A Comprehensive Review on the Cost Reduction and Uptake of BIPV through the Integration of PV and Prefabricated Building Industries

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“BIPV can be defined as a PV module and a construction product together, designed to be a component of the building. A BIPV product is the smallest (electrically and mechanically) non-divisible photovoltaic unit in a BIPV system which retains building-related functionality. If the BIPV product is dismounted, it would have to be replaced by an appropriate construction product” (IEA Task 15, 2018)
Introduction

• BIPV have unique benefits in comparison to BAPV such as,
  • Providing an iconic architectural design
  • Executing the main functions of a building envelop material
  • Improving indoor thermal comfort and reducing the building energy demands
  • Providing adequate daylight illuminance with daylight-dimming capability

• The total annual BIPV installation capacity is less than 1 MW in Australia during the last 5 years.

• The real contribution of BIPV to PV market up until 2018 is 2.3 GW (approximately 1%) (Osseweijer et al., 2018).
Introduction

Reasons for slow BIPV uptake

- Lack of economic confidence in the building sector
  - Limited soft cost reduction
  - Expensive hardware
- Lack of understanding and collaboration between the PV and building industries
  - PV manufacturers are not involved in the building design process
- Lack of BIPV specific regulations
  - Building permit and approval
  - Building codes and standards
Aim:
This research aims to evaluate the mechanisms driving the cost reductions and deployment of prefabricated BIPV.

Objectives:

• Mapping the BIPV hardware and soft costs
• Presenting BIPV cost reduction potentials and deployment drivers in a single platform
• Evaluating how BIPV costs have been reduced in the past and how they can be further reduced in the future

We intend to Learn from the past to create a stable market for BIPV systems
1. BAPV-BIPV Comparison

Source: James et al. (2011)
2. BIPV- Conventional Building Materials Cost Comparison

Source: PV Sites (2016)
PV Module Costs

- The rapid decline of PV module trading prices from early 2011 to early 2015.
- The cost difference between crystalline modules and thin film modules are significantly high until 2015 and afterwards become insignificant.
- BIPV hardware costs are not always economical. E.g.: BIPV roof modules vs. conventional roof tiles
- BIPV can be an expensive option depending on the building design and the aesthetic requirements.
BIPV Hardware Cost Reduction Potentials

- Automated manufacturing and process optimization
- Resource utilization
- Mass production and bulk purchasing of raw materials
- Continuous research and development (R&D)
- Government support
- Minimise capital expenditure

PV Module Cost Reduction
Source: IRNEA (2018)

Cost Reduction of Lithium-ion Batteries
Source: IRNEA (2017)
A significant reduction cannot be evidenced in PV/BIPV soft costs over last few years.
BIPV Soft Cost Reduction

• BIPV specific design tools and software
• Having a common decentralized platform specific to BIPV designing (similar to BIM), communication and information sharing which can integrate the stakeholders
• Integrating PV and prefabricated building industries for a comprehensive planning and design process
• Decentralized information sharing platform for supply chain management (RFID and blockchain-based supply chain management)
• Increasing market transparency
• Knowledge enhancement
• Well-trained labour and professionals
• Through supervision
• BIPV specific building codes, standards, legislation and policies
Most of these BIPV deployment drivers have currently been executed to some extent; nevertheless, the real contribution of BIPV to PV market has not exceeded more than 2%.
Integration of PV and Prefabricated Building Industry

Prefabricated Building Industry

• A sustainable construction method which manufactures building elements/parts/modules in an offsite manufacturing plant

• Provides a number of benefits such as reduced material wastage, high quality production, fast onsite assembly, easy dismantling and compatible reuse

• Cost reductions due to energy efficient manufacturing, limited labour usage in assembling, limited time consumption for project completion, standardized design and avoiding weather extremes during construction
Integration of PV and Prefabricated Building Industry

Source: Adapted from Hickory (2018); RIBA (2017)
BIPV Deployment Drivers

Integration of PV and Prefabricated Building Industry

Preparation, Brief and Tendering → Project team induction and initial planning → Concept design and architectural validation → Detail design → Procurement and Technical design (shop drawings)

PV integrated prefabricated building participates in the process
Reviews module breakup parameters against logistic plan
Reviews BIPV module integration parameters against module breakup

Documentation and project commencement

Manufacturing → Manufacturer’s procurement and preparation of BOM
Module and assembly drawings
BIPV integrated prefabricated element modelling

BIM/Parametric Modelling

Delivery to site and installation

Design
Manufacturing
Installation

Building elements
BIPV modules
Optimal BIPV and prefabricated building element integration

PV Integrated Prefabricated Building Industry
• BIPV system costs include hardware costs such as PV modules, inverters and batteries and soft costs such as design, installation, PII and O&M.

• Even though, the hardware costs experienced a significant reduction, soft costs remain unchanged/ slightly reduced.

• BIPV soft costs can be reduced mainly by ensuring effective stakeholder collaboration, introducing BIPV specific design tools and legislation.

• Soft cost reduction, government support and introducing BIPV specific business models accelerate BIPV uptake.

• Nevertheless, the contribution of BIPV to PV market has not significantly increased.

• This study recommends integrating PV and prefabricated building industries to accelerate the BIPV uptake by eliminating the lack of understanding.

  • Participation of PV manufacturer in building design process
  • Builders partnering with PV manufacturers to deliver a specific BIPV design system
  • PV integrated prefabricated building construction


THANK YOU

Questions?