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Article

Integration of Photovoltaics in Buildings—Support Policies Addressing Technical and Formal Aspects

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Abstract: The integration of photovoltaic (PV) generators in the envelope of a building by means of building-integrated photovoltaics (BIPV) offers an immense potential, both in market development and the production of renewable electric energy that is close to the point of electricity consumption. In Germany, for example, by integrating photovoltaics in buildings up to 50% of the electricity demand can be covered. The political support of BIPV would contribute to the development and installation of BIPV components and therefore also promote the development of new business areas for industries dealing with components used in building envelopes and photovoltaic generators. BIPV can be separated into three different integration types: "technical", "formal" and "technical & formal". Political instruments for the support of PV-installations, particularly BIPV are discussed in this paper using Germany and France as examples. Due to successful financial support policies, PV became the most powerful electricity production technology in Germany. In France, the unique financial support of BIPV is resulting in an exemplary development and growth of certified BIPV components available on the market and, from a technical, aesthetic architectural and legal certainty point of view, facilitating the easy and widespread integration of photovoltaic generators in buildings.

Keywords: photovoltaic; building integration; BIPV; architectural design; building industry; financial support policy; France; Germany

1. Introduction

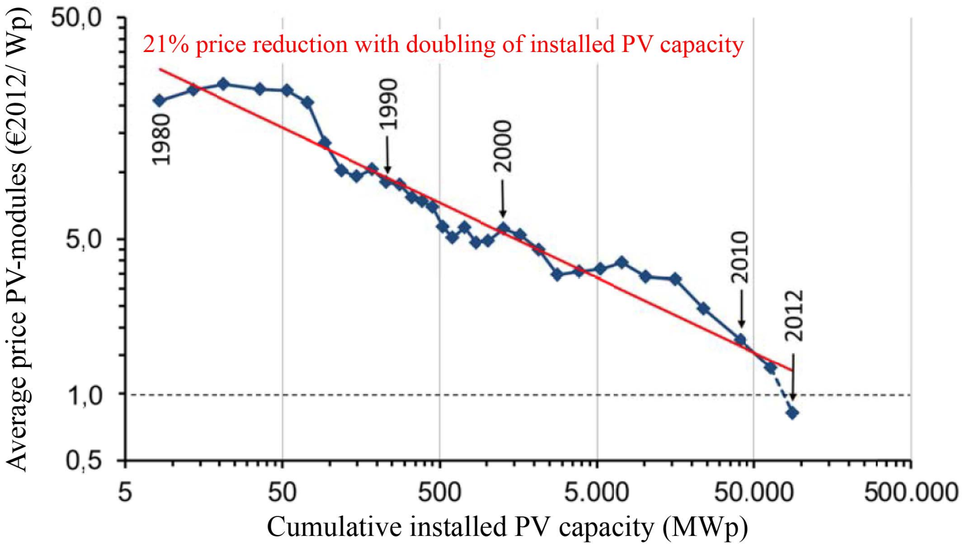
The integration of photovoltaic construction elements in buildings and other architectural structures is called building-integrated photovoltaics (BIPV). In spite of worldwide growth in the photovoltaic sector, the interest in BIPV up until now has been relatively small. By 2009 only ca. 1% of the total distributed cumulative installed PV system capacity was integrated into buildings [1]. This section discusses the current state, the expected development, and as well the challenges for an increased installation and integration of PV in energy and electricity distribution systems for better understanding of the current state of the PV market and the future potential of BIPV. Accordingly, and as discussed in the subsequent sections of this paper, an increase in the market for building integrated photovoltaics can be expected in the future.

Worldwide, approximately 102 gigawatt (GW) of cumulative photovoltaic capacity had been installed by the end of 2012 [2]. Worldwide, 32.340 GW was installed in 2012 alone, when the PV sector rose by 23% compared with 2011. For 2013, the sector is expected to grow by another 18% worldwide compared with 2012 to 38 GW of newly installed PV peak capacity. In 2012, with 7.63 GW the largest PV capacity was installed in Germany (1st), followed by China, (2nd), with 4.95 GW, Italy (3rd), with 4.22 GW, the USA (4th), with 3.28 GW, Japan (5th), with 1.79 GW, India (6th), with 1.48 GW, and France (7th), with 1.01 GW [3]. At the end of 2012, the top six countries with the highest total installed electrical PV capacity were France with 3.84 GW, Japan with 6.7 GW, USA with 7.67 GW, China with 8.04 GW, Italy with 16.99 GW, and Germany, with 32.51 GW [4]. By 2012, almost 30% of the World's total PV capacity had been installed in Germany. Assisted by successful support policies, photovoltaics became, with regards to capacity, the most powerful electrical energy source in Germany by August 2012, when installation capacity reached 30 GW, compared with wind power, 29 GW, black coal and natural gas plants, 21 GW and 20 GW, respectively of installed capacity [5]. Compare this to brown coal and nuclear power plants with 17 GW and 12 GW, respectively.

Generally, the production costs for PV-electricity are currently higher than for electricity from conventional power plants. Therefore, the installation of photovoltaics is aided by financial support policies, as discussed in Section 3, using the examples of Germany and France. The aim of these support policies is a continuous lowering of the production costs of PV-electricity. The price of PV modules is responsible for approximately half of the investment costs of a PV-power plant. In recent years these costs have declined on average by 15% per year, as a result of technological progress and scale effects. According to historical development, the PV-module prices follow a price learning curve. If the total installed capacity doubles, the prices decline by a specific permanent factor. According to an analysis of the average price development for all market-relevant technologies (including thin film and crystalline) the prices decline by approximately 20% when the worldwide installed PV capacity doubles (Figure 1). This trend is expected to continue in the future if further efforts can be made in the development of PV products and production processes. The historical development of worldwide installed cumulative PV capacity and module prices is illustrated in Figure 1 (according to PSE AG and Fraunhofer ISE, based on data from Unlimited/Navigant Consulting, 2012 estimated, refer to [6]).

PV has developed into an important component of Germany's electricity supply [5]. In the public eye, photovoltaics benefits from a high level of acceptance [5] compared with other forms of renewable energies such as wind power, energy crops and biogas plants [7]. The PV-electricity produced with the installed PV capacity of more than 30 GW already covers a large part of the daily peak load during sunny days in spring and summer, which has a significant price reducing effect at the electricity exchange. In such peak periods, due to its very low marginal costs, PV-electricity replaces conventional power plants that have high marginal costs, such as coal and natural gas electricity, in the merit-order when the highest fees are charged for these energy sources (merit-order effect) [6]. PV-electricity therefore substantially reduces the amount of highly priced peak electricity that electricity suppliers need to buy, reducing the overall cost [8]. With growing installed PV capacity it is expected that the prices at the energy exchange will be very low more often and for longer periods of time [6]. In principal, the merit-order effect shifts profits from generation companies to consumers. Therefore, the cost of support of PV-electricity in an electricity system that is carried by the consumer is reduced [8]. However, many electricity supply companies in Germany do not yet pass these cost saving effects on to their customers [6]. Whether the savings created on the market are handed down to consumers depends on the competitiveness of the consumer market [8]. Considering photovoltaics alone, also in the coming years, no surplus of PV-electricity will be produced. Considering the production of both PV-electricity and wind-electricity, already today a surplus of renewable energy is being produced and a residual basic load has to be reduced and therefore conventional power plants have to reduce their electricity production [6].

Figure 1. Worldwide cumulative installed PV capacity and historical development of PV-module prices (inflation-adjusted in Euro on 2012 level, in [6]). The straight red line shows the trend of price development for PV-modules.



According to a long-time energy scenario study [9] which has been commissioned by the German Federal Environment Agency [10], in Germany by the end of 2020 a capacity of approximately 53 GW photovoltaics will be installed, producing in the same year approximately 50 TWh of PV-electricity [9]. Furthermore, it would be technically feasible to cover, by the year 2050, the total electricity demand in Germany with renewable energy produced in an ecologically responsible way. According to a simulation by Fraunhofer ISE of an economically optimized production mix of the renewable energy supply for the total electricity and heat demand in Germany, photovoltaics would contribute to the electricity supply with an installed capacity of 200 GW [11]. According to the dynamic "Oceans" scenario in the Royal Dutch Shell study "New Lens Scenarios", worldwide, a PV capacity of 500 GW could be installed before 2020. The same study expects photovoltaics to become the main important primary energy source by 2060, ahead of, coal, oil and gas [12].

In Germany, by the end of 2012, more than 98% of the solar power plants were connected to the decentralized low voltage system [13] and were producing electricity close to the consumer. PV power plants with a capacity of less than 1 MW made up approximately 85% of the total installed PV capacity, and installations of up to 100kWp made up 56% (according to PSE AG/FRAUNHOFER ISE in [6]). A decentralized and equally distributed installation of PV power plants in the low voltage system, close to electricity consumers, facilitates the intake and distribution of PV-electricity through the existing electricity distribution network [5,6]. However, an accumulation of installed PV capacity in areas with low settlement density requires the support of a distribution network and transformer capacities. With growing capacity PV power plants have to take on the additional responsibility of stabilizing the control variable of the electricity distribution network [6]. In contrast, a predominantly decentralized supply of PV-electricity to the distribution networks close to the consumer, BIPV being a case in point, reduces distribution network management costs. Further advantages are their possible cost-effective contribution to distribution network services, such as local voltage control. Decentralized PV power plants can be integrated in higher-level distribution network management systems and can contribute to the enhancement of distribution network stability [14].

For a massive, technologically and ecologically controllable integration of PV-electricity in existing energy and electricity distribution systems, numerous complementary measures have to be implemented. A basic complementary measure for the controllable integration of PV-electricity in existing energy and electricity distribution systems is the increased directional orientation of PV modules, which differs from static installations, with an optimized yearly PV-electricity gain per module area (southern orientation in northern hemisphere and northern orientation on southern hemisphere). In Germany, for example, the orientation of PV modules in a easterly/westerly direction would reduce the yearly PV-electricity gain per module area compared with a southern orientation, but would widen the daily peak of the PV-electricity supply [6]. These easterly/westerly oriented systems can be created by both ground-mounted PV power plants in open areas and systems mounted on or in buildings.

Compared with ground-mounted systems, the decentralized installation of photovoltaics on or in buildings (e.g., in the form of BIPV) offers advantages regarding the implementation of complementary measures, such as decentralized electricity storage, own consumption of decentralized produced PV-electricity and the adjustment of an electricity utilization profile. Furthermore, the different surfaces of building envelopes are orientated in different directions. Therefore, the integration of photovoltaics in building skins with different directions can contribute to a widening of the daily peak of PV-electricity supply.

2. Approach and Methods

This article focuses on the latest insight from the author's own investigation into the technical and formal aspects of BIPV and its market potential in relation to support policies. The case studies presented for PV and BIPV support policies in Germany and France act as "snapshots" of the current situation and challenge regarding the sound practices of specific support, and range from the general support of PV installations to the specific support of technically and formally building-integrated photovoltaics. A framework of the PV market development, supportive policies for the application of

BIPV and different building integration typologies are presented to better introduce the latest approach for BIPV.

This paper aims to identify, examine and prove the effectiveness of some of the new support policies for BIPV. Primarily based on the technical integration of PV modules in buildings by replacement of conventional building components with BIPV components, the insights from French and German case studies serve to prove the applicability of such support policies both for stimulation of the BIPV component and market development and the future renewable electricity supply of buildings, both in the framework of renovation of the building stock and new constructions.

Quantitative data about the installed cumulative PV capacity, the BIPV potential as well as support policies of PV and BIPV installations was collected, using Germany and France as examples. At the same time, a qualitative analysis of approved BIPV concepts was made, based on recent research findings and the author's own investigations, including the advantages and disadvantages of BIPV in comparison with conventional PV systems. Finally, the concept of technically and formally integrated BIPV emerges as the necessary step towards the next transition in renewable energy policy and the decentralized generation and management of photovoltaic energy. The certification and building approval systems for BIPV components in France and Germany were examined in terms of the applicability of an integrated way forward for an easy and increased installation of approved BIPV construction elements and the replacement of conventional components.

3. BIPV—Market, Aspects of Building Integration and Characteristics of Political Support Policies

3.1. Future Market of Building Integrated Photovoltaics

The integration of photovoltaics in buildings has huge development potential regarding both the market for BIPV systems and the contribution to renewable electricity production. In Germany, for instance, the BIPV market potential for building surfaces alone is estimated at 3000 km^2 amounting to an installation peak capacity of approx. 300 GW [15], quantifying coverage of approx. 50% of Germany's electricity demand [16].

The future development of this potential, in addition to already available building surfaces, is a great challenge for architects, specialized planners and systems manufacturers. This is because, in the European Union, at the end of 2010, only 29.3 GW of peak installed capacity had been reached, which amounted to only 10% of potential building surfaces in Germany. In Germany, in 2009, only 2% of the installed PV capacity was integrated into buildings [17]. In 2010, 440 MW were generated worldwide using BIPV, but it is expected that by 2015 only the USA and Germany will have developed the gigawatt capacity to be able to create a viable market [18].

In 2012, the value of the global BIPV market was only US$2.1 billion, but it is expected that the market will increase to US$7.5 billion by 2015. By 2015, it is estimated that the comparably small BIPV walling market will generate revenues of US$830 million. In 2016, the BIPV market for roofing components will be worth US$3.9 billion and generate revenues in the vicinity of US$2.5 billion, which is four times as much as in 2012. It is projected that revenues from BIPV glass products will reach US$4.2 billion by 2015 due to the comparably high cost for architectural glass that underpins these BIPV components. As the glass sector offers good opportunities for the integration of

PV and the enhancement of building fabric functionalities, it is expected that, by 2015, approximately US$375 million will be generated by BIPV glass products, that are fully integrated in the building envelope [19]. The biggest portion, 63% of the BIPV revenues, is expected to be associated with product applications in new buildings [20]. The growth of the BIPV industry and its market share are associated with the greater availability of PV components for building integration, combined with a growing demand for BIPV due to a worldwide trend towards the construction of zero-energy buildings.

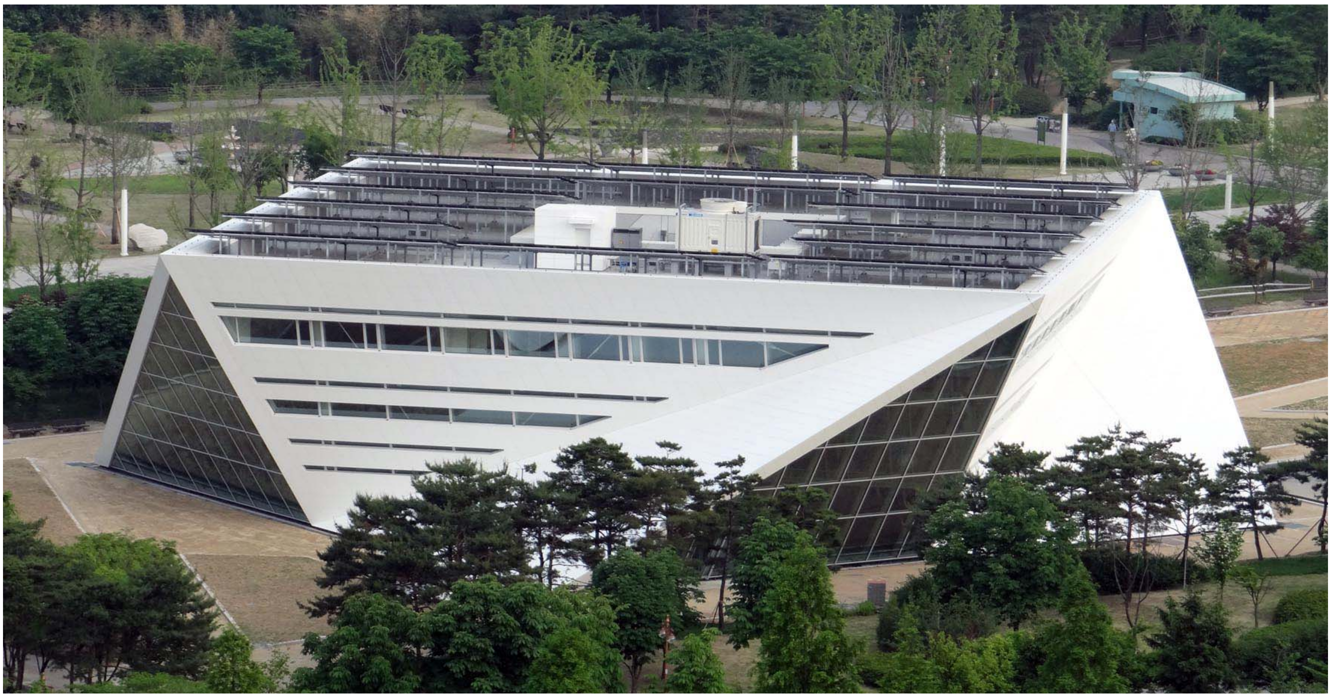
According to the European "directive on the energy performance of buildings" [21] from 2021 all member states must construct new buildings and public buildings as soon as 2019, as "nearly zero-energy buildings". This means that the electricity needed for use on the premises must be renewable energy generated on site or in close proximity to the building. According to the directive, the production of a surplus in renewable energy is also greatly encouraged. These requirements also correspond to the trend in the Republic of Korea, where, according to the Korea Energy Management Corporation (KEMCO), from 2025, all new buildings should carry the zero-energy building status [22]. Not only is a significant improvement in the energy efficiency of buildings necessary in order to meet these requirements in the short term, but in particular, a massive expansion of BIPV capacities must also take place to facilitate the proper integration of photovoltaics in buildings regarding technical and formal criteria.

3.2. Building Integrated Photovoltaics from a Technical and Formal Point of View

The building integration of photovoltaic components can be separated, in principle, into "technical" and "formal" integration. In formal integration, creative aspects are the focal point. From an architectural point of view, the aim is to achieve an aesthetic quality for photovoltaic generators in the envelope of buildings, or alternatively outside of it (in, next to, in front of or on buildings). Hence, one can distinguish between "additional" (Figure 2) or "integrated" construction measures.

The technical integration of photovoltaic components means that these are integral with the tectonics of a building—just like conventional components, without which a building would not function [23]. They serve, for example, as weather protection, heat insulation, fire prevention and sound insulation and, in addition, generate electric energy. Furthermore, they also take on complementary functions, such as radiation protection (electromagnetic radiation), electromagnetic communication (planar antenna in the building envelop) or natural light management (shadowing, light control). If these functions are not taken into consideration in the technical integration process, additional components are usually needed [24]. As part of installation technology they have a positive influence on the entire energy efficiency of a building, lowering the primary energy requirements and contributing substantially to future-oriented town planning development [25].

Figure 2. Additional construction features of elevated, but formally integrated PV installation with mono-crystalline cell technologies on the roof of the "Energy Dream Center" in Seoul, South Korea.



Architecture and civil engineering determine the creative, design and construction concepts of building integrated PV components, whereas the photovoltaic use determines the energy concepts. Electricity production from sunlight is an additional function, which, on account of the specific appearance of different PV technologies, can offer complementary possibilities for creativity in architecture. Integrated photovoltaic construction elements, which differ retrospectively from fitted elevated installations, are also an element of creativity for façades and roofs. Accordingly, from an architectural point of view, a seamless, technically designed integration of PV components into buildings also results in a formally creative integration (Figure 3). In contrast, the primary and exclusive function of additionally integrated PV modules is the production of electricity from sunlight, with the aim of gaining the highest yield and the associated financial return. This is also reflected in the design and construction concepts of such installations. Here, the seamless, formally creative and additional integration is a challenge, which is seldom adequately solved, in particular, when PV modules are provided without architectural drafts and concepts and installed into existing buildings.

Technically integrated BIPV components have multifunctional properties because they function as both part of the building envelope and as PV generators. Therefore, they have advantages in contrast to conventional PV systems, which are not a constructive part of the building envelope, and are generally elevated on roofs or fixed in front of the façades of buildings or are ground-mounted. Non-technical PV and BIPV installations have no multifunctional properties. Therefore, PV installations that are technically integrated into buildings have an enormous market potential. Thus, it is to be expected that demand in the future will also rise. However, the successful development of BIPV components is challenging due to the specific structures of the fast moving, high tech, PV industry which does not match well with the comparably slow, traditional, risk adverse, and reserved building products industry. Furthermore, there is a mismatch of technical skills between PV installers and traditional roof installers. The aforementioned challenges contribute to the complexity and slowdown of BIPV product development.

Figure 3. Formally and constructively integrated photovoltaic components with different cell technologies and appearance in the façade of the "Climate Change Research Building" in Incheon, South Korea. In this case components with crystalline silicon appear in dark blue and black color and components with thin film technology look dark red.

From the construction and electrotechnical points of view, the development of wide application fields for such systems must keep in mind easy assembly, as well as a versatile, creative and constructional integration in combination with different, including conventional, components and materials. The assembly of BIPV components should be similar to conventional building components and not associated with considerable, additional effort and installation costs. The cables for the connection of generators should be connected with unambiguous assigned socket outlets and plugs to facilitate fast and easy installation, e.g., by roof and/or façade construction firms. For example, the cable duct could be set in the air space of rear ventilated BIPV components, in the profiles of BIPV components in curtain facades or in the back of non-rear ventilated, opaque BIPV components in roofing or facades [26]. The further development of conventional building component systems for roofing and cladding, and expansion of such systems with BIPV components could facilitate the proper combination of conventional and BIPV components in terms of constructive and creative aspects.

Efficient BIPV component production processes, as well as innovative components and mounting systems, could partly compensate the potential disadvantages of BIPV compared to conventional ground mounted PV systems [27]. Possible disadvantages might be, for example, module orientation, which, in the case of building integrations, can seldom be optimized in order to produce the most electricity. It is likely that the orientation and tilt of facades and roofs is, in many cases, and especially in existing buildings, not optimal for maximum PV-electricity production per module area. However, as discussed in the introduction, the direction of PV modules from e.g., the optimal southern (northern hemisphere) or northern (southern hemisphere) direction would widen the daily peak of the PV-electricity supply in electricity distribution networks and is therefore a complementary measure for the technologically and ecologically controllable integration of volatile PV-electricity in existing energy and electricity distribution systems [6].

Generally, BIPV components without rear ventilated PV modules have a lower efficiency than conventional PV modules [26,28] due to higher cell temperatures [29]. Shadowing effects of BIPV by unsuitable building or facade geometries, building parts, surrounding buildings and vegetation have negative impacts on the efficiency and conflict with an optimal planning of BIPV installations. However, the shadowing of PV generators caused by the sun's orbit can be counteracted by partition and assignment of module strings that demand optimized alternating-current converters [26].

In existing buildings, which do not require the renewal of building components, it is unlikely that conventional building components would be dismantled to install technically integrated BIPV due to the comparably high constructional and financial input for the exchange of still acceptable building components compared with the installation of conventional and non-technically integrated photovoltaics.

3.3. Characteristics of Financial Support Policies for PV and BIPV in Germany and in France

3.3.1. Characteristics of Financial Support Policies for PV and BIPV in Germany

Due to the specific nature of support policies in Germany since 2000, today, Germany is the country with the largest installed cumulative PV capacity, with nearly 30% of the worldwide installed PV capacity. However, the German support policies neither take into consideration, nor do they offer financial compensation for the technically constructional and/or formally creative integration of photovoltaics in buildings.

Since 2000, remuneration for renewable electricity production fed into the public power grid has been regulated by the Renewable Energy Sources Act (Erneuerbare Energien Gesetz—EEG). The central support mechanism, stipulated in the EEG, is a technology-dependent feed-in tariff (FiT) granted to operators of renewable energy power plants. The EEG obligates grid operators and electricity suppliers to purchase renewable electricity [30].

The support of renewable energy production according to the EEG is not based on subsidies but on cost allocation. Energy consumers pay a compulsory levy, known as the EEG-surcharge. The amount of the cost allocation complies with the balance-costs (FiT) and profit (estimated attainable price). According to the German energy policy, in 2013 more than 50% of the amount of electricity consumed by industrial enterprises is, to a large extent, exempt from the EEG-surcharge. Consequently, the compulsory levy has to be reallocated, resulting in a higher EEG-surcharge for consumers, who do not profit from the exemption [6]. According to Frantzen and Hauser [31], the energy intensive industries in Germany profit most from the merit-order effect, because these industries are either totally exempt, or pay only a reduced EEG-surcharge rate of 0.05 euro ct/kWh, overcompensating their costs for the EEG-surcharge significantly. The EEG-surcharge for private households in 2013 was 5.27 euro ct/kWh, consisting of 2.29 euro ct/kWh for the support of renewable energies (including 1.38 euro ct/kWh for photovoltaics), 1.22 euro ct/kWh for the industrial EEG-surcharge exemption, 0.85 euro ct/kWh for the declining electricity exchange price, and 0.9 euro ct/kWh for other costs [32].

The EEG includes a special FiT for electricity generated using photovoltaics, in, next to or on buildings, however, it defines no specific requirements for the method of installation. From 2004 to 2008 there was a special FiT bonus of 5 cents/kW for electricity generated in, or in front of façades. The last amendment of the EEG in 2012, which was approved in August 2012 and came into force retrospectively as of 01.04.2012 [33], defines, in §32 paragraph 2 EEG, only two different types of photovoltaic solar installations. These are installations on buildings or noise protection walls, as well as installations on sealed or converted land up to and including a capacity of 10 MWp.

In Germany, installations on buildings or noise protection walls are divided into four capacity categories; >0–10 kW, >10 kW–40 kW, >40 kW–1 MW and >1 MW–10 MW. The FiT for electricity produced by installations belonging to more than one category is calculated proportionately according to the respective categories. In addition, electricity generated by PV installations outside of non-residential buildings is reimbursed independent of capacity. The FiTs are subject to a monthly degression. Future revaluations depend on expansion in capacity of the PV installation. As long as the EEG remains valid, energy suppliers are obliged to provide photovoltaic generated electricity for a period of 20 years, set at the rate that was guaranteed by the EEG when the installation went online. The EEG and the specific FiTs aim to give sufficient financial incentives to foster investments in the installation and operation of PV systems. In the following, the tariffs listed are those with which electricity generated by PV installations must be remunerated for a period of 20 years, according to the FiT stipulated in the EEG. These installations were connected to the public electricity grid in the months of March and April 2013 (see also Table 1).

Table 1. Overview of FiTs for photovoltaic generated electricity in Germany (01.03.2013–30.04.2013) [34,35] and France (01.10.2012–31.03.2013) [41], sorted by installed capacity, location of installation and type of BIPV.

Country/ period	Location PV installation	Type of BIPV installation	Installed total capacity of PV installation	Feed-in tariff in euro cents/kWh	Proportion of electricity produced receiving feed-in tariff	Average feed-in tariff in euro cents/kWh for produced electricity
Germany 01.03.2013 – 31.03.2013	Buildings & noise protection walls	All	0 –10 kWp	16.28	100%	16.28
		All	10 kWp–40 kWp	15.44	90%	13.90
		All	40 kWp–1 MWp	13.77	90%	12.39
		All	1 MWp–10 MWp	11.27	100%	11.27
	Outdoor area of non-residential buildings & sealed or converted land	*No building integration*	*0–1 MWp*	*11.27*	*100%*	*11.27*

Table 1. *Cont.*

Country/ period	Location PV installation	Type of BIPV installation	Installed total capacity of PV installation	Feed-in tariff in euro cents/kWh	Proportion of electricity produced receiving feed-in tariff	Average feed-in tariff in euro cents/kWh for produced electricity
Germany 01.04.2013 – 30.04.2013	Buildings & noise protection walls	All	0 kWp–10 kWp	15.92	100%	15.92
		All	10 kWp–40 kWp	15.10	90%	13.59
		All	40 kWp–1 MWp	13.47	90%	12.12
		All	1 MWp–10 MWp	11.02	100%	11.02
	Outdoor area of non-residential buildings & sealed or converted land	*No building integration*	*0 MW–1 MWp*	*11.02*	*100%*	*11.02*
France 01.10.2012 – 31.12.2012	Residential buildings	Complete (IAB)	0 kWp–9 kWp	34.15	100%	34.15
		Complete (IAB)	9 kWp–36 kWp	29.88	100%	29.88
	Buildings for education and health care	Complete (IAB)	0 kWp–9 kWp	22.79	100%	22.79
		Complete (IAB)	9 kWp–36 kWp	22.79	100%	22.79
	Other Buildings	Complete (IAB)	0 kWp–9 kWp	19.76	100%	19.76
	All building types	Simplified (ISB)	0 kWp–36 kWp	19.34	100%	19.34
		Simplified (ISB)	36 kWp–100 kWp	18.37	100%	18.37
	All installation types	*No building integration & all above maximum integration capacity*	*0 MW–12 MW*	*8.40*	*100%*	*8.40*
France 01.01.2013 – 31.01.2013	Residential buildings	Complete (IAB)	0 kWp–9 kWp	31.59	100%	31.59
		Complete (IAB)	9 kWp–36 kWp	27.64	100%	27.64
	Buildings for education and health care	Complete (IAB)	0 kWp–9 kWp	21.43	100%	21.43
		Complete (IAB)	9 kWp–36 kWp	21.43	100%	21.43
	Other Buildings	Complete (IAB)	0 kWp–9 kWp	18.58	100%	18.58
	All building types	Simplified (ISB)	0 kWp–36 kWp	18.17	100%	18.17
		Simplified (ISB)	36 kWp–100 kWp	17.27	100%	17.27
	All installation types	*No building integration & all above maximum integration capacity*	*0 MW–12 MW*	*8.18*	*100%*	*8.18*
France 01.02.2013 – 31.03.2013	All building types*	Complete (IAB)	0 kWp–9 kWp	31.59	100%	31.59
		Simplified (ISB)	0 kWp–36 kWp	18.17	100%	18.17
		Simplified (ISB)	36 kWp–100 kWp	17.27	100%	17.27
	All installation types	*No building integration & all above maximum integration capacity*	*0 MW–12 MW*	*8.18*	*100%*	*8.18*
	*An additional feed-in tariff bonus of 10% or 5% is available for components made in Europe meeting IAB or ISB criteria in installations with a maximum capacitiy of less than 100 kWp					

In March 2013, the FiT for PV installations on buildings and noise protection walls up to 10 kW was set at 16.28 euro cents/kWh for 100% of the electricity produced. For capacities of >10 kWp–40 kWp, 90% of the electricity produced was remunerated at 15.44 cents/kWh. Likewise, for capacities of

>40 kWp–1MWp the FiT of 90% of the electricity generated was set at 13.77 euro cents/kWh. For PV installations with a capacity of >1 MWp–10 MWp, 100% of the electricity was remunerated at 11.27 euro cents/kWh. This amount was identical to the FiT for electricity generated by PV installations installed outside of non-residential buildings (independent of capacity) and on sealed or converted land (capacity of >0–10 MWp) [34,35].

On the basis of a monthly degression, the FiT for the same types of installation and capacity categories in the subsequent month, April 2013, was as follows: For PV installations on buildings and noise protection walls up to 10 kW, the FiT for 100% of electricity generated was set at 15.92 euro cents/kWh. For capacities of >10 kWp–40 kWp, 90% of the electricity generated was remunerated at a rate of 15.10 cents/kWh. Likewise, for capacities of >40 kWp–1MWp, 90% of the electricity generated was remunerated at a rate of 13.47 euro cents/kWh. For PV installations with a capacity of >1 MWp–10 MWp, 100% of the electricity generated was remunerated at 11.02 euro cents/kWh. This amount was identical to the FiT for electricity generated by PV installations installed outside of non-residential buildings (independent of capacity) and on sealed or converted land (capacity of >0–10 MWp) [34,35].

The development work in the area of BIPV systems could be supported by a separate regulation and FiT for electricity that, according to technical and formal criteria, can be perfectly integrated into building envelopes, and in particular, for electricity generated from PV installations in façades. This is why associations such as the Federal Building Industry Union of Berlin, the Professional Building Integration Group, the German Registered Society for Solar Energy (DGS) and the Federal Solar Industry Association (BSW-solar) demand a review of the EEG and a higher FiT for electricity produced by BIPV. According to the proposal of BSW-solar for roof-integrated installations, a 10% bonus should be granted and for façade-integrated installations a bonus of up to 30% should be granted over and above the applicable FiT [25,36]. Up to now, however, German legislators have shown neither interest in special financial support of BIPV, nor passed regulation as to how differing forms of integration could be defined and remunerated.

3.3.2. Characteristics of Financial Support Policies for PV and BIPV in France

France is a good example of a country in which the future BIPV potential has been recognized and addressed accordingly in the financial support policy [37]. A remarkably higher FiT is offered there for electricity generated using PV components that are, from a technical design viewpoint, integrated into building envelopes. France boasts being the only country in the world where this is the case [38].

In France, at the end of 2011, 2802 MWp of installed PV capacity was connected to the power grid. The proportion of smaller, building integrated PV installations in residential buildings with a capacity of less than 3 kWp, amounted to 89% of the entire number of installations and 20% of the entire installed capacity. In March 2011, a government resolution was reached to direct focus, using the relevant support, towards the installation of new building integrated PV systems with the aim of reaching at least 500 MWp per year. Thus, 80% of the accumulated installed capacity in France is generated by PV installations, which, to a large extent, are technically and formally integrated into constructions and buildings (and not only mounted on buildings). In France only 18% of the totally installed PV capacity was installed in the form of ground-mounted systems (hence neither on nor in buildings) [39].

By 2020, the French government plans to have installed a PV capacity of 5400 MW of PV, for the most part in buildings, by using financial incentives like FiTs, tax advantages and direct subsidies from regional federal state authorities. Industry associations are demanding far more and estimate the installed capacity of 20 GW by 2020 and 40 GW by 2030 will be much higher. How high the installed capacity in actual fact will be, is, by virtue of French support policies, primarily dependent on when grid parity is reached. In addition, there are already completed BIPV projects, which do not receive special FiTs. With the application of the French heat insulation law for buildings "RT 2020" (BEPOS or positive energy building), from 2018, or at the latest 2020, the integration of PV systems in new buildings is supposed to be standard regulation [39].

The resolution of the 4th of March 2011 sets out new basic conditions for FiTs that were defined using exact, technical requirements. The French committee for the evaluation of photovoltaic products for building integration CEIAB (Comité d'Evaluation de l'Intégration Au Bâti) decides whether PV systems for building integration conform to the technical criteria for "Building Integrated Photovoltaic systems "(IAB)" or to those for "Simplified Building Integrated Photovoltaic Systems" (ISB). Building Integrated Photovoltaic systems adopt the function of construction components. In roofs, these must be arranged, for example, parallel with the roof surface, must have a waterproof and airtight seal with it, and may only have a maximum ridge line overhang of approximately 2 cm. "Simplified Building Integrated Photovoltaic Systems" do not carry out the function of a construction component and, hence, may be mounted on roofs [39].

For the period from the 1st of October to the 31st of December 2012, the FiT for IAB installations in residential buildings amounted to 34.12 euro cents/kWh (for installed capacity up to 9 kWp) and 29.88 cents/kWh (for installed capacity between 9 kWp and 36 kWp). For educational institution or public health service buildings, the FiT for installed capacity up to 36 kWp amounted to 22.79 euro cents/kWh. For other building integrated PV installations, the FiT was set at 19.76 euro cents/kWh for a capacity up to 9 kW. The FiT for ISB installations in the same period for all above mentioned building types was uniformly set at 19.34 euro cents/kWh (for installed capacity up to 36 kWp) and 18.37 euro cents/kWh (for installed capacity between 36 kWp and 100 kWp). All other forms of PV systems and installations were remunerated up to a capacity size of 12 MW at 8.4 euro cents/kWh [40]. In the period from the 1st of January to the 31st of January 2013, the guaranteed FiTs for electricity from PV installations were adjusted as follows [41].

Electricity from IAB installations in residential buildings was remunerated at a rate of 31.59 euro cents/kWh (for installed capacity up to 9 kWp) and 27.64 euro cents/kWh (for installed capacity between 9 kWp and 36 kWp). For educational institutions or public health service buildings the FiT for installed capacity up to 36 kWp amounted to 21.43 euro cents/kWh. For other building integrated PV installations up to a capacity of 9 kW, the FiT was set at 18.58 euro cents/kWh. ISB installations in the same period for all above mentioned building types was uniformly set at 18.17 euro cents/kWh (for installed capacity up to 36 kWp) and 17.27 euro cents/kWh (for installed capacity between 36 kWp and 100 kWp). All other forms of PV systems and installations were remunerated up to a size of 12 MW at 8.18 euro cents/kWh [41].

From the 1st of February 2013, the FiTs were highly simplified and no longer differentiated between building types. In general, small IAB installations up to a capacity of 9 kWp were specially subsidized. In January and February 2013, the special, guaranteed subsidized rate for residential buildings of 31.59 euro cents/kWh was extended, for the period from the 1st of February 2013 to the 31st of March 2013, to integrated installations in all building types. For IAB installations with capacities of more than 9 kWp, FiTs were not raised. Instead, the same tariffs for ISB installations were applied. The rates for ISB installations with capacities of 0–36 kWp, were 18.17 euro cents/kWh and for ISB installations with installed capacities of between 36 kWp–100 kWp, 17.27 euro cents/kWh. All other forms of PV systems and installations up to a capacity size of 12 MW were remunerated (identical to the period January, 2013) at 8.18 euro cents/kWh. In addition, complementary subsidies were introduced in the period from February to the end of March 2013, for installed photovoltaics modules made in the EU with the aim of promoting local industry and protecting the market against cheap, non-European imports. For modules that conformed to the IAB criteria, a bonus of 10% was granted for all abovementioned FiTs. For European modules that conformed to the ISB criteria a smaller bonus of 5% was granted for all abovementioned FiTs [41].

The demand for financially supported, building integrated photovoltaic systems, motivates French companies to use this support and develop systems for this purpose. Numerous companies already produce ISB or IAB systems for roofs, roof terraces and façades. In the October 2001 issue of the magazine *Journal du Photovoltaïque*, 70 products for building integration were featured.

CEIAB decides whether PV integration processes conform to ISB or IAB systems. The committee comprises representatives of public organizations (DGEC, CSTB, ADEME and DREAL). In 2011, approx. 110 products conformed to the IAB and 45 to the ISB definitions and were therefore eligible to claim the above mentioned FiT. Current lists containing the specific information regarding conform products are available on the CEIAB website [42].

In addition, the French Environment and Energy Management Agency (ADEME) recommends project initiators confirm BIPV products have also received a technical photovoltaic evaluation from the French Scientific and Technical Centre for Buildings (CSTB—Centre scientifique et technique du bâtiment) or that the products have, at the least, a “green innovation” certificate (Pass’Innovation Vert). BIPV products and processes can therefore benefit from technical evaluations and certification by the CSTB, because being a BIPV gives the right to claim remuneration according to the definitions set out by the CEIAB.

In France, the 10-year guarantee on construction performance is also applicable to BIPV systems. This is guaranteed by the company installing the products and refers to the faultless function with regards to the intended building function. This refers to, for example, the repair of leaks caused by IAB systems. In addition a separate so-called “fitting” guarantee on the perfect electrotechnical function of the photovoltaic system is applicable to IAB systems [39].

4. Conclusions and Outlook for BIPV

In the framework of this paper the market perspectives for technically and formally integrated BIPV and its consideration in financial support policies has been discussed. While in Germany, the installation of BIPV receives no special FiT compared with conventional PV, in France a remarkably higher FiT is guaranteed for electricity generated using technically integrated BIPV components. The investigation and discussion of the rationale for the German policy to not support technically integrated BIPV with a special FiT and the rationale for the French policy to support the BIPV with a special FiT was not the aim and scope of this paper. However, according to the findings and specific policies discussed, it can be supposed that the German EEG and FiT primarily aimed for the installation of large PV capacities, resulting in the reduction of module prices and PV-electricity costs following a price learning curve, and the reduction of electricity prices at the electricity exchange through the merit-order effect. It can be assumed that the French policy supported particularly small and completely integrated photovoltaic installations (IAB) with a special FiT to stimulate the proper installation of photovoltaics in buildings regarding formal and technical criteria, and to foster the market and product development of BIPV components certified for the application in buildings according to the French building code. The bonus provided for certified European products, indicates that the FiT also has a market protection component and also aims to strengthen the French and European BIPV component development, production and marketing for certified BIPV components. On the other hand, it can be assumed that the primary aim of the French policy is not the installation of large PV capacities, which is indicated, for example by the French FiT for ground-mounted PV power plants, which was significantly lower than the German FiT for the same installation type.

The French model of special FiT for electricity generated from technically integrated PV modules in buildings would also stimulate demand for building integrated photovoltaic components in other countries. Furthermore, specific national norms, regulations and laws referring to the energy requirements of buildings and building-integrated photovoltaics would have to be made. Concerning future drafts or amendments of energy performance certifications (in Germany for example "energy saving regulation—EnEV") these should be simply and appropriately balanced. Within the scope of financial subsidy programs for new energy efficient buildings and the upgrading of existing buildings, building-integrated photovoltaic components should be considered and classed as explicitly eligible for subsidies and/or a creditworthy building measure, because they are a permanent component of the building envelope and by virtue of their multifunctional qualities improve the standard of efficiency. The tax administration and the regulation of capital investment bonuses and write-offs should not disadvantage BIPV systems compared with conventional, non-integrated PV systems.

Concerning their in-use properties, BIPV construction elements must be checked according to the relevant norms and be described accordingly in data sheets. In the future, they should preferably be referred to as regulated building products (in Germany, for example, in the Building Rules List A part 1). Other countries should also be allowed to use approved BIPV construction elements, as in the French model, without the need for individual approval. In Germany this would be the case if they had a general building approval from the German Institute of Civil Engineering (DIBt). The resulting developmental growth, approvals and offers would facilitate the easy and increasing substitution of conventional components with photovoltaic components. This would apply, in particular, to new buildings and upgrades where the installation of new components in the building envelope is necessary. Since building-approved photovoltaic components differ from conventional components, primarily due to their special function of producing electricity from light, they do not require the additional installation of photovoltaic generators outside of the building envelope. This means that their use has design and creative formal advantages and economic advantages compared with photovoltaic modules which have no function as construction components [23]. In addition, market leadership of the solar industry in countries adopting the French model could be strengthened, by subsidizing the development and installation of building approved photovoltaics. BIPV products produced, for example, for the European market could be regulated by additional CE certification.

To sum up, it can be stated that, in the short term, the technical and formal building-integration of photovoltaic components is establishing itself as a market according to the status of technology. This development would contribute substantially to the strengthening of the building and solar industries in countries which dispose of the technical potential. In the future, these countries will also have to take into consideration, in particular, aspects of the creative and technical building-integration of photovoltaics into national support policies in order to stimulate and promote research, development, production and installation. This would contribute not only to a sustained development of the construction culture, economy and energy supply, but also substantially to the development of international markets.

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Conflict of Interest

The author declares no conflict of interest.

References

1. James, T.; Goodrich, A.; Woodhouse, M.; Margolis, R.; Ong, S. *Building-Integrated Photovoltaics (BIPV) in the Residential Sector: An Analysis of Installed Rooftop System Prices*; NREL/TP-6A20-53103; NREL National Renewable Energy Laboratory: Golden, CO, USA, 2011; p. 50.
2. Hall, M. World Passes 100 GW Installed PV Capacity Mark. Available online: http://www.pv-magazine.com/news/details/beitrag/world-passes-100-gw-installed-pv-capacity-mark_100010145/#axzz2WGhwHqSz (accessed on 16 February 2013).
3. Nicola, S. Germany Added Record Solar Panels in 2012 Even as Subsidies Cut. Available online: http://www.bloomberg.com/news/2013-01-07/germany-added-record-solar-panels-in-2012-even-as-subsidies-cut.html (accessed on 16 February 2013).

4. Parkinson, G. The Top Solar Countries—Past, Present and Future. Available online: http://reneweconomy.com.au/2013/the-top-solar-countries-past-present-and-future-96405 (accessed on 16 February 2013).
5. Burger, B. Photovoltaik ist mit 30 Gigawatt stärkste Stromerzeugungstechnik in Deutschland (Photovoltaics is with 30 Gigawatts most powerful Electricity Production Technology in Germany). Available online: http://www.ise.fraunhofer.de/de/aktuelles/meldungen-2012/photovoltaik-ist-mit-30-gigawatt-staerkste-stromerzeugungstechnik-in-deutschland (accessed on 16 February 2013).
6. Wirth, H. *Aktuelle Fakten zur Photovoltaik in Deutschland* (*Current Facts Regarding Photovoltaics in Germany*); Fraunhofer-Institut für Solare Energiesysteme (Fraunhofer Institute for Solar Energy Systems) Fraunhofer ISE: Freiburg, Germany, 2013; p. 76.
7. Kress, M.; Landwehr, I. *Akzeptanz Erneuerbarer Energien in EE-Regionen*; Institut für ökologische Wirtschaftsforschung (IÖW): Berlin, Germany, 2012; p 40.
8. Sensfuß, F.; Ragwitz, M.; Genoese, M. The Merit-Order Effect: A Detailed Analysis of the Price Effect of Renewable Electricity Generation on Spot Market Prices in Germany; Fraunhofer Institute Systems and Innovation Research (Fraunhofer ISI): Karlsruhe, Germany, 2007; p. 28.
9. Nitsch, J.; Pregger, T.; Naegler, T.; Heide, D.; de Tena, D.L.; Trieb, F.; Scholz, Y.; Nienhaus, K.; Gerhardt, N.; Sterner, M.; *et al. Langfristszenarien und Strategien für den Ausbau der Erneuerbaren Energien in Deutschland bei Berücksichtigung der Entwicklung in Europa und Global* (*Long-term scenarios and strategies for the development of renewable energies in Germany considering the development in Europe and global*); Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Technische Thermodynamik Abt. Systemanalyse und Technikbewertung, Fraunhofer Institut für Windenergie und Energiesystemtechnik (IWES), Ingenieurbüro für neue Energien (IFNE): Stuttgart, Kassel, Teltow, Germany, 2012; p. 345.
10. Klaus, T.; Vollmer, C.; Werner, K.; Lehmann, H.; Müschen, K. *Energieziel 2050: 100% Strom aus Erneuerbaren Quellen* (*Energy Target 2050: 100% Electricity from Renewable Sources*); Umweltbundesamt (German Federal Environmental Agency): Dessau-Roßlau, Germany, 2010; p. 196.
11. Henning, H.-M.; Palzer, A. *100% Erneuerbare Energien für Strom und Wärme in Deutschland* (*100% Renewable Energies for Electricity and Heat in Germany*); Fraunhofer-Instituts für Solare Energiesysteme (Fraunhofer Institute for Solar Energy Systems) Fraunhofer ISE: Freiburg, Germany, 2011; p. 37.
12. Shell. *New Lens Scenarios: A Shift in Perspective for a World in Transition*; Royal Dutch Shell International: London, UK, 2013; p. 48.
13. Statistische Zahlen der deutschen Solarstrombranche (Photovoltaik) [Statistical Figures of the German Solar Electricity Industry (Photovoltaics)]; Bundesverband Solarwirtschaft e.V. (German Solar Industry Association) BSW-Solar: Berlin, Germany, 2012; p 4.
14. Bofinger, S.; Glotzbach, T.; Saint-Drenan, Y.-M.; Braun, M.; Erge, T. Rolle der Solarstromerzeugung in Zukünftigen Energieversorgungsstrukturen—Welche Wertigkeit hat Solarstrom? (Role of Solar Electricity Production in Future Energy Supply Structures – What is the Siginificance of Solar Electricity?) Institut für Solare Energieversorgungstechnik e.V. (Institute for Solar Energy Supply Technology) ISET e.V.: Kassel, Germany, 2008.

15. *Gebäudeintegrierte Photovoltaik-Systeme* (*Building-Integrated Photovoltaic Systems*); Bundesverband Bausysteme e.V. (Federal Asscociation Construction Systems): Koblenz, Germany, 2012; pp. 1–4.
16. AG Energiebilanzen e.V. Bruttostromerzeugung in Deutschland von 1990 bis 2012 nach Energieträgern (Gross Electricity Production in Germany from 1990 to 2012 by Energy Carriers). Available online: http://www.ag-energiebilanzen.de (accessed on 16 February 2013).
17. *Gebäudeintegrierte Photovoltaik-Systeme* (*Building-Integrated Photovoltaic Systems*); Bundesverband Bausysteme e.V. (Federal Asscociation Construction Systems): Koblenz, Germany, 2010; pp. 1–4.
18. Bernsen, O. Outlook on BIPV—Economische Kansen voor PV in Nederland. In *NL Agency—Ministry of Economic Affairs*; De Balie: Amsterdam, The Netherlands, 2012.
19. Design-Build Solar Global BIPV Market Forecast to Hit US$7.5 Billion by 2015. Available online: http://www.designbuildsolar.com/news/global_bipv_market_forecast_to_hit_us7.5_billion_by_2015/ (accessed on 16 February 2013).
20. *Building-Integrated Photovoltaics Markets—2012*; NanoMarkets: Glen Allen, VA, USA, 2012.
21. European Commission. *Energy Performance of Buildings*; Directive 2010/31/EU; European Parliament and the Council of the European Union: Brussels, Belgium, 2010; p. 23.
22. Chun, S.; Korean Energy Management Cooperation, Building Energy Policies in Korea. In *International Workshop EPC (Energy Performance Certificate) and Assessor System for Buildings*; Korean Energy Management Cooperation: Seoul, Korea, 2012.
23. Schuetze, T.; Hullmann, H. Wirtschaftliche Aspekte Beim Einsatz Multifunktionaler Photovoltaischer Bauteile (Economical Aspects of Mutifunctional Photovoltaic Building Component Applications). In Proceedings of the Symposium on Photovoltaische Solarenergie, Kloster Banz, Bad Staffelstein, Germany, 2–4 March 2011; pp. 546–551.
24. Bendel, C. Multifunktionale Photovoltaikprodukte (Multifunctional Photovoltaic Products). In Proceedings of the Symposium on Photovoltaische Solarenergie, Kloster Banz, Bad Staffelstein, Germany, 5–7 March 2008; pp. 1–16.
25. *Vorschläge Zur Aktuellen EEG Debatte* (*Proposals to the Current EEG Debate*). Bundesverband Bausysteme e.V. (Federal Asscociation Construction Systems): Koblenz, Germany, 2012.
26. Hullmann, H.; Schuetze, T.; Bendel, C.; Funtan, P.; Kirchhof, J. Multifunktionale Photovoltaik—Photovoltaik in der Gebäudehülle (Multifunctional Photovoltaics—Photovoltaics in the Building Envelope); hwp—hullmann, willkomm & partner & Institut für Solare Energieversorgungstechnik (Institute for Solar Energy Supply Technology) ISET e.V.: Hamburg & Kassel, Germany, 2006; p. 92.
27. Niederfuehr, M. BIPV—Technology Transfer from Bonded Construction Systems to PV. In Proceedings of the 27th European Photovoltaic Solar Energy Conference and Exhibition, Frankfurt, Germany, 25 September 2012; pp. 4224–4226.
28. Lai, C.-M.; Lin, Y.-P. Energy saving evaluation of the ventilated BIPV walls. *Energies* **2011**, *4*, 948–959.
29. Dubey, S.; Tiwari, G.N. Analysis of PV/T flat plate water collectors connected in series. *Sol. Energy* **2009**, 1485–1498.

30. Langniß, O.; Diekmann, J.; Lehr, U. Advanced mechanisms for the promotion of renewable energy—Models for the future evolution of the german renewable energy act. *Energy Policy* **2009**, 1289–1297.
31. Frantzen, J.; Hauser, E. Kurzfristige Effekte der PV-Einspeisung auf den Großhandelsstrompreis (Short-term Effects of PV Feed-In on Wholesale Electricity Price); Institut für Zukunfts EnergieSysteme (Institute for Future Energy Systems) IZES: Berlin, Germany, 2012; p. 40.
32. *Hintergrund zur EEG-Umlage 2013* (*Background Information on EEG Surcharge*); Bundesverband Erneuerbare Energie e.V. (Federal Association Renewable Energy) BEE: Berlin, Germany, 2012; p. 14.
33. Bundesministerium für Umwelt Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety). *Photovoltaik: Einigung im Vermittlungsausschuss—Neuregelungen treten rückwirkend zum* 1 April 2012 in Kraft (Photovoltaics: Agreement in the Conciliation Committee—*New Regulation is Coming Into Effect with Retroactive Effect from 1 April 2012*). Berlin, Germany, 28 June 2012. Available online: http://www.erneuerbare-energien.de/erneuerbare_energien/pressemitteilungen/pm/48562.php (accessed on 16 February 2013).
34. Bundesnetzagentur (Federal Network Agency) EEG-Vergütungssätze für PV-Anlagen (EEG Feed-In Tariffs for PV Installations). Available online: http://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetGas/ErneuerbareEnergienGesetz/VerguetungssaetzePVAnlagen/VerguetungssaetzePhotovoltaik_node.html (accessed on 16 February 2013).
35. Solarenergie-Förderverein Deutschland e.V. (German Solar Energy Development Association) Solarstrom-Vergütungen im Überblick (Overview Solar Electricity Feed-In Tariffs). Available online: http://www.sfv.de/lokal/mails/sj/verguetu.htm (accessed on 16 February 2013).
36. Ernst, W. PV-Fassaden im Trend. Marktübersicht fassadenintegrierte Solarmodule (Trendy PV Facades. Market Overview Façade-Integrated Solar Modules). *Metallbau* **2012**, *23*, 52–63.
37. Morlot, R.; La reglementation pour L'integration des Produits Photovoltaiques au Bati (Regulation for the Integration of Photovoltaic Products in Buildings); PHOTON Réseau : Mise en oeuvre des systèmes photovoltaïques raccordés au réseau électrique (PHOTON Network: Implementation of Grid-Connected Photovoltaic Systems), Ademe: Centre d'Accueil de Valpré, Écully, France, 2005; pp. 69–83.
38. Ministry of Territorial Equality and Housing & Ministry of Ecology Sustainable Development and Energy Solar Decathlon 2014 in France. Available online: http://www.solardecathlon2014.fr (accessed on 26 August 2012).
39. Durand, Y. *Photovoltaic Power Applications in France. National Survey Report 2011*; French Agency for Environment and Energy Management (ADEME): Paris, France, 2012; p. 25.
40. Pouthier, A. Photovoltaïque: le tarif d'achat de l'électricité produite par les installations intégrées en toiture entre 36 et 100 kWc augmenté de 5% (Photovoltaics: The Purchase Price of Electricity Genenerated by Integrated Rooftop Installations between 36 and 100 kWp Increased by 5%). Available online: http://www.lemoniteur.fr/137-energie/article/actualite/19151001-photovoltaique-le-tarif-d-achat-de-l-electricite-produite-par-les-installations-integrees-en-toiture (accessed on 16 February 2013).

41. Actu-Evironnement (News-Environment) Photovoltaïque: les nouveaux tarifs d'achat intègrent les mesures d'urgence (Photovoltaics: New Purchase Prices include Emergency Measures). Available online: http://www.actu-environnement.com/ae/news/tarifs-achat-photovoltaique-baisse-bonification-simplification-17716.php4 (accessed on 16 February 2013).
42. CEIAB Comité d'Evaluation des produits photovoltaïques Intégrés au Bâti (Committee for the Assessment of Building-Integrated Photovoltaic Products) Liste des procédés d'intégration photovoltaïques éligibles (List of eligible Photovoltaics Integration Processes). Available online: http://www.ceiab-pv.fr/ (accessed on 26 August 2012).
43. HWP—Hullmann, Willkomm & Partner. Available online: http://www.hwp-hullmann-willkomm.de (accessed on 17 June 2013).
44. KORANET Joint Call on Green Technologies. Available online: www.koranet.eu (accessed on 17 June 2013).

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