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# A Comparison and Classification of BIPV Application for BIPV Products Selection

Buildings cause approximately 19% of energy-related greenhouse gas emissions, 32% of global final energy use and 51% of global electricity consumption [1]. To reduce the energy consumption from the building sector, Building-Integrated Photovoltaics (BIPV) is seen as one of the promising solutions to reach the concept of nearly-Zero Energy Buildings (nZEB). However, there are multiple obstacles that prevent the development and wide application of BIPV. One of the most discussed issues is the complexity of BIPV products, which makes it difficult for building designers and architects to select the best fit BIPV products for their projects [2]. To improve the application of BIPV technologies, a clear and accurate BIPV system classification is the foundation to match BIPV products to their most suitable building element.

While the classification of BIPV system looks like a straight-forward task to distinguish everything between roof and façade, it is inaccurate and can at times be misleading for BIPV designers. As a result, the PV community has not reached a consensus about a standard categorization of BIPV applications [3]. There are four types of BIPV mainstream upper-level classifications exist in the academic field [3-11]. However, none of them meets the requirements for all types of BIPV application under a unified structure. Some of them are not appropriately dealing with externally integrated devices, and the others are not appropriately handling the interior accessibility of the BIPV products. Besides the problem of lacking a standard BIPV application structure, lacking standard terminologies and leading to confusion when the same terminology is used in the building component area and again in the BIPV product area are the other two critical reasons for complexity and confusion in BIPV system classification.

In order to address these existing problems, this paper conducted a literature review across BIPV standards, industry reports, journal articles and websites regarding BIPV classification. Through comparing existing BIPV classification structures, giving definitions for commonly used terminologies, and creating a typology for all defined terms, this paper proposes a newly built BIPV application typology, which covers most commonly used application types with clearly defined terminologies.

As a result, this study proposes a new BIPV system typology based on EN 50583 to facilitate the selection of appropriate BIPV products. In the proposed typology, all BIPV applications can be categorized into roof, façade and externally integrated devices. Under the roofing category, cold roof, flat & curved roof and skylight are the three main types of classifications for the BIPV system. For the façade application, rain-screen façade, spandrel panel, double-skin façade, curtain wall and window are the primary building elements which can imply BIPV systems. Furthermore, the group of the externally integrated device is less considered by the other BIPV typologies, while our proposed BIPV system typology considers balconies, canopy, louvres and parapets under externally integrated devices. The significant difference between our proposed BIPV system typology and others is that our proposed structure distinguishes internal accessibility, as required by EN 50583 [11]. As the accessibility of the product would have a great impact on the BIPV project at the installation stage, the designer should put it into consideration at the beginning of the system design. Moreover, to solve the issue of mix use of different types of terminologies, this classification distinguishes building components and BIPV products into two layers with a clear boundary. Furthermore, the explanation and definition of each component are provided to define the scope of each term.

This study can bring valuable insight into the implementation of BIPV products. First of all, this study can facilitate and improve the accuracy of language in BIPV related descriptions. Since the construction industry uses a number of terminologies with highly similar meanings, a group of defined terminologies can help industry participants to exchange information with little or no confusion. Secondly, this study can create a foundation for further BIPV product database developments. A localized BIPV product database plays a vital role to promote the implementation of BIPV projects [12]. A well-defined BIPV system typology is the precondition to building the database. Thirdly, this study can facilitate the optimization of BIPV related standards and regulations. The lack of standards and the regulatory discrepancies between countries prevent manufacturers and installers from reaching the necessary economies of scale [2]. A clearly defined BIPV system typology can help manufacturers and installers follow the same BIPV system classification, which would eventually facilitate the wide application of BIPV products.

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