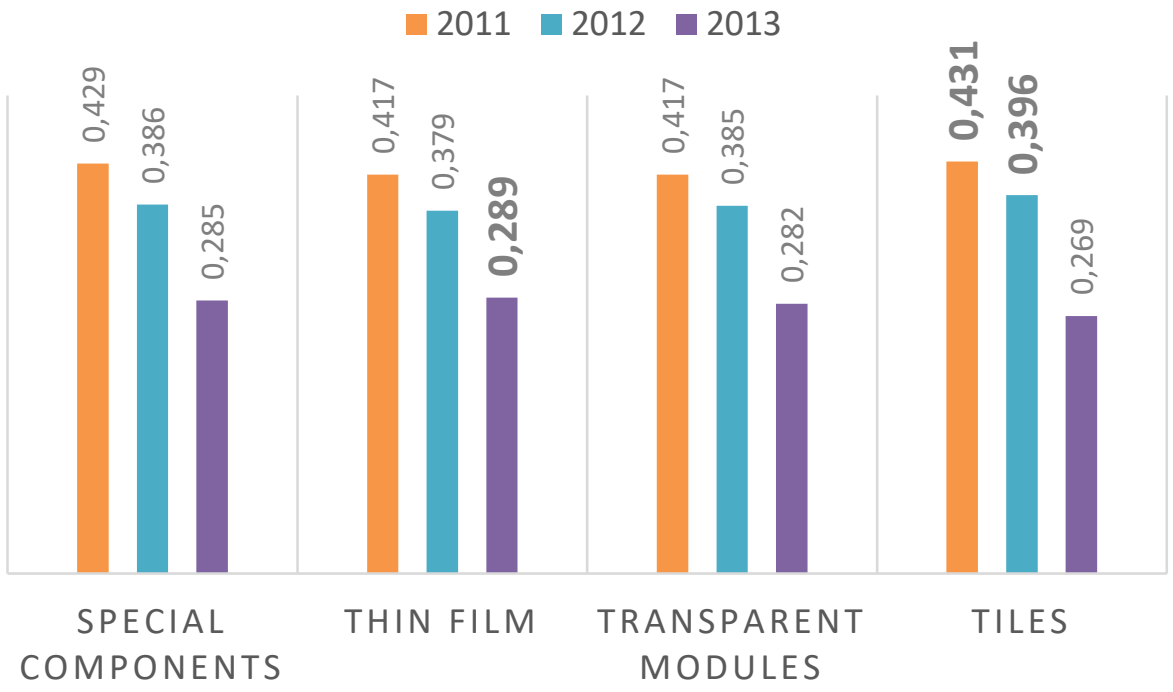
Number and capacity (kW) of BIPV plants according to the PV owner/typology of building



Average investment cost of BIPV plants according to the PV owner/ typology of building

Data confirms our investigation on the average tariffs granted by categories of products over the years. In 2011 and 2012, the highest tariffs were granted for plants with Tiles, due to the small size of the systems. In the years following, Tiles producers faced critical issues on

certification of the product, especially when applying for European bonus for using components produced in EU. Components of the BIPV Tile often came from more than one production site, thus the certificates involved a number of production locations, with rising cost.



Granted tariffs according to different categories of product (€/kWh)

4.2 Policies, Structure and Culture (Innovative BIPV)

The path of introduction and implementation of BIPV through the FiT Law in Italy was done step by step, decree after decree. First partially and then totally integrated BIPV was considered, then the concept of BIPV innovation was introduced. This progression allowed manufacturers a period of adjustment during the production phase, for example, for the module certification or for the European patent. More generally, the aim was to give producers, installers, plant owners, etc. sufficient time to understand the rules and the mechanism to access incentives.

Regarding ***the publications***, GSE decided to follow its traditional strategy based on full transparency. The *Guide of Photovoltaic Plants Integrated with Innovative Characteristics* of the Third Decree was published and made available for consultation on the GSE website together with the Technical Rules, as required by the Energy Authority regulation. These documents were revised following observations from stakeholders and were subsequently submitted to the control of the Energy Authority and then published on the GSE website. Further updates of the Guide were done over the fourth and fifth FiT decree after further consultations with stakeholders.

Moreover, GSE published a *Catalogue of Photovoltaic Plants Integrated with Innovative Characteristics*. The publication is still now a catalogue of BIPV plants that had accessed incentives, with specifications of the commercial products used and built according to the rules of the FiT law. It is a recognition of the general characteristics and technical requirements of innovative plants that allows them access to the Innovative BIPV tariffs. The Catalogue,

together with the Technical Rules and the BIPV Guide, supported the chief stakeholders of the process (producers, installers, etc.) in better understanding the rules of the decrees.

The sharing with all the stakeholders who took part in this process was also important (module and inverter producers, installers, investors, certification bodies, public administrations, citizens). Focus groups dedicated to particular issues were formed during conferences, and individually. Dedicated answers to all their questions were provided, being careful not to issue binding preliminary opinions. This was needed since the requirements for access to incentives were assessed after the commissioning of the plant and following the submission of the documentation to the GSE.

During these meetings we received requests for specific cases outside of the examples provided in the Guide or in the Technical Rules, such as, i.e., ventilated roofs or facades. Requests were often related to the building, the installation criteria, the European patent of the mounting system and the certification of modules and inverters. On each proposed technical solution (not indicated in the BIPV Guide), the main construction solutions existing on the market were analysed and compared with national and international technical specifications. This was done in order to understand if the solution proposed could be accepted from a technical and a legislative point of view.

These consultations were a great opportunity for internal growth within the GSE. This professional skill and asset were exploited to conduct university lectures, speak at conferences and host other training about PV, BIPV and building energy efficiency in order to develop culture of awareness about these issues.

The constant ***dialogue*** established with the certification bodies was important since it helped to solve any possible difficulties that could have been created given the strict criteria of the decrees. The relations with these bodies also allowed us to identify cases of fake certification and label of PV modules (not only BIPV), which subsequently evolved into complaints to the procurement offices.

This experience confirms that GSE established a relationship with all the stakeholders, especially with the institutional ones (like public administrations), that gradually become fruitful and based on a ***mutual trust*** with all working for the same purpose.

The certification of the products (especially PV modules) has been a key issue for all decrees. Until 2007, when the second FiT decree was enacted, the certification requiring a factory inspection, and therefore a certification of process quality was on voluntary basis and certification bodies were few. Later, there was a significant ***qualitative improvement*** and a fast growth of certification bodies all over the world, thanks largely to the requirements of the Italian decrees which resulted in the financing of a total 18 GW of installed capacity.

Probably the most relevant element introduced was the European patent for the Special Components mounting system. GSE realized from the beginning that systems with standard modules/laminates had a lower cost when compared to products developed specifically for building integration. As suggested by associations of producers, and with the support of the Ministry of Economic Development, GSE introduced the requirement of the European patent on the mounting system. This moved the focus of standard modules producers towards ***innovation*** aimed at architectural integration, both in Italy and abroad. Several products that were presented were later published in the Catalogue (once installed and incentivised). As a result, producers of standard modules were stimulated towards BIPV (very few of them already had a European patent for architectural integration). Consequently, standard module producers were encouraged (by the significant tariff incentives) to embrace the concept of

integration and the substitution of a building element by a PV module, addressing intellectual property issues.

The ***role of the building*** on which the BIPV plant was installed was particularly important. The plant was considered integrated not only as single element, but as an integrated system with the building, replacing traditional elements of the roof or of the facade. The building had to be a closed volume in order to calculate the heat transfer and the energy needs with parameters defined according to existing technical specifications. This new approach made the energy efficiency concept relevant and meant that photovoltaics also contributed to the building envelope performance. Given the existing concurrent energy regulation in Italy, when differences among regional laws emerged (this happened for the building definition and for the building energy efficiency bonus), GSE gave priority to the national regulation to guarantee the same incentives at national level.

The GSE ***BIPV Guide*** became an instrument adopted by some regions to regulate and facilitate installations (i.e., access to particular financing schemes).

Up to the second decree, ***the market*** was covered, in general, by the PV industry and the element to be integrated (totally or partially) was the standard photovoltaic module.

The third decree added the concept of innovation to the integration (building installation criteria/mounting system patent, etc.) enlarging the market to further interested parties in the building market, namely the construction industry. At this point there were two main elements to be integrated – Innovative Modules and Special Components. It is interesting to note that a niche roofing industry developed (especially in Italy) investing in BIPV, particularly in producing tiles for historical urban areas.

We created a ***culture*** where it did not exist.

5 WHAT DID NOT WORK

The second FiT decree aimed to boost the PV and BIPV market, and it succeeded.

The subsequent decrees revised the tariffs and incentive mechanisms and introduced Innovative BIPV requirements regarding modules, inverters and building installation criteria. Several operators, at the beginning of this process, had difficulty understanding the new criteria and its differences from previous criteria, reporting (even during the fourth and fifth decrees) some critical issues, mostly about ***certification***:

- Certifications of module and inverters, especially for those who applied for the bonus for using components produced in EU, as applied to BIPV, and considering the strict requirements for the Innovative Modules and Special Components. For Innovative BIPV, in order to access the EU content bonus, the Attestation, coupled with the Factory Inspection Certificate, had to specify the process steps that determined the innovation related to its EU origin (see chapter 2 and *Guide of Photovoltaic Plants Integrated with Innovative Characteristics*);
- Certification of the products, especially modules, proved an economic barrier for some BIPV categories. Particularly in regard to the niche category of Italian manufacturers of BIPV Tiles specially designed for historical town centres. These photovoltaic elements are made up of PV cells with a support, which could require the factory inspection at different sites around the world, with high final cost of the products.

We had the opportunity to verify the consistency of all these challenges.

Furthermore, we observed other issues that deserve to be taken into account.

- The ***performance*** of Innovative BIPV systems not correctly installed as a building component. For example, installed on an insulation layer without a ventilation space, or installed using the patented mounting system outside of the waterproofing specifications required by the patent. This last case does not concern the performance of the PV modules, but unfortunately without the minimum slope of the roof required by the patent of the mounting system, water infiltrations occurred with damages to the building. Several BIPV owners reported that the “BIPV component” was not as reliable as a building component.

  With high incentives granted to BIPV plants, even with non-optimal conditions for installations, there is a need for performance monitoring.
- Given the high tariffs and the complexity of the rules, unfortunately there have been cases of ***counterfeiting*** of PV modules, labels, and infringement of patents of mounting systems. GSE proceeded, for the Responsible Parties of the mentioned plants, to present the complains to the prosecutor offices.

- BIPV in the Italian FiT law is a success with around 2,5 GW of integrated plants including almost 300 MW of Innovative BIPV. More than 80% of the installed Innovative BIPV capacity and 90% of the innovative plants were built with Special Components. This result is due to the different ***costs***. Components and Innovative Modules had completely different characteristics and costs, but it was too complex to set different tariffs. With the same tariff, the niche of Innovative Tiles or Transparent modules suffered, also due to the decreasing tariffs and the stricter requirements.

6 WHERE WE ARE NOW

Once the "Conto Enegia" FiT was over in 2013, detailed data was no longer collected. In order to understand whether the BIPV market in Italy is still existing after the incentive period, a questionnaire was sent in late 2020 to a list of producers of modules and mounting systems published in GSE *Catalogue of Photovoltaic Plants Integrated with Innovative Characteristics*.

The questionnaire asked:

- If they still have a market share of their BIPV solutions in Italy
- For an estimate of the annual capacity installed (or sold) in Italy after the FiT era
- For the percentage drop of the annual product cost
- If they developed other BIPV products different from those already published in the above-mentioned Catalogue.

We identified 33 producers of BIPV, among those published in the Catalogue, nine of them replied (eight module producers and one patented mounting system producer), and further interviews were conducted with installers. The module producers interviewed cover 23 percent of the BIPV plants installed between 2011-2013 under the FiT law across all categories of the BIPV Guide and the Catalogue. The mounting system producer interviewed covers around 70% of the number of Innovative BIPV plants installed and commissioned in the same period.

At this point, however, an issue arises: How to evaluate the success of a BIPV/PV (or RES) incentive policy? This was the question that led us to interview the producers. Is it the installed capacity? A cultural shift towards BIPV/PV (or RES)? Or, perhaps the most important indicator, after the incentive period, is there still a market? We opted to discover whether the market still exists as evidence of a cultural shift. The purpose of an incentive scheme is to support the market, but afterwards the market needs to work without subsidies.

The answers from the operators interviewed showed that, despite significant reduction (which could be foreseen), the BIPV market in Italy still exists after the FiT era. In Italy, between 2014 and 2020 the producers interviewed sold/installed several MW of BIPV plants, and since 2017 they have reported a new growth in the market in terms of installed capacity. Almost all interviewees think that Italy is an attractive market for BIPV on which to focus, although the market dropped after the end of the FiT, with one interviewee replying that the BIPV business is now concentrated on a more global/international scale.

The BIPV market continues to be dominated by producers of Special Components who were originally simply PV module producers. This dominance is also because some manufacturers of the construction industry sold their BIPV branches of activity.

In general, from the questionnaires and interviews, the following trend can be observed on the product/producer categories highlighted in the GSE Guide and in the Catalogue:

- Producers of Special Components are still in the BIPV market, trying to develop new products, mostly targeting the residential sector. The reduction in the market size brought efficiencies as module producers, with contracts with more manufacturers of mounting system, focused on a single mounting system for their PV laminates.
- A number of the big players coming from construction industry, usually addressing the large industrial BIPV roofs, are still on the market, but others are back to their core business of building materials.

- Few excellent manufacturers of transparent modules (often custom made) are on the market, but they are a niche that sometimes joins European projects with research institutes and universities.
- Some of the BIPV producers of thin film with a rigid/flexible support (an Innovative Module) stopped production due to the shortage of PV thin film.
- BIPV Tiles producers suffered the most due to the requirements about certification and costs (as was seen in 2012-2013), but after the FiT era they have tried to develop new prototypes. BIPV Tiles always had a higher cost than Special Components, in 2021 an installed plant with a Special Component cost is between 1.500 and 1.700 €/kW (depending on the typology of product), while the cost of a plant with BIPV Tiles is nearly double.

BIPV modules costs dropped, on average, by 35% in 2013-2020, while soft costs decreased less. At the end, the total plant cost decreased by 25%.

Some issues continued to be relevant over the years, such as the certification of plant components (especially modules) that were so significant during the incentive scheme era. Although not for all cases, the cost of certification is still an issue. Most manufacturers (both of Special Components and Innovative Modules, such as Tiles), continued to develop new products, but they all complained about the costs of certification. Some Special Components producers, consequently, are still selling their products published in the Catalogue. Tile producers, who are always focused on the development of products suitable for urban contexts, especially those in historic cities, have continued to develop prototypes for which they have also complained about the costs of certification.

In light of the above, trying to answer the initial question, whether the BIPV process of the implementation of the incentive scheme has been effective, it can reasonably be said that a market still exists in Italy and that relevant results have been achieved.

7 SUGGESTIONS FOR FUTURE POLICIES

The analysis of this report is based on GSE data of BIPV plants, experience on managing BIPV rules and incentives of the FiT Law and surveys of producers. The aim was to study the effectiveness of the incentive policy, and the process of dissemination of a culture concerning BIPV and the building, an approach that might be extended to other countries.

The producers involved in the GSE *Catalogue of Photovoltaic Plants Integrated with Innovative Characteristics* publication and our interviewees come from all over the world, not just Italy, granting more of an international market vision. In the early stages of the implementation of the decree, the constant debate of issues and exchange of views with them enriched the development. It gave GSE a wider vision on the approach to the *Guide of Photovoltaic Plants Integrated with Innovative Characteristics* and how to apply the rules of the decrees. Therefore, while the framework of the analysis is an Italian one, the shared path with the stakeholders, data collection and analysis process (including the questionnaires) was international and can be applied anywhere.

Barriers for a strong development of BIPV still exist. However, it could be wrong to believe that they might be overcome only by an incentive scheme. Incentives can help to overcome economic barriers, while the cost of a technology decreases, but they do not have a specific leverage on other barriers to the deployment of BIPV, such as authorization processes.

BIPV requirements in buildings in addition to the existing PV requirements in new buildings could be an important step for improving the BIPV market. A financial support in this context could help with dissemination of BIPV, smoothing the impact of the obligation.

BIPV plants, in addition, could benefit from a simplified authorization process. This approach could be in line with the new ambitious European 2030 decarbonization targets, which outline a strong portfolio of measures to encourage the spread of renewable energies.

This report is prepared to capture the benefit of the lessons learnt from the Italian experience with BIPV incentives and to share the outcomes broadly, so that all the bodies in charge of managing or setting rules for new installations (ministers, public administrations, local authorities, regions, etc.) can review and adopt the practices and guidelines tested and demonstrated in Italy. They could consider the results of the processes outlined regarding the stakeholders' experience, the quality and performance of products, the different costs, and the role of the building, in order to give continuity to a path that started several years ago and that has provided significant results.

GSE will continue to support BIPV policy pathways and actively contribute, building on its expertise.

8 REFERENCES

1. Ministerial Decree of 28 luglio 2005, “Criteri per l'incentivazione della produzione di energia elettrica mediante conversione fotovoltaica della fonte solare”, Gazzetta Ufficiale n. 181 of 5 August 2005.
2. Legislative Decree of 29 December 2003, n. 387, "Attuazione della direttiva 2001/77/CE relativa alla promozione dell'energia elettrica prodotta da fonti energetiche rinnovabili nel mercato interno dell'elettricità", Gazzetta Ufficiale n. 25 of 31 January 2004 - Supplemento Ordinario n. 17.
3. Directive 2001/77/CE of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market, Official Journal of the European Communities of 27 October 2001, L 283/33.
4. Authority Decree 188/05, Definizione del soggetto attuatore e delle modalità per l'erogazione delle tariffe incentivanti degli impianti fotovoltaici, in attuazione dell'articolo 9 del decreto del Ministro delle attività produttive, di concerto con il Ministro dell'ambiente e della tutela del territorio, 28 luglio 2005”, Gazzetta Ufficiale n. 234 of 7 October 2005.
5. Ministerial Decree of 6 February 2006, “Criteri per l'incentivazione della produzione di energia elettrica mediante conversione fotovoltaica della fonte solare”, Gazzetta Ufficiale n. 38 of 15 February 2006.
6. Ministerial Decree of 19 February 2007, “Criteri e modalità per incentivare la produzione di energia elettrica mediante conversione fotovoltaica della fonte solare, in attuazione dell'articolo 7 del decreto legislativo 29 dicembre 2003, n. 387”, Gazzetta Ufficiale n. 45 of 23 February 2007.
7. Gestore dei Servizi Elettrici, “Guida al Conto Energia”, 2007 (updated March 2009, April 2010).
8. Gestore dei Servizi Elettrici, “Guida agli interventi validi ai fini del riconoscimento dell’integrazione architettonica del fotovoltaico”, 2007 (updated April 2009).
9. Ministerial Decree of 6 August 2010, “Incentivazione della produzione di energia elettrica mediante conversione fotovoltaica della fonte solare”, Gazzetta Ufficiale n. 196 of 24 August 2010.
10. Gestore dei Servizi Energetici, “Regole Tecniche Per Il Riconoscimento Delle Tariffe Incentivanti Previste Dal Dm 6 Agosto 2010”, December 2010.
11. Gestore dei Servizi Energetici, “Guida alle applicazioni innovative per l’integrazione architettonica del fotovoltaico, Terzo Conto Energia”, January 2011.
12. Ministerial Decree of 5 May 2011, “Incentivazione della produzione di energia elettrica da impianti solari fotovoltaici”, Gazzetta Ufficiale n.109 of 12 May 2011.
13. Gestore dei Servizi Energetici, “Regole applicative per il riconoscimento delle tariffe incentivanti previste dal dm 5 maggio 2011 (quarto conto energia per il fotovoltaico)”, July 2011 (updated August 2011).
14. Gestore dei Servizi Energetici, “Guida alle applicazioni innovative per l’integrazione architettonica del fotovoltaico, Quarto Conto Energia”, July 2011 (updated August 2011).
15. Gestore dei Servizi Energetici, “Catalogue of Photovoltaic Plants Integrated with Innovative Characteristics”, April 2012 (updated August 2012).
16. Ministerial Decree of 5 July, 2012, “Attuazione dell’art. 25 del decreto legislativo 3 marzo 2011, n. 28, recante incentivazione della produzione di energia elettrica da impianti solari fotovoltaici (c.d. Quinto Conto Energia)”, Gazzetta Ufficiale n.159 of 10 July, 2012.
17. Gestore dei Servizi Energetici, “Regole tecniche per l’iscrizione al registro per i grandi impianti fotovoltaici di cui al dm 5 maggio 2011, July 2011.
18. Gestore dei Servizi Energetici, “Regole applicative per l’iscrizione ai registri e per l’accesso alle tariffe incentivanti dm 5 luglio 2012 (quinto conto energia)”, August 2012.
19. Gestore dei Servizi Energetici, “Guida alle applicazioni innovative finalizzate all’integrazione architettonica del fotovoltaico, Quinto Conto Energia”, August 2012.

Technology Collaboration Programme
by iea

ISBN 978-3-907281-22-2