University of Applied Sciences and Arts
of Southern Switzerland

SUPSI

IEA PVPS

20TH ADVANCED BUILDING SKINS

BIPV Characterization, Performance and Reliability

Fabio Parolini, SUPSI (CH)

20th Advanced Building Skins Conference & Expo - 03-04 November 2025, Bern, Switzerland

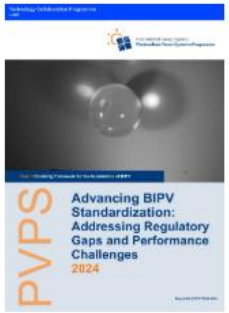
IEA Photovoltaic Power Systems Programme

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

- **(BIPV) Integration: solar modules embedded in building elements, façades, roofs, or windows, combining energy generation and architectural function.**
- **Potential: BIPV façades offer high technical and economic value for solar energy in buildings.**
- **Challenges: need for improved testing under real conditions (fire, temperature, shading) to ensure long-term durability.**

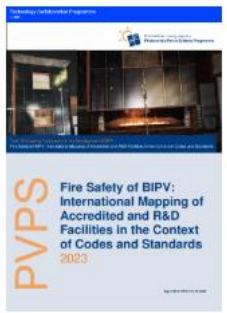
TASK – 15

Multifunctional Characterisation of BIPV



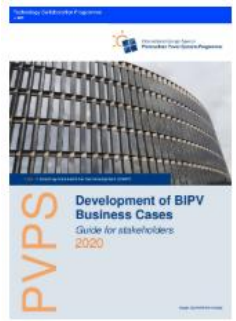
TASK – 15

Advancing BIPV Standardization: Addressing Regulatory Gaps and Performance Challenges



TASK – 15

Fire Safety of BIPV: International Mapping of Accredited and R&D Facilities in the Context of Codes and Standards 2023



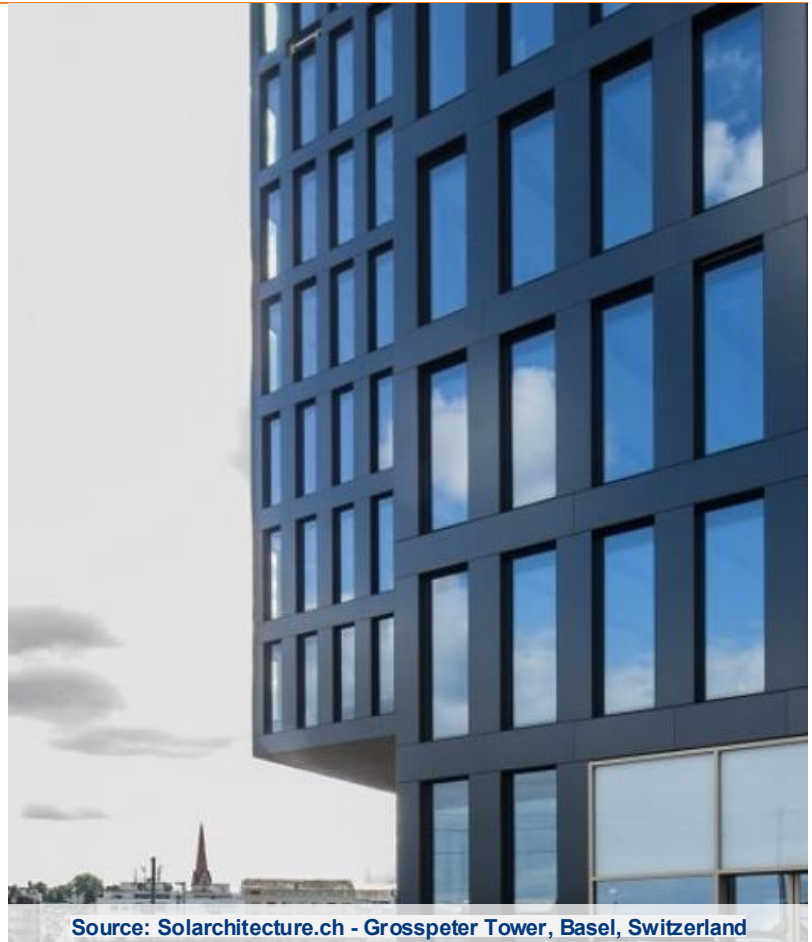
TASK – 15

Development of BIPV Business Cases - Guide for stakeholders

Connecting Research, Regulation, and Design

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

- Pre-normative research enables reliable and harmonized BIPV standards.
- Testing insights drive innovation in safe and expressive façades.
- Bridging the lab and design: from performance data to real buildings.
- Standardization as an enabler for creative, scalable solar architecture.



Source: Solarchitecture.ch - Grosspeter Tower, Basel, Switzerland

BIPV as an Enabler for Sustainable Architecture

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

Source: Multipurpose Center, Pregassona, Switzerland

Buildings as active energy generators, not passive envelopes.

BIPV merges energy production + architectural function.

Integrate innovation into safety and regulation driven sectors.

PVPS

From Research to Real Façades

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

- **Research outcomes**
Guiding integration of solar materials into façades

- **Testing results**
Design parameters for real projects

- **Innovation**
Regulation as enabler of design freedom

Source: SUPSI PVLab: impact test with soft body impact

Source: BIPVBOOST Demo site - Residential building, Morbegno, Italy

BIPV boost

This project has received funding from the *European Union's Horizon 2020 research and innovation programme under grant agreement* N° 817991

PVPS

The Dual Nature of BIPV

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

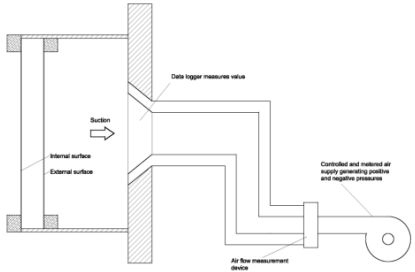
REHOUSE
Co-funded by the European Union

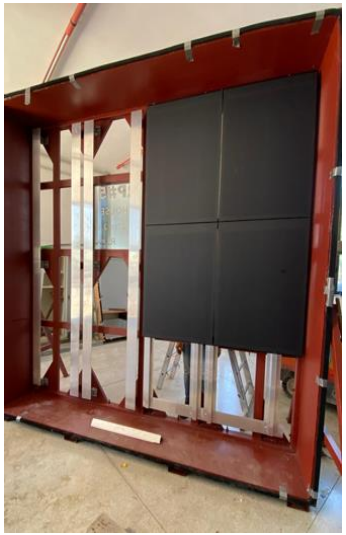
BIPV is both an electrical and a construction product, unique in the building industry.

Requires compliance with IEC (electrical) and ISO/CEN (building) standards.

Project funded by
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

Source: SUPSI PVLab - flash test and IV curves



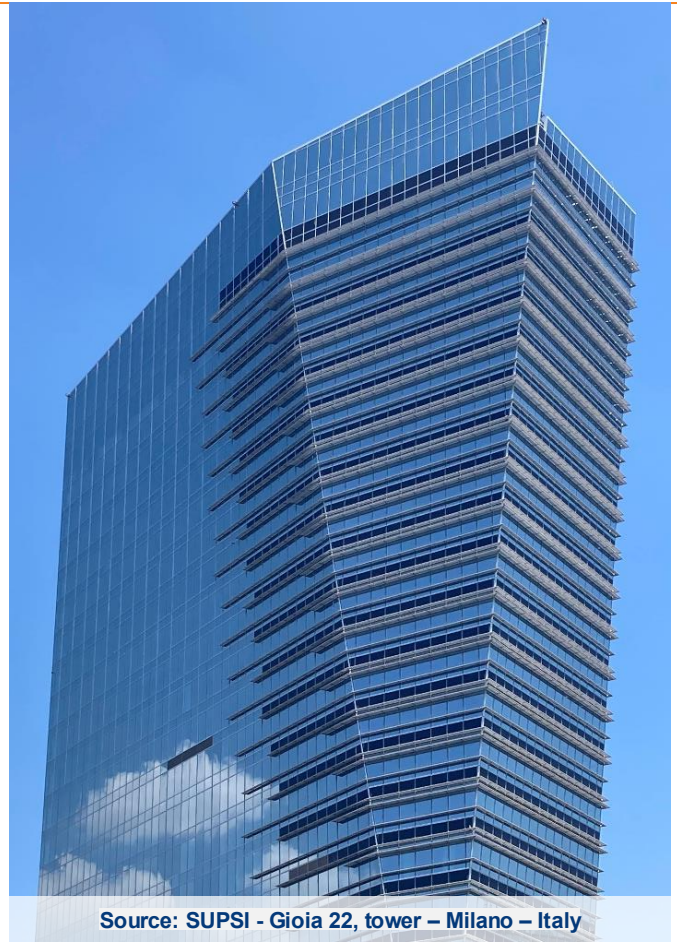


Source: RI SPA – wind suction and pressure load test

PVPS

Why Façades Matter

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

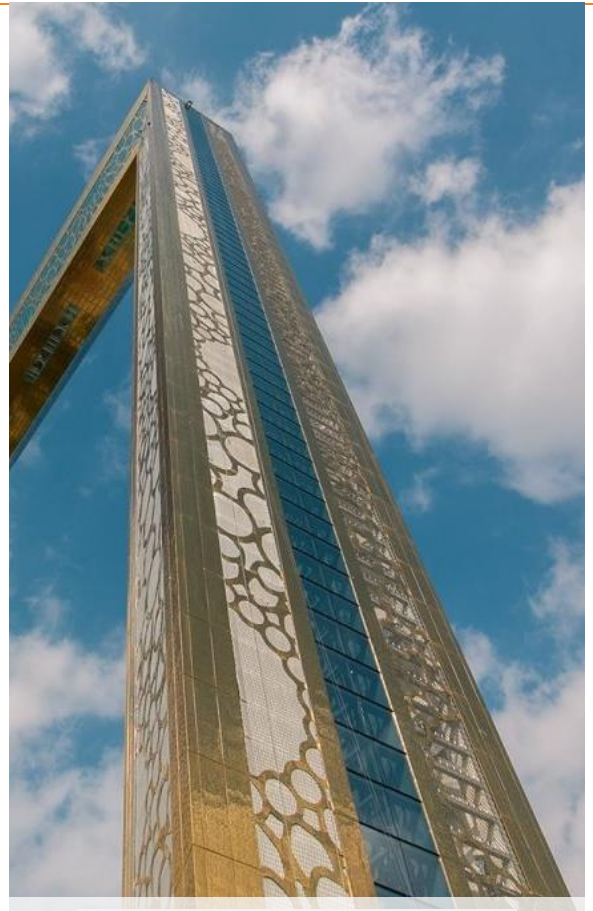


Source: SUPSI - Gioia 22, tower – Milano – Italy

- **Façades represent the largest potential surface for urban PV integration.**

Why Façades Matter

University of Applied Sciences and Arts of Southern Switzerland
SUPSI



Source: Guardian glass - The Dubai Frame

- Façades represent the largest potential surface for urban PV integration
- **Façades shape architecture, express its language, and bring a strong aesthetic impact.**

Why Façades Matter

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

Source: SUPSI – V.Le Restelli – Milano - Italy

- Façades represent the largest potential surface for urban PV integration.
- Façades shape architecture, express its language, and bring a strong aesthetic impact.
- **Façades must combine safety, durability, and resilience, performing under mechanical loads, weather exposure, and fire conditions.**

PVPS

Safety and Reliability of BIPV

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

Building product →

Local rules, such as CPR (EU) or other national rules

+ Active electrical part →

International and local rules, such as IEC 61730 and the Low Voltage Directive (EU)

BIPV = Building product with active part

Deep impact on normative use, retesting, and double certification

PERFORMANCE-BASED APPROACH - LIMIT STATES - POST-BREAKAGE BEHAVIOR

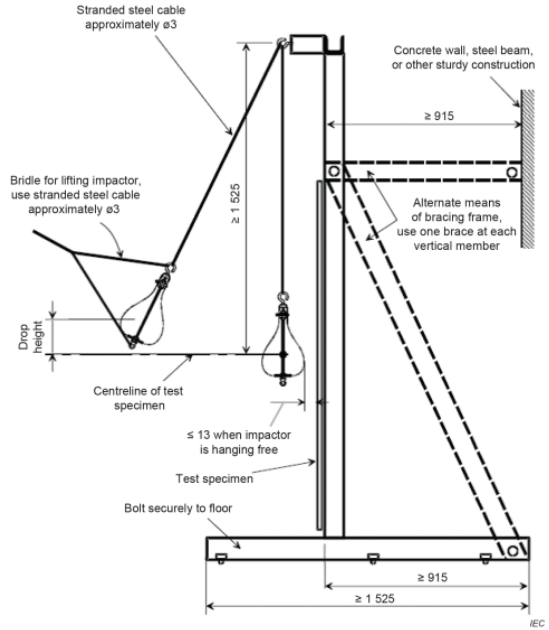
Source: SUPSI PVLab - movable shading mask – mechanical load test – Impact resistance test

PVPS

Performance-Based Testing Approach

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

Moves from prescriptive (fixed rules) to performance-based (functional targets).



Source: IEC 61730-2 - 10.21 Module breakage test MST 32

Source: SUPSI PVLab – Soft body impact to simulate human body impact

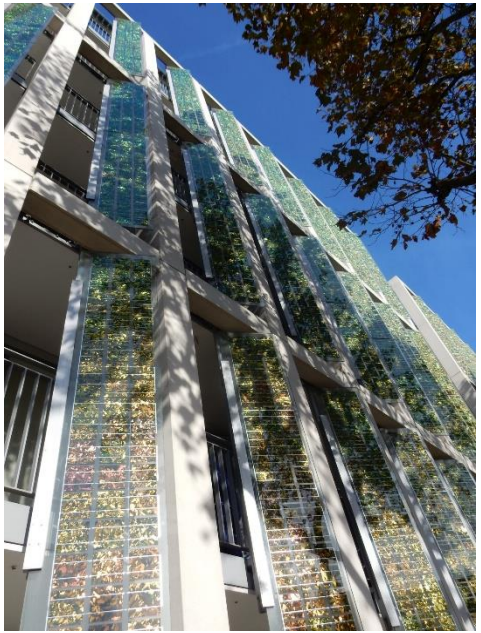
PVPS

Performance-Based Testing Approach

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

Reflects real conditions of façade integration (temperature, loads, moisture, shadows).

Source: Solarchitecture – JOM Architekten GmbH / Angelo Brack – Egga building, Davos, Switzerland



Source: SUPSI – Kingsgate House, Chealsea, London, UK

Limit states

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

BIPV-Serviceability limit state (SLS)

"BIPV product under a frequent use condition can change its behaviour/condition but it must remain reliable and functional for its intended use without damage"

BIPV- Safeguard limit state (SfLS)

"BIPV under a rare event may suffer permanent damage but it must ensure safe user evacuation for people and things. It does not maintain the initial functionality".

BIPV-Ultimate limit state (ULS)

"BIPV collapses in a performance mechanism. Safe conditions are no longer guaranteed".

Source: SUPSI PVLab – Impact test in climatic room with different temperatures

Limit states

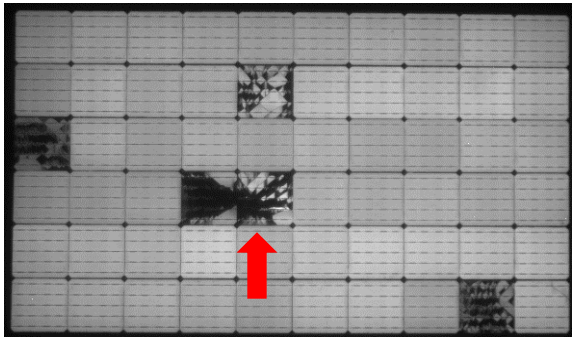
Source: SUPSI PVLab – Impact test in climatic room with different temperatures

This project has received funding from the *European Union's Horizon 2020 research and innovation programme under grant agreement* N° 817991

Limit states

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

Source: SUPSI PVLab – Impact test in climatic room with different temperatures

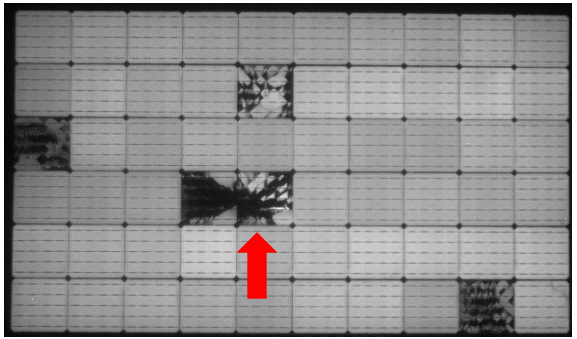


Temperature impact @ 25° C – glass breakage

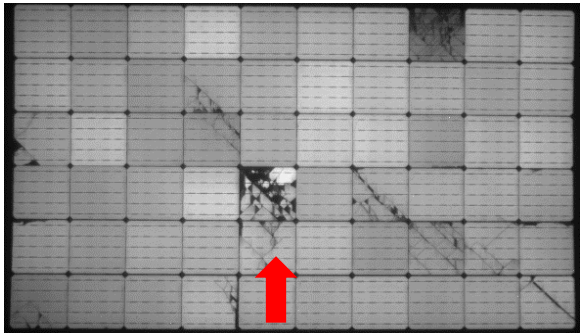
This project has received funding from the *European Union's Horizon 2020 research and innovation programme under grant agreement* N° 817991

Limit states

Source: SUPSI PVLab – Impact test in climatic room with different temperatures



Temperature impact @ 25° C – glass breakage

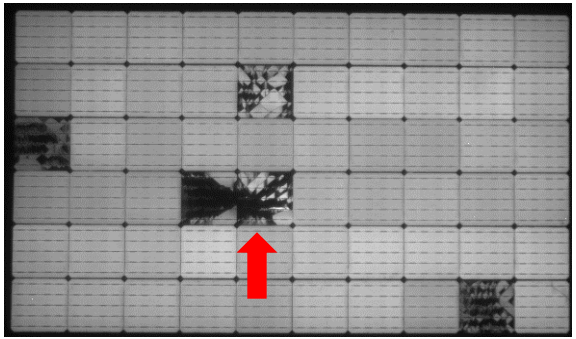


Temperature impact @ 90° C – glass breakage

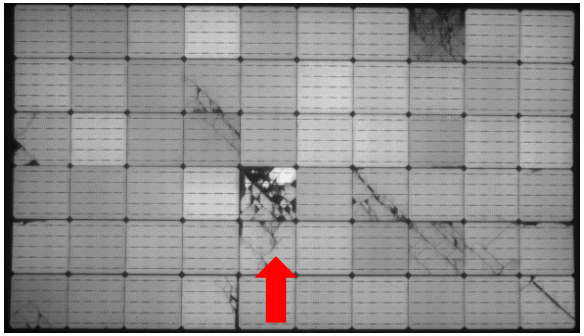
This project has received funding from the *European Union's Horizon 2020 research and innovation programme under grant agreement* N° 817991

Limit states

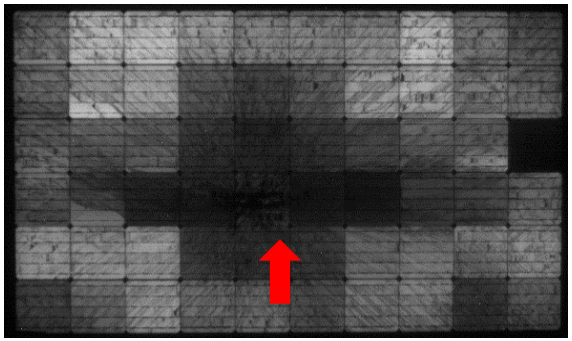
Source: SUPSI PVLab – Impact test in climatic room with different temperatures



Temperature impact @ 25° C – glass breakage



Temperature impact @ 90° C – glass breakage

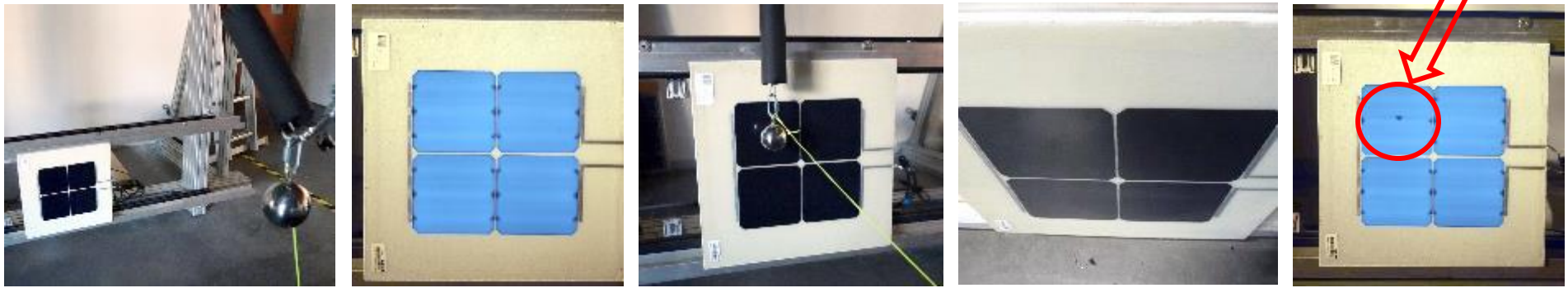


Temperature impact @ -25° C – NO glass breakage

This project has received funding from the *European Union's Horizon 2020 research and innovation programme under grant agreement* N° 817991

Limit states

University of Applied Sciences and Arts of Southern Switzerland
SUPSI



Source: SUPSI PVLab – hard body impact test sequence

Seamless-PV

Co-funded by the European Union

Project funded by

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

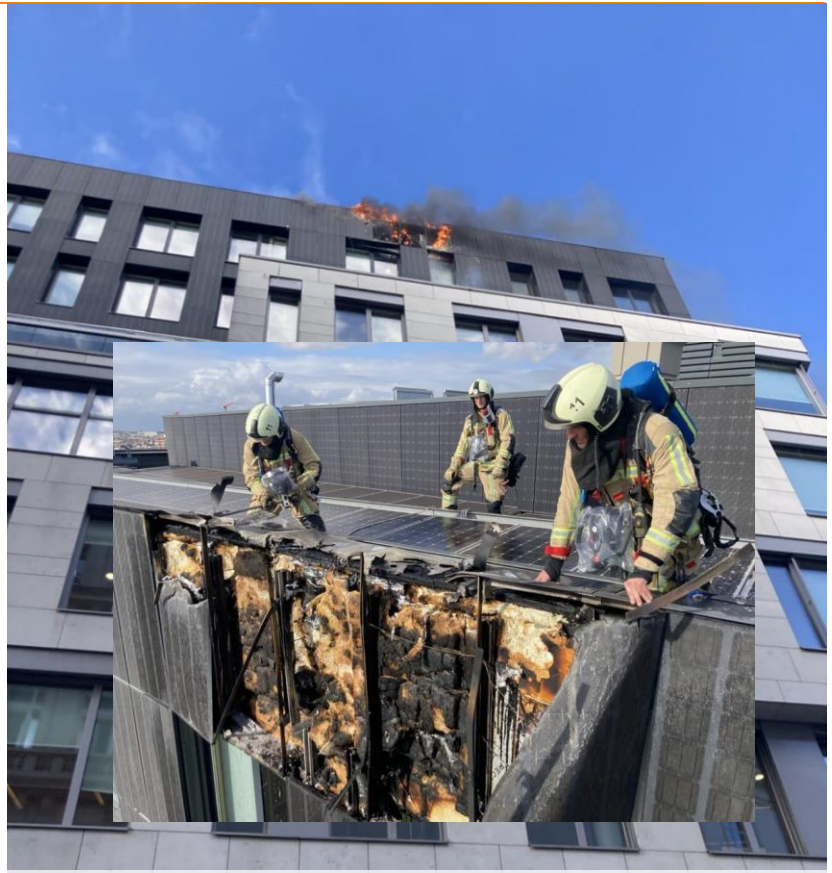
Environmental Performance

Source: IEA PVPS Task 15 – Advancing BIPV Standardization: Addressing Regulatory Gaps and Performance Challenges - Large-scale rotatable box for rain and wind tightness testing of sloping building surfaces (RAWI box) - A. Fedorova, B. P. Jelle, B. D. Hrynyszyn, and S. Geving, "A testing methodology for quantification of wind-driven rain intrusion for building-integrated photovoltaic systems," *Build Environ*, vol. 199, Jul. 2021, doi: 10.1016/j.buildenv.2021.107917

Fire safety requirements

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

Source: SUPSI – SBI test in Istituto Giordano (IT)



Source: Brussel Fire Brigade / The Brussels Times - https://www.brusselstimes.com/

PVPS

Conclusion & Key Impact Areas

University of Applied Sciences and Arts of Southern Switzerland
SUPSI

- Product innovation → development of safe, tested BIPV components
- System integration → façade-level performance and reliability
- Standardization → pre-normative research enabling harmonized testing
- Market adoption → simplified pathways and trust in BIPV solutions

BIPV must be seen as a building system, not just a product.

Considering the whole façade behavior is key to safety, performance, and the best design.

PVPS

Source: Copenhagen International School - Jens Cederskjold from København S, Danmark

Thank you for your attention

Fabio Parolini
fabio.parolini@supsi.ch

IEA PVPS

University of Applied Sciences and Arts of Southern Switzerland

SUPSI