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Insurance Challenges for BIPV Projects: The role of standardisation for risk reduction

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INSURANCE FOR BIPV

Insurance plays a fundamental role in the financing of renewable energy projects, which are often perceived as high-risk investments. Insurance can help transfer these risks, thereby increasing the attractiveness of renewable energy projects. Indeed, in the absence of insurance, most renewable energy projects are unlikely to be considered for investment and in some cases will not be built. Insurance can also reduce risk by advising clients on best practices and diffusing knowledge about the market. Effective de-risking solutions can promote a pipeline of bankable projects and accelerate innovation in renewable energy technologies. De-risking energy transition projects is critical for long-term funding to be made available at affordable rates.[1]

The European Union (EU), in alignment with the Paris Agreement, emphasises the crucial role of cities in advancing towards a low-carbon economy. Buildings play a vital role in the energy efficiency of urban areas, as they are responsible for a significant portion of urban energy consumption. In Europe, buildings account for 41% of the total energy use in cities. Therefore, transitioning to self-sufficient buildings is a key strategy for achieving nearly zero-energy cities. The first step towards achieving nearly zero-energy buildings involves enhancing the thermal insulation of buildings. Once these improvements have been done, the next effective strategy to reduce a building's primary energy balance is the integration of on-site renewable energy systems, including solar energy.[2]

Photovoltaic (PV) installations are expected to play a crucial role as the most important technology for the supply of electrical energy of buildings. Indeed, buildings offer the possibility of consuming PV electricity close to its place of production and of generating PV electricity without taking up more land. PV in buildings is rapidly expanding beyond the traditional module structure with building integrated PV (BIPV) and its multiple of applications on roofs, façades, balconies and skylights among others.

Building-applied photovoltaics (BAPV) and BIPV represent two approaches to incorporating solar energy systems into buildings. BAPV refers to PV systems added to an existing structure as an attachment, such as PV panels mounted on rooftops. This approach is commonly used when retrofitting building, without altering the design of the building. In contrast, BIPV integrates PV systems directly into the building's structure during construction or renovation. BIPV systems serve dual purposes, acting as building elements (roof tiles, windows or cladding), while also generating electricity.

BIPV technology is rapidly evolving with systems already economically viable in many European countries. With ongoing technological advancements and supportive frameworks, BIPV systems have a promising future, offering economic and environmental benefits under multiple business models.[3] However, several challenges and barriers to the effective rollout of BIPV in Europe exist and need to be addressed. Insurance has emerged as one of these challenges.

Insurance companies have been identified in the literature as stakeholders for BIPV projects, often mentioned alongside banks and investors in discussions regarding business models.[4] Despite this, their specific challenges and concerns are rarely given detailed attention. This paper seeks to contribute to this gap in knowledge and initiate exchanges between the BIPV and insurance sectors.

Standard rooftop PV systems, which are BAPV systems, are covered by home insurance by most insurance companies. In this case, panels are considered part of the building and are covered as long as they are kept in good condition and installed by a professional. The value of the house with the

[1] WeESG Group, Insuring renewable energy projects (September 2022).
[2] Gholami, H.; Nils Røstvik, H.; Steemers, K. The Contribution of Building-Integrated Photovoltaics (BIPV) to the Concept of Nearly Zero-Energy Cities in Europe: Potential and Challenges Ahead. *Energies*. 2021, 14, 6015 ; BIPVBOOST, Potential contribution to BIPV systems to nearly Zero Energy Buildings and methodology for project outputs assessment (July 2020).
[3] BIPVBOOST, BIPV Solutions in Europe: Competitiveness status and roadmap towards 2030 – White paper (July 2021), IEA PVPS Task 15, Inventory on Existing Business Models, Opportunities and Issues for BIPV, Report IEA-PVPS T15-03:2018 (April 2018).
[4] IEA PVPS Task 15, Development of BIPV Business Cases, Guide for stakeholders, Report IEA-PVPS T15-10:2020 (June 2020) ; BIPVBOOST, Update on BIPV market and stakeholder analysis (October 2018) ; MC2.0, Market archetypes report and competitiveness (January 2024).

addition of PV panels should be reflected in the insurance cover.[5] The presence of solar panels may lead to an increase in the insurance premium. While standard PV systems have been successfully integrated into insurance processes, this is not yet the case for BIPV. The primary reasons for this include the relatively small size of the BIPV market, the insurance industry's limited experience with these systems, and some negative experiences in certain instances.

If insurance cannot be secured for a BIPV project, it poses significant risks for project developers, including financial and legal complications. Many lenders require insurance before releasing funds, making financing difficult without an insurance. Construction contracts often stipulate that the project must be insured, and failure to comply can result in legal disputes, penalties or contract termination. Some jurisdictions also require insurance for permits, meaning work may be delayed, causing cost overruns, or even cancelled if coverage is not available. Insurance is thus essential for mitigating risks and ensuring project success. Additionally, in some cases, lack of insurance can hinder to testing and deployment of new BIPV products in demonstration sites in the context of research projects, slowing market adoption on the long run.

The methodology of this paper involved conducting a literature review of reports and papers on BIPV, with a particular focus on stakeholder engagement, financing, market uptake barriers, standardisation and fire safety. The review also included documentation from the insurance sector, notably on guidelines on PV installation. Additionally, interviews were conducted with partners from the Increase project, as well as with representatives from insurance companies and sectoral associations. The topic of insurance was further explored in discussions held during two workshops organised by the Increase project in Belgium, in April 2024 and France, in October 2024, where various topics related to BIPV uptake were discussed. All data was collected until October 2024.

This paper first examines the insurance sector’s perspective on the risks associated with BIPV projects, with a particular emphasis on fire safety, which is a major concern for the insurance sector. Water damage from inadequate watertightness is also highlighted as a significant risk. Interviews with insurance sector stakeholders revealed that negative experiences from the early 2010s have eroded trust in BIPV, contributing to the sector’s hesitancy to offer coverage. Building on this overview, the paper proposes key recommendations to improve the insurability of BIPV projects by addressing insurers’ concerns, with a focus on the standardisation of equipment, practices, and knowledge.

RISKS IN THE SCOPE OF INSURANCE

The installation of BIPV systems on building poses several risks from the perspective of the insurance sector. Central to these concerns is fire safety, which remains a predominant issue for insurers due to the potential hazards associated with electrical components and system failures. Beyond fire risks, insurers have identified several other concerns related to watertightness, exposure to natural hazards and electrical risks. More critically, past negative experiences with BIPV projects leading to high damages and claims have contributed to a pronounced reluctance among insurers to provide coverage for BIPV projects. This is particularly the case for France. However, it must be noted that each country has its own framework to assess BIPV and PV-related risks in an insurance context and that overall, the sector has limited experience with BIPV. This lack of experience makes it difficult to have specific frameworks in place to assess BIPV projects from an insurance point of view.

[5] Axa, Cover for solar panels, accessed June 2024.

Figure 1: Overview of BIPV risks in the scope of insurance

FIRE SAFETY

- Fire safety is the main concern of the insurance sector
- BIPV systems are considered as higher risk than standard PV modules by the insurance sector, because of fire risks related to BIPV equipment and additional risks related to the potential amplification of fire
- Insurance guidelines for standard PV modules exist but not for BIPV

Fire safety and a perception of high fire risks are a central concern for insurance providers.[6] Like all electrical equipment, it is possible for rooftop PV equipment and BIPV elements to catch fire. Furthermore, rooftop PV systems can alter the fire dynamics of buildings. Overall, the occurrence of fires in solar PV system is rare, with causes typically associated with installation quality or equipment defects. However, fire risks in buildings remain a critical concern due to the potential dangers it poses to occupants.

While statistics about fires involving PV systems in Europe are scares and not recent, data shows that PV systems on residential buildings caused fires in 0.006% to 0.014% of cases in Germany (1993-2013) and the Netherlands (2018).[7] In the rare instances, where the PV system caused a fire, it usually results from DC arc faults or localised overheating. Another study conducted on publicly available data from Australia, Germany, Italy, the UK and the USA, calculated an annual fire incident frequency of 0.289 fires per MW of installed capacity in these countries.[8] The analysis identified electrical arcing as the primary cause of PV-related ignition incidents.

[6] Allianz Risk Consulting, Fire Hazard of Photovoltaic (PV) Systems, Tech Talk Vol 8, 2019.
[7] SolarPower Europe, Rooftop PV Fire Safety Factsheet ; Fraunhofer ISE, Recent Facts about Photovoltaic in Germany (2024)
[8] Mohd Nizam Ong, N. A. F., Sadiq, M. A., Md Said, M. S., Jomaas, G., Mohd Tohir, M. Z., & Kristensen, J. S. (2022). Fault tree analysis of fires on rooftops with photovoltaic systems. *Journal of Building Engineering*, 46, 103752.

BIPV elements are exposed to two main categories of fire risks: those arising from the BIPV equipment itself and additional risks related to the potential amplification of fire due to the BIPV installation. BIPV modules share the same fire hazards as conventional PV systems, such as ignition from hot-spots, electrical arcing and installation errors. During the installation of BIPV elements, an accumulation of debris between the building envelope and the PV can occur, creating a significant fire hazard. Temperatures in this space can reach 90°C or higher, further exacerbating the risk of fire and presenting additional challenges. From the perspective of the insurance sector, BIPV systems are considered to carry a higher risk of fire due to the extensive number of electrical connections involved, particularly in application such as roof tiles PV.

Furthermore, BIPV elements can exacerbate fire spread due to the presence of combustible materials and the absence of protective layers between the PV components and the underlying roof structure. These factors increase the risks to building occupants, including obstructions to evacuation, falling debris and the release of toxic gases. Fire and rescue personnel may also encounter additional hazards, such as electric shocks and restricted access to the building.[9] These amplified risks contribute to heightened concerns among insurers regarding BIPV systems.

To limit fire risks, insurance companies have developed guidelines for standard PV. They recommend not to install PV on combustible roofs, select modules complying with international standards, approved by recognised testing laboratories and installation should follow applicable electrical requirements. They recommend the availability of a DC disconnector switch between the module and the inverter. There should be adequate access in case of fire, in accordance with applicable fire protection standards and local fire department should be familiarised with the PV installation. Regular inspections for maintenance should be undertaken regularly and by qualified professionals.[10] These recommendations apply to standard PV, some are still valid for BIPV.

OTHER RISKS

- Water damage due to a lack of watertightness is another risk identified by the insurance industry
- Other risks include natural hazards and building-related risks

Besides fire hazards, other risks have been identified by insurers for rooftop PV systems, including water damage, natural hazards and building-related hazards.[11] The IEA PVPS report "Quantification of Technical Risks in PV Power Systems" provides a detailed overview of PV failures, their main causes and origin and their impact on safety, performance and reliability of PV systems.[12]

Water damages due to a lack of watertightness have been identified as a major BIPV hazard. In 2013, the Agence Qualité Construction (AQC) published an inventory of the damage caused by rooftop PV installations in France between 2008 and 2012, based on 195 expert reports and found 114 water-related damage claims.[13] The identified primary causes of water damage were defects in the connections between support systems and the roof on existing buildings, with often poorly executed overlapping of tiles. Additionally, the AQC identified frequent non-compliance with technical recommendations during the installation of integration supports. A lack of maintenance further exacerbated the problems, as the accumulation of dust and leaves clogged drainage profiles, leading to water infiltration.

[9] Yang, Rebecca, et al. "Fire Safety Requirements for Building Integrated Photovoltaics (BIPV): A Cross-Country Comparison." Renewable and Sustainable Energy Reviews, vol. 173, Mar. 2023, p. 113112.
[10] Allianz Risk Consulting, Fire Hazard of Photovoltaic (PV) Systems, Tech Talk Vol 8, 2019 ; Axa, Property Risk Consulting Guidelines, Photovoltaics Systems, 2021 ; RSA, Risk Control Guide: Photovoltaic (Solar) Panels ; Zurich, Photovoltaic systems – Roof mounted, Property considerations for the peril of fire, 2016 ; Zurich, Photovoltaic (PV) systems on buildings (2023).
[11] Axa, Property Risk Consulting Guidelines, Photovoltaics Systems, 2021.
[12] IEA-PVPS Task 13, Quantification of Technical Risks in PV Power Systems, Report IEA-PVPS T13-23:2021 (2021).
[13] Agence Qualité Construction, Panneaux Photovoltaïques : état des lieux des pathologies, October 2013.

PV systems are vulnerable to natural hazards, such as hail, lightning, wind and earthquakes. These hazards can cause material damage to the systems, potentially leading to faults that may result in fires. Hail can crack panels, causing electrical shorts and fires, while unsecured arrays may loosen during earthquakes, short-circuit, and damage the roof or fall off.

Building-related hazards include roof overloading, insufficient design for panel weight, or wind effects. Building and structural related risks are less a concern for BIPV than for standard PV as BIPV elements are themselves building elements.

NEGATIVE EXPERIENCES AND HIGH DAMAGE CLAIMS

- Past negative experiences with BIPV installations have eroded the insurance sector's trust in BIPV solutions. Especially in France since the 2010s
- Fires tend to cause more extensive damage and result in higher insurance claims compared to other hazards

Interviews with stakeholders the insurance sector revealed that past negative experiences have significantly eroded the sector's trust in BIPV, leading to a pronounced reluctance to provide insurance coverage for such projects today. This was particularly the case in France where, in 2006, the government introduced various incentives, including doubling the feed-in tariff, offering a building integration premium, and increasing tax credits for renewable energy equipment to 50%. These incentives catalysed a rapid expansion in PV installations, including BIPV, by 2007. However, the surge in installations was accompanied by a sharp increase in insurance claims, particularly related to integrated PV systems. The Agence Qualité Construction (AQC) reported significant damage from PV installations in the 2010s, highlighting issues such as inadequate competence, non-compliance with recommendations, and poor maintenance. By approximately 2015, the mounting costs of claims, especially those related to fire damage and the recurrence of water damage issues, prompted insurers to withdraw coverage for BIPV installations. Despite technical advancements and approvals from bodies such as the Commission for Product Prevention (C2P), insurers remain cautious, evaluating BIPV projects on a case-by-case basis.[14]

Given the niche nature of the BIPV market and the wide range of available applications, a case-by-case approach appears to be the standard practice for insurance companies in Europe when assessing BIPV projects. It must be noted that France represents a unique example within Europe, as it is the only country to impose a ten-year civil liability ("responsabilité civile décennale") on all construction work. Nonetheless, the French experience offers valuable insights into the challenges faced by the insurance sector across Europe.

A few studies have been done on the topic of insurance for PV, showing the high value of claims related to fire damages. The ACQ report from 2013 found that repair costs are significantly higher for fire-related damages, generally amounting around 10 times the average cost of an installation.[15] In a more recent but non-European 2020 study, Verisk analysed insurance claims for residential and commercial PV systems in the United States from 2014 to 2019.[16] The study found that most claims (98%) were residential, but with higher values for commercial claims. Overall, the three most frequent causes of loss for claims involving solar equipment for both residential and commercial properties were hail (53% of all claims), wind (32%), and fire (8%). Other causes of loss included lightning, theft, vandalism, freeze (including ice and snow), animal damage, vehicle collisions, collapse, earthquakes, falling trees, food spoilage, and structural defects. While hail and wind accounted for a large number of claims, the losses per claim were typically modest, often involving some module breakage. In

[14] It must be noted that France has a unique mandatory decennial insurance system for the construction sector, covering structural integrity and fitness for purpose, including fire damage, areas often excluded in other European countries.
[15] Agence Qualité Construction, Panneaux Photovoltaïques : état des lieux des pathologies, October 2013.
[16] NREL, Insurance in the Operation of Photovoltaic Plants (December 2020).

contrast, fire resulted in fewer claims but caused higher losses, often resulting in the complete loss of the system.

As an electrical component, PV systems are susceptible to fire risks, which insurance companies consider a significant hazard. Fires tend to cause more extensive damage and result in higher insurance claims compared to other hazards. However, fire incidents involving PV systems are relatively rare, according to the study. The primary sources of damage to standard PV panels are weather-related events.

Having outlined the insurance sector's perspective on the risks associated with BIPV projects, with fire safety and water damage being key concerns, and highlighted the erosion of trust due to negative experiences in the early 2010s, the paper now shifts its focus to potential solutions. The next chapter explores recommendations aimed at improving the insurability of BIPV projects. These recommendations centre around addressing insurers' concerns through the standardisation of equipment, practices, and knowledge, providing a framework for fostering greater confidence in the market.

STANDARDISATION FOR BETTER RISK MITIGATION?

The negative experiences from the early 2010s and the associated perception of high risks have made the insurance sector increasingly cautious, and in many cases, reluctant to insure BIPV projects. However, significant advancements have been made in the BIPV and broader PV sectors since that time, encompassing improvements at the module, system, and installation levels. While it is essential for the industry to continue these advancements, it is equally important to effectively communicate these improvements to key stakeholders, particularly within the insurance sector, and showcase and demonstrate the professionalisation of the sector in order to create a common understanding and overcome challenges. This section discusses how standardisation, in a broad sense, of equipment, practices and knowledge can enhance the insurability of BIPV projects by addressing the concerns of insurers.

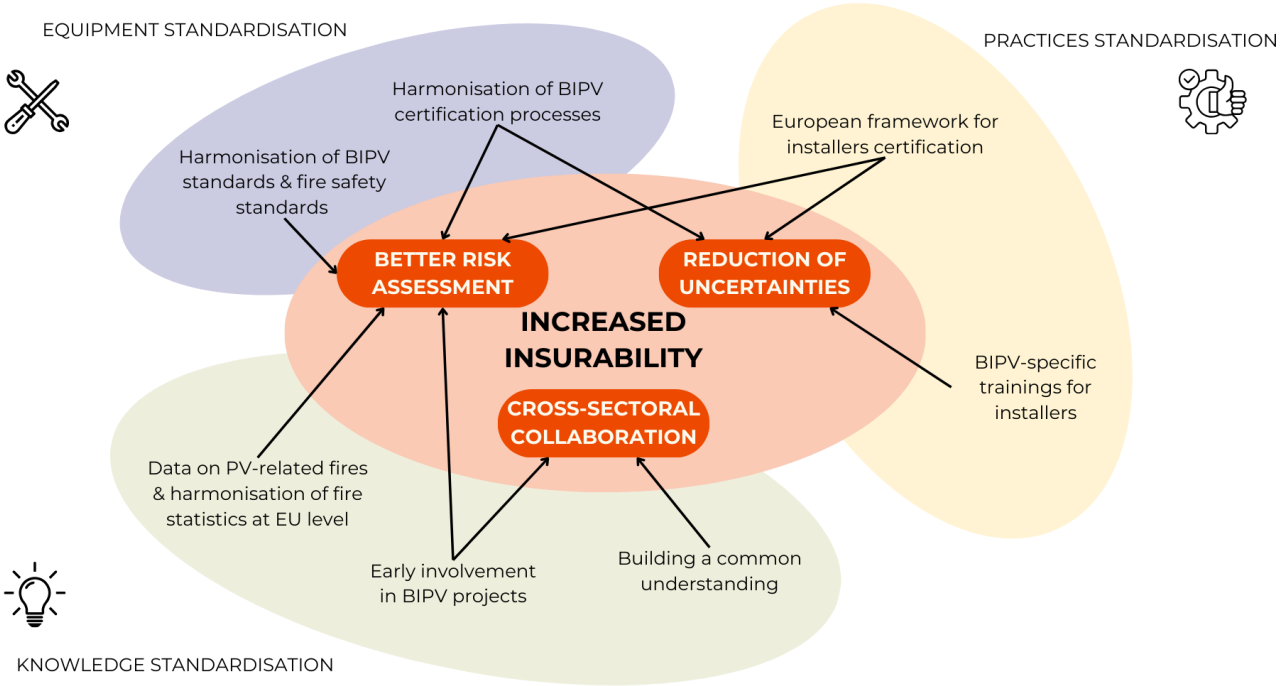

Figure 2: Overview of BIPV standardisations for better risk mitigation and increased insurability

EQUIPMENT STANDARDISATION: HARMONISATION AT EUROPEAN LEVEL

- BIPV certification processes and standards, especially dealing with fire safety, should be harmonised at European level
- Standardisation reduces uncertainty and mitigates risks for insurers
- It simplifies risks assessment and coverage determination, reducing the need for a case-by-case analysis

BIPV should comply with two different standardisation and regulation schemes, one derived from building requirements, which are often regulated by local building codes and international standards, and the other derived from PV electrical requirements.

As electrical components, BIPV elements must comply with relevant electrical requirements, most notably international standards for PV, IEC 61215:2021 parts 1 and 2, and IEC 61730:2021 parts 1 and 2, and the reference standard for BIPV which includes building and electrotechnical requirements, IEC 63092:2020 Part 1 and 2. Depending on the behaviour of BIPV in the building, other standards might apply. For instance, ISO/TS 18178:2018 applies for laminated solar photovoltaic (PV) glass for use in buildings, with technical specifications regarding appearance, durability, safety, test methods and designation. At European level, EN 50583 Part 1 (BIPV Modules) and 2 (BIPV System) apply. These European standards include references to the European Construction Products Regulation CPR 305/2011 on building elements and references to electrotechnical standards, such as the Low Voltage Directive 2006/95/EC/ and CENELEC standards. EN 50583:2016 is the only European standard on BIPV to date and is neither formalised and nor harmonised, as it remains voluntary.[17]

As building elements, BIPV products must comply with relevant national and local building codes and regulations. Every country has its own fire regulation guiding the fire performance of building elements where BIPV modules can be installed, such as external walls, roofs/skylights, windows and other openings, and ancillary element/attachment. However, the requirements differ in each country. Consequently, the lack of harmonisation in fire safety standards necessitates testing BIPV products in multiple countries, which increases development costs for manufacturers and brings uncertainty for investors, insurers and other stakeholders.[18]

In this complex regulatory environment, the BIPV industry faces significant challenges due to the lack of specific standards for its rapidly evolving solutions. Existing standards do not provide a clear definition of the requirements that should be evaluated for BIPV products, as they are based on methodologies from other sectors. PV-specific standards, designed for maximising energy production in PV modules, are not suitable for BIPV products as they do not consider architectural requirements. This makes the certification of BIPV products difficult. Additionally, the certification process is not harmonised, products must meet various requirements and tests from different sectors, making the process costly, time-consuming, and challenging. This cumbersome process slows down the development and market adoption of BIPV.[19]

Moreover, the high level of customisation in BIPV products means manufacturers must interpret and adapt standard testing procedures, with each variation requiring re-testing. Current certification schemes need to be adapted to accommodate the flexibility and customisation of BIPV products. The Seamless-PV project addresses these gaps in standards, particularly regarding mechanical, electrical, and fire safety. The harmonisation of BIPV standards, would be beneficial for the insurance sector, as it reduces uncertainty and helps mitigate risks.

[17] Seamless-PV, Analysis of regulatory frameworks applicable to IPV systems (October 2023), and Seamless-PV, Performance risks and identification of related gaps in current standardisation frameworks of IPV products (April 2024).
[18] Yang, Rebecca, et al. "Fire Safety Requirements for Building Integrated Photovoltaics (BIPV): A Cross-Country Comparison." Renewable and Sustainable Energy Reviews, vol. 173, Mar. 2023, p. 113112.
[19] Seamless-PV, Performance risks and identification of related gaps in current standardisation frameworks of IPV products (April 2024)

Nonetheless, different aspects need to be considered for standardisation of BIPV systems. With respect to safety standards, the only currently harmonised standard is IEC 61730, which primarily addresses electrotechnical aspects rather than specific building requirements. The standard that aims to integrate both electrotechnical and construction considerations, EN 50583-1 and -2, is currently under review but remains non-harmonised. This lack of harmonisation represents a significant barrier to BIPV uptake. Furthermore, there is no harmonisation of fire safety construction products at European level. In the context of fire safety, IEC 61730 specifies that fire requirements are determined by national or local building codes applicable to the installation site. This reliance on region-specific regulations constitutes an additional obstacle.

By adhering to a common standard, BIPV products are tested and certified for safety, performance and reliability, ensuring consistency across installations. This allows insurers to better assess potential risks and simplifies the evaluation process, making it easier to determine coverage terms, reducing the need for case-by-case assessments. Furthermore, established standards foster trusts in the technology, as insurers can rely on products meeting recognised criteria, ultimately lowering the likelihood of claims and encouraging more widespread coverage for BIPV projects.

PRACTICES STANDARDISATION: INSTALLATION AND TRAININGS

- Specific BIPV training for installer should be created, covering both electrical and building envelope (façade and roofing) competences
- A common European framework for installers certification should be created
- Specific trainings and certifications limit installation-related issues, thus reducing uncertainties from the point of view of insurers, enhancing the overall insurability of BIPV projects

A home insurance policy only covers liability losses for which the homeowner is legally responsible, including damages and injuries. It will not cover any damage to the house caused by installers or other third-party contractors, nor will it cover faulty installation of PV or subsequent breakdowns. Therefore, installers and contractors should have adequate insurance coverage, including a general liability and professional liability insurance. Professional liability insurance covers claims related to PV system design, consulting, engineering, or installation.[20]

As the market demand for BIPV increases, there will be a greater need for trained installers. This raises important considerations regarding the availability of qualified installers and their insurance coverage. Most PV installers do not have expertise in façade systems, solar tiles, and solar roofs. Conversely, façade builders and roofers often lack knowledge and experience in PV technology. Hence, creating dedicated training programmes for BIPV installers covering both electrical and building envelope competencies is essential to ensure adequate installations.

Furthermore, installer qualifications for BIPV systems vary significantly across different countries, with some having strict rules and other lacking regulations entirely. Few guidelines exist on the topic. Notably, CSTB published a Guide for installing PV systems for developers, project manager and companies in January 2024, covering both standard PV and integrated PV on roofs and façades.[21] This inconsistency creates a need for streamlined and clear standards for installation. Furthermore, poor installation practices not only compromise system safety and performance but also tarnish the reputation of qualified installers. Standardisation or a common European framework for certification would ensure better installation quality and consistency across the industry.

[20] NREL, Insurance in the Operation of Photovoltaic Plants (December 2020).
[21] CSTB, Guide pour installer des systèmes photovoltaïques à l'attention des aménageurs, maîtres d'ouvrage, maîtres d'oeuvre, entreprises (January 2024).

Specific BIPV training and certification are beneficial for the insurance sector as they ensure that installers possess the necessary expertise to carry out installations correctly, reducing the likelihood of errors that can lead to damage claims. Poor installation practices in the 2010s, which resulted in costly claims, undermined the insurance's sector confidence in BIPV. By certifying installers and providing specialised training, insurers can be more confident that industry professionals meet recognised standards of competence, thereby lowering the risks of installation-related issues. This, in turn, decreases the potential for claims and enhances the overall insurability of BIPV projects.

KNOWLEDGE STANDARDISATION: EXPERIENCE, SKILLS AND WORKFLOWS

- More data on PV-related fires is needed from fire fighters and local authorities and the harmonisation of fire statistics at the EU level should be facilitated
- Building a common understanding and framework between the BIPV and insurance sectors is essential
- Insurers should be involved in the early stages of BIPV projects to reduce uncertainties and enable proactive risk assessment
- Overall, cross-sectoral collaboration contributes to better risk assessment

BIPV technology is rapidly evolving. Hence, insurance companies are struggling to keep pace with the rapid changes in technology. In extreme cases, particularly with new technologies or insurance coverages that have limited historical loss data, initial estimates may differ significantly from actual losses. New technologies require consistent technical evaluation and underwriting expertise to benchmark them against previous iterations. As the speed of technology accelerates, keeping up with international standards and certifications presents ongoing challenges for risk consultants, engineers and underwriters. Insurers struggle to build their in-house expertise in line with the evolution and growth of the BIPV sector, impacting their ability to understand and confidently underwrite BIPV risks.

It is then essential to build a common understanding of BIPV systems between the sectors and establish a framework of cooperation that works for everybody. As underwriters gain experience with specific exposures, like those associated with PV systems, they can price coverage more accurately. They can also identify potential insureds who have favourable characteristics and lower risk exposures. Additionally, they can encourage insureds to take measures to reduce the likelihood or severity of losses, which helps lower premiums and improve profitability.

In turn, the BIPV sector should integrate the perspective of the insurance industry early in its projects. Market fragmentation is high in the value and supply chains of BIPV project and involves many stakeholders. It is difficult for stakeholders outside of the BIPV industry to navigate these complex frameworks and workflows and create an effective dialogue.[22] Hence, collaborative approaches are critical to support the uptake of BIPV and build a common understanding among stakeholders. As such, insurers should be involved in the early stages of a BIPV project, from its development to the construction phase, in case changes occur.

While fire hazard are a potential concern for both PV and BIPV systems, as with any electrical component, more data is needed from firefighters and public authorities to better understand the correlation between fires and PV installations, including BIPV systems, in order for insurance companies to be able to effectively assess risks. The origin of fire involving a PV system should also be researched in case of incident. Furthermore, it is essential to study not only the fire risks associated with BIPV but also the broader fire safety implication arising from the integration of PV with building structures.

[22] MC2.0, Value and Supply Chain Analysis (June 2024)

The availability of more fire data and closer collaboration between the insurance and BIPV sectors significantly enhance the insurability of BIPV projects. Currently, the nature and format of collected input data for fire statistics vary significantly across EU Member States. This variability poses an obstacle to data accuracy, analysis and the effective evaluation of potential best practices and safety approaches.[23] Facilitating the harmonisation of fire statistics at the EU level and enabling more robust analyses to enhance fire prevention and mitigation strategies for building fires is crucial for accurate analysis and informed decision-making regarding the assessment of building fires across Europe.[24] With robust fire data, insurers can better understand the specific risks associated with BIPV systems, enabling more accurate risk assessments and tailored coverage.

Finally, joint efforts to build a common understanding of BIPV technology also help align the perspectives of both sectors, ensuring that insurers are aware of advances in safety measures and installation practices. Involving insurance companies early in BIPV projects allows for proactive risk mitigation, such as recommending appropriate safety standards or design adjustments, which ultimately reduces the likelihood of damage and claims, making these projects more attractive for insurance coverage.

CONCLUSIONS AND RECOMMENDATIONS

- Insurance is essential for the successful advancement of BIPV projects, but there are significant barriers to coverage
- Fire safety, from both fire risks resulting from BIPV modules and additional risks related to fire amplification, and other risks, notably water damage are major concerns for insurers
- Negative past experiences have made insurers cautious about BIPV
- The harmonisation of BIPV standards, especially for fire safety, and their certification at European level can increase the insurability of BIPV by reducing uncertainties and simplifying risk assessment and coverage determination
- The standardisation of practices with BIPV-specific trainings and European certification for installer can increase insurability by demonstrating the professionalisation of the sector and by reducing uncertainties for insurers
- Knowledge sharing and cross-sector collaboration is essential to develop a shared understanding of the technology and risks, leading the tailored insurance solutions and better risk mitigation

Insurance plays a crucial role in the advancement of BIPV projects. Significant challenges have contributed to the insurance industry's reluctance to provide coverage for BIPV projects. Fire safety is a central concern for insurers, both fire risks resulting from BIPV modules and additional risks related to the potential amplification of fire due to the BIPV installation. Other risks have been identified for BIPV, such as damages from a lack of watertightness, natural hazards and building-related risks. Negative experiences have created a climate of caution among insurers, necessitating a strategic approach to restore confidence in this technology.

The paper proposes key recommendations to improve the insurability of BIPV projects by addressing insurers' concerns, with a focus on the standardisation of equipment, practices, and knowledge, with recommendations beyond the sole BIPV sector. The lack of harmonised BIPV standards in Europe is hindering the market uptake of BIPV. Standards harmonisation for BIPV equipment also has the potential to enhance the insurability of BIPV projects. It reduces uncertainties and establishes a

[23] Manes, Martina, *et al*. "Closing Data Gaps and Paving the Way for Pan-European Fire Safety Efforts: Part I—Overview of Current Practices for Fire Statistics." *Fire Technology*, vol. 59, no. 4, July 2023, pp. 1925–68.
[24] Manes, Martina, et al. "Closing Data Gaps and Paving the Way for Pan-European Fire Safety Efforts: Part II—Terminology of Fire Statistical Variables." *Fire Technology*, vol. 59, no. 4, July 2023, pp. 1969–2000.

foundation for safety and reliability that insurers can depend upon. The creation of dedicated training programmes for BIPV installers covering both electrical and roof competencies is essential to ensure adequate installations. European-level certification of installers would address a critical gap identified in past practices, minimising errors and potential damages claims from the point of view of insurance. Finally, fostering cross-sectoral collaboration between the insurance and BIPV sectors is essential for developing a common understanding of the technology and risks. By sharing robust data and insights, both sectors can align their interests, resulting in tailored coverage solutions that adequately address the unique challenges posed by BIPV installations.

Ultimately, by adequately engaging with the insurance industry, the sector can transform its approach to BIPV projects, facilitating greater adoption of BIPV technologies. This alignment not only benefits insurers through reduced risks and claims but also supports the broader uptake of BIPV solutions. As BIPV technology continues to evolve, the establishment of a collaborative framework between stakeholders will be paramount in driving forward the decarbonisation of the European building stock.

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6	IBS	Institute of Baltic Studies
7	ONYX	Onyx Solar Energy SL
8	Soltech	Soltech
9	Sunstyle	Sunstyle International
10	FOCCHI SPA	Focchi SPA
11	BECSA	Becsa Sociedad Anonima
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13	METABUILD	Metabuild GMBH
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15	AIE/ EuropeOn	Association Européenne de l'Installation Electrique
16	EPIA	SolarPower Europe
17	EBC	European Builders Confederation
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