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IEA PVPS Task 15 Subtask C BIPV Guidebook

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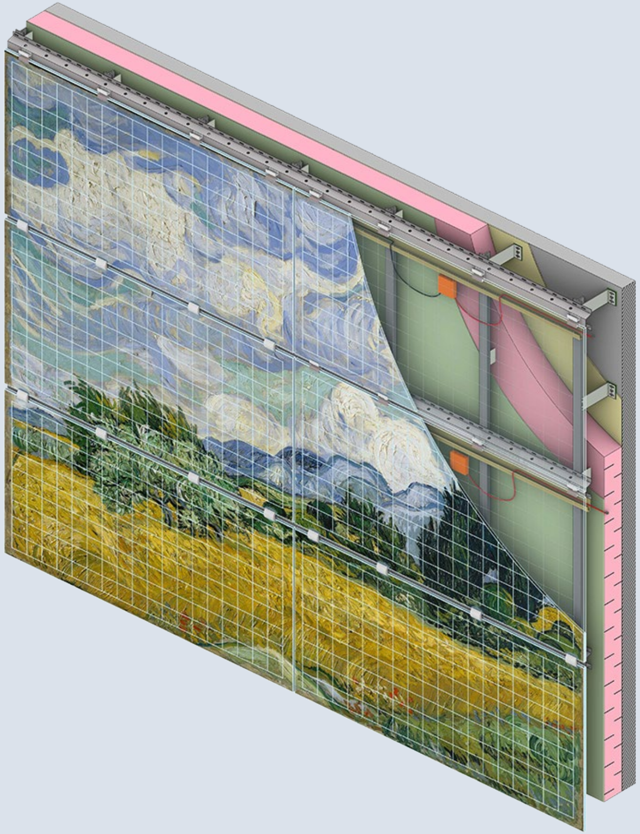

Subtask C: BIPV Guidebook

Objectives

- Consolidate existing BIPV industry knowledge;
- Support the implementation of best BIPV practices (for new and retrofit buildings);
- Drive the decision-making process that could lead to an effective BIPV design & a robust BIPV installation.

Deliverables

- Produce a BIPV guidebook with the complete pathway from BIPV design to installation, operation, maintenance & safety.

Target Groups

- Building professionals: architects, engineers, consultants and PV installers

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Subtask C: BIPV Guidebook

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Foreword

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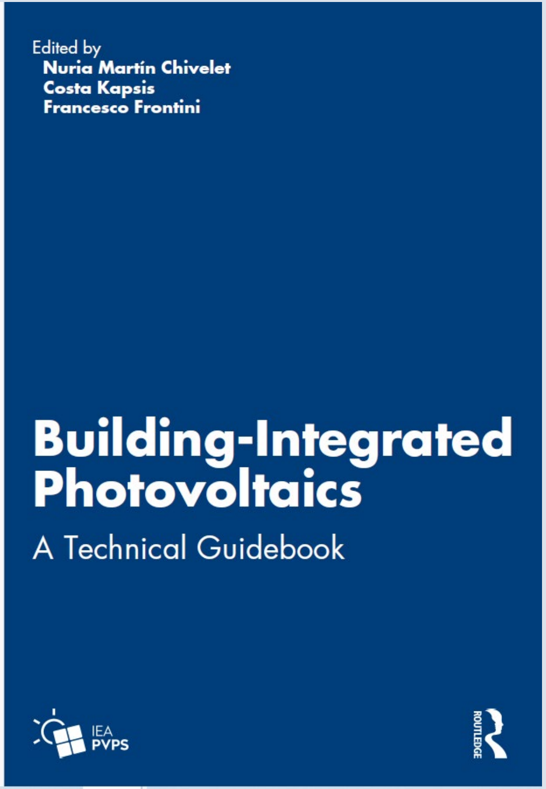

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Subtask C: BIPV Guidebook

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BIPV APPLICATION CATEGORIES

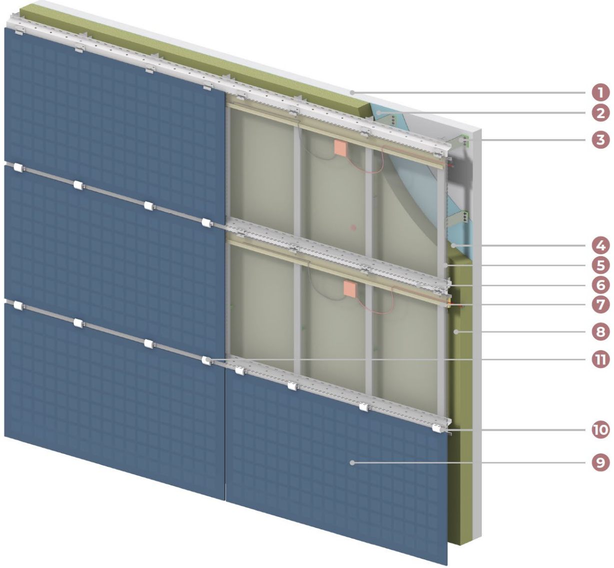
- Rainscreens
- Curtain Walls
- Roofs
- Skylights
- Solar Shading
- Canopies & Shelters

DESIGN ASPECTS ADDRESSED

- General Considerations
- Structural
- Hygrothermal Performance
- Fire Safety
- Electrical
- Architectural
- Sustainability & Circularity

BIPV Rainscreens

1. Load bearing backing wall
2. Water/air barrier, adhered membrane or spray applied
3. Wall bracket, thermally-broken
4. Thermal insulation, mineral wool
5. Vertical substructure rail
6. Horizontal substructure girt
7. Cable management tray
8. Drainage/air flow cavity, 80 mm or more
9. BIPV module, frameless
10. Pressure plate
11. Pressure cap
12. BIPV module junction box and DC cables



General: A BIPV rainscreen can be a cost-effective envelope solution for both new-build and retrofit projects. Its design considerations align with those of conventional rainscreen systems, supplemented by electrical and fire safety requirements [8].

Structural Design: The BIPV rainscreen must be engineered to endure and transfer both dynamic and static loads to the load bearing backing wall ①, in compliance with the local building codes. These primarily include the dead load resulting from the weight of the BIPV modules and sub-frame members, as well as dynamic wind loads. The connections between the brackets ③ and the vertical rails ⑤ are typically made with self-drilling screws or bolts and nuts, using fixed or sliding points. The sliding points are used to allow thermal expansion of the rails. The BIPV modules ⑫ can be mounted on the horizontal rails ⑥ using visible compression fittings ⑩ or concealed anchors adhered to the rear side of the BIPV modules. BIPV rainscreens tend to be drained and ventilated with open joints between modules to increase rear air flow while also allowing thermal expansion of the modules. When using a steel structure (galvanized or stainless) with framed BIPV modules, it is important to avoid electrical contact between metals and prevent galvanic corrosion of the anodized aluminium frame. This is not of concern with frameless BIPV modules.

Hygrothermal Performance: The BIPV cladding plays the role of the primary water barrier, deflecting most of the direct rain. A rainscreen cavity ⑧ allows any penetrating moisture to drain or evaporate and vent to the outside. The rainscreen cavity should be on average 100 mm or more to ensure adequate natural air flow for the BIPV modules and avoid overheating. Parapet and drain flashing should permit air flow while the installation of a permeable insect screen at the top and bottom course of rainscreen is recommended. An additional water/air barrier ② is applied (e.g., adhered membrane or spray applied) on the exterior face of the backing wall to eliminate any further water ingress and ensure an airtight construction. If required, electrical conduit penetrations should be used to bring the DC wiring from the rainscreen to the electrical room, using a flexible silicone grommet that offers an airtight and watertight seal, while also allowing the conduit to move without compromising the seal. The choice of thermal insulation ④ material and thickness depends on local building codes, fire safety regulations, and sustainability needs. Thermally broken brackets ③ should be used to reduce thermal bridging.

Fire Safety: The use of non-combustible insulation (e.g., mineral wool) is advised to reduce or prevent fire propagation through the rainscreen cavity. The use of fire barriers with an intumescent strip installed across the cavity can be an additional fire and smoke control practice.

Electrical Considerations: Effective cable management and labelling ensure BIPV rainscreen longevity. The use of cable trays ⑦, clips, and ties can help secure the wiring, prevent mechanical stress, and avoid abrasion from sharp corners and movement due to wind or other vibrations that could damage wiring or connectors. The connectors should have a minimum rating of IP 65 while the DC cables should be installed to avoid induction loops that can generate significant magnetic fields. When possible, the modules should be connected in a leapfrog fashion (vs daisy chain wiring). Façade shading should be accounted for during the string design. When applicable, low-profile pressure caps ⑪ are recommended to avoid casting shadows to the BIPV modules under high solar incidence angles.

Architectural Considerations: The use of coloured BIPV enables architects and designers to seamlessly integrate solar panels into the building's design, as the BIPV rainscreen can be customized to match or complement the building's colour scheme and architectural style, creating visually appealing and innovative structures that stand out while still being sustainable. When the BIPV rainscreen is susceptible to impacts or damage, protection can be ensured by taking precautions like installing the modules at least 0.8 m above the ground or above the wall skirting.

Sustainability: The BIPV rainscreen should be engineered to last for at least 35 years with future reuse in mind. Designing an adaptable sub-frame that accommodates different types of modules, enables the building envelope to adapt to changing technologies or aesthetic preferences. The system design should also consider ease of maintenance. Components that require periodic maintenance or replacement should be easily accessible without disrupting building operations.

Manitou a bi Bii daziigae

PROJECT DESCRIPTION	
LOCATION	Winnipeg, Manitoba (49° 53’4” N)
USE	Academic
PV PRODUCER	SolarLab
ARCHITECT	Diamond Schmitt Architects and Number TEN Architectural Group
ENGINEER	SolarLab, SMS Engineering, Crosier Kilgour
INSTALLER	Flynn

PROJECT CHARACTERISTICS	
ANNUAL HORIZONTAL SOLAR IRRADIATION	1.37 MWh/m2
KÖPPEN CLIMATE CLASSIFICATION	Humid continental – Dfb
BIPV APPLICATION	Rainscreen
TYPE OF CONSTRUCTION	New
PV TECHNOLOGY	Opaque coloured mono-Si (BIPV), Bifacial mono-Si (rooftop)
BIPV ARRAY NOMINAL POWER	94 kW (BIPV), 54 kW (rooftop)
ANNUAL ELECTRICITY GENERATION PER BIPV MODULE AREA	112 kW/m2
ANNUAL ELECTRICITY GENERATION	80 MWh (BIPV) + 89 MWh (rooftop)

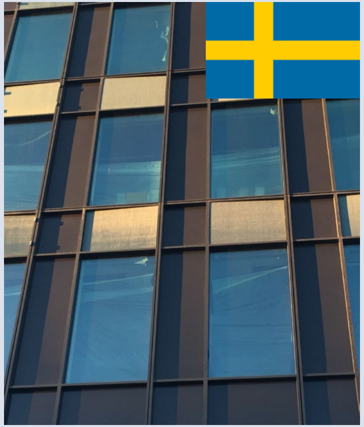
Fanshawe College Innovation Village

PROJECT DESCRIPTION	
LOCATION	London, Ontario (42° 59′ 1″ N)
USE	Research Facility
PV PRODUCER	SolarLab
ARCHITECT	Diamond Schmitt Architects
ENGINEER	SolarLab, German Solar & Smith +Andersen
INSTALLER	German Solar

PROJECT CHARACTERISTICS	
ANNUAL HORIZONTAL SOLAR IRRADIATION	1.5 MWh/m^2
KÖPPEN CLIMATE CLASSIFICATION	Humid continental- Dfb
BIPV APPLICATION	Rainscreen
TYPE OF CONSTRUCTION	New
PV TECHNOLOGY	Opaque coloured mono-Si
BIPV ARRAY NOMINAL POWER	174.9 kW
ANNUAL ELECTRICITY GENERATION PER BIPV MODULE AREA	263 kWh/m^2 (for active cell area only)
ANNUAL ELECTRICITY GENERATION	123 MWh (façade only)

BIPV Curtain Walls

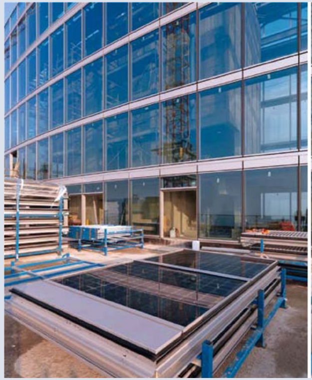
NCC Headquarters

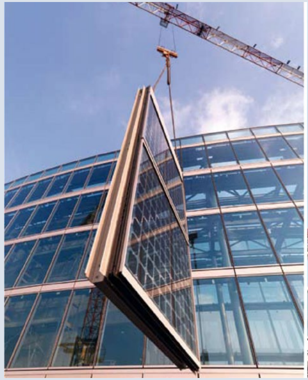
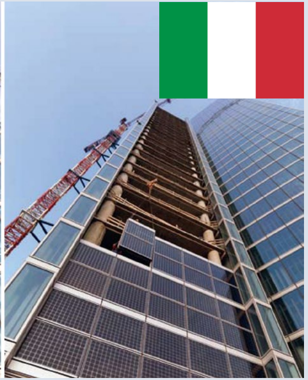


PROJECT DESCRIPTION	
LOCATION	Solna, Sweden (59° 22′ 0″ N)
USE	Office
PV PRODUCER	NCC
ARCHITECT	Cenit Vision by ISSOL
ENGINEER	White Arkitekter
INSTALLER	NCC

PROJECT CHARACTERISTICS	
ANNUAL HORIZONTAL SOLAR IRRADIATION	0.9 MWh/m^2
KÖPPEN CLIMATE CLASSIFICATION	Humid temperate - Cfb
BIPV APPLICATION	Curtain wall
TYPE OF CONSTRUCTION	New
PV TECHNOLOGY	Opaque coloured mono-Si
BIPV ARRAY NOMINAL POWER	36.0 kW
ANNUAL ELECTRICITY GENERATION PER BIPV MODULE AREA	60 kWh/m^2
ANNUAL ELECTRICITY GENERATION	22.0 MWh

Palazzo Lombardia

PROJECT DESCRIPTION	
LOCATION	Milan, Italy (45° 29' 12" N)
USE	Government & Retail
PV PRODUCER	EnergyGlass
ARCHITECT	Sistema Duemila Architettura e Ingegneria
ENGINEER	PEI Cobb Freed & Partners, Caputo Partnership Consortium
INSTALLER	ISA S.p.A.

PROJECT CHARACTERISTICS	
ANNUAL HORIZONTAL SOLAR IRRADIATION	1.1 MWh/m^2
KÖPPEN CLIMATE CLASSIFICATION	Humid temperate – Cfb
BIPV APPLICATION	Curtain Wall
TYPE OF CONSTRUCTION	New
PV TECHNOLOGY	Semi-transparent mono-Si
BIPV ARRAY NOMINAL POWER	170.4 kW
ANNUAL ELECTRICITY GENERATION PER BIPV MODULE AREA	73.5 kWh/m^2
ANNUAL ELECTRICITY GENERATION	104.4 MWh

Glasberga Residential District

PROJECT DESCRIPTION	
LOCATION	Södertälje, Sweden (59° 11' 44" N)
USE	Residential
PV PRODUCER	Advanced Solar Power
ARCHITECT	The Paradoumo Group
ENGINEER	Soltech Energy Sweden
INSTALLER	Soltech Energy Sweden

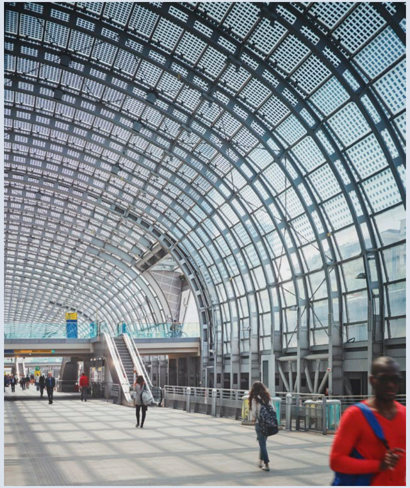
PROJECT CHARACTERISTICS	
ANNUAL HORIZONTAL SOLAR IRRADIATION	900 kWh/m^2
KÖPPEN CLIMATE CLASSIFICATION	Humid continental – Dfb
BIPV APPLICATION	Roof
TYPE OF CONSTRUCTION	New
PV TECHNOLOGY	CdTe solar shingles
BIPV ARRAY NOMINAL POWER	75.8 kW
ANNUAL ELECTRICITY GENERATION PER BIPV MODULE AREA	73.5 kWh/m^2
ANNUAL ELECTRICITY GENERATION	104.4 MWh

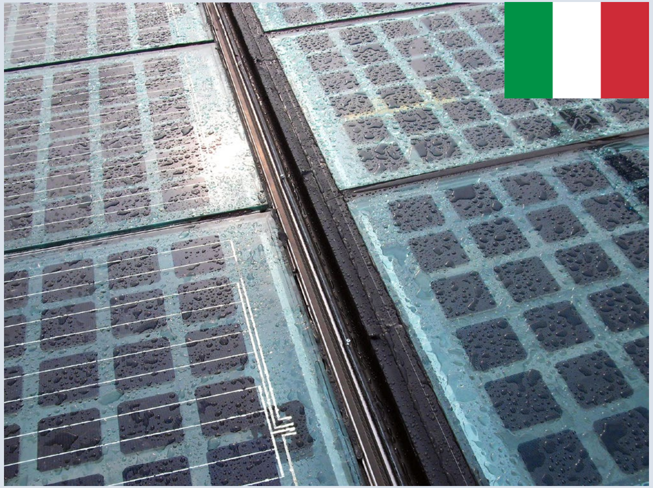
Andreas Bjorns Gade 1

PROJECT DESCRIPTION	
LOCATION	Copenhagen, Denmark (55° 40' 31" N)
USE	Residential, Multi-Family
PV PRODUCER	Owners Association
ARCHITECT	Luxor (mounting system by Renusol)
ENGINEER	Krydsrum Arkitekter
INSTALLER	Ekolab

PROJECT CHARACTERISTICS	
ANNUAL HORIZONTAL SOLAR IRRADIATION	1 MWh/m^2
KÖPPEN CLIMATE CLASSIFICATION	Marine West Coast - Csb
BIPV APPLICATION	Roof
TYPE OF CONSTRUCTION	Retrofit
PV TECHNOLOGY	Opaque mono-Si
BIPV ARRAY NOMINAL POWER	20.3 kW
ANNUAL ELECTRICITY GENERATION PER BIPV MODULE AREA	121.4 kWh/m^2
ANNUAL ELECTRICITY GENERATION	17 MWh

Stazione AV Tornio Porta Susa

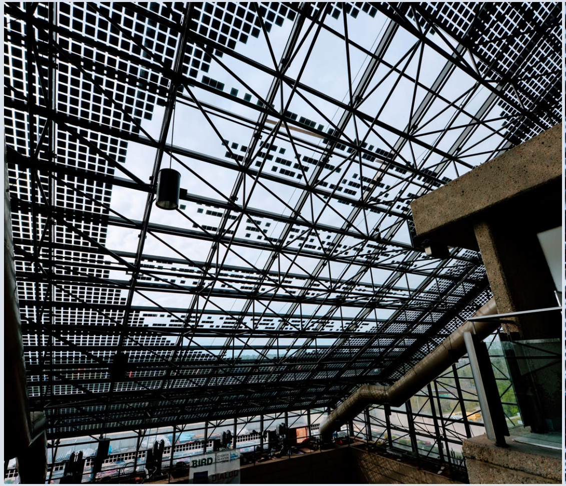


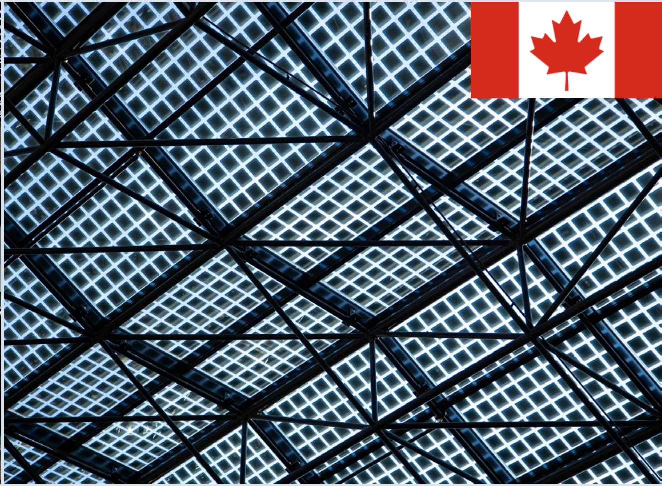


PROJECT DESCRIPTION	
LOCATION	Turin, Italy (45° 4′ 22″ N)
USE	Train station
PV PRODUCER	EnergyGlass, GruppoSTG
ARCHITECT	AREP, Silvio d'Ascia Architecture, Agostino Magnaghi
ENGINEER	AREP
INSTALLER	GruppoSTG

PROJECT CHARACTERISTICS	
ANNUAL HORIZONTAL SOLAR IRRADIATION	1.1 MWh/m^2
KÖPPEN CLIMATE CLASSIFICATION	Humid subtropical - Cfa
BIPV APPLICATION	Skylight
TYPE OF CONSTRUCTION	New
PV TECHNOLOGY	Semi-transparent mono-Si
BIPV ARRAY NOMINAL POWER	765 kW
ANNUAL ELECTRICITY GENERATION PER BIPV MODULE AREA	75 kWh/m^2
ANNUAL ELECTRICITY GENERATION	680 MWh

Edmonton Convention Centre

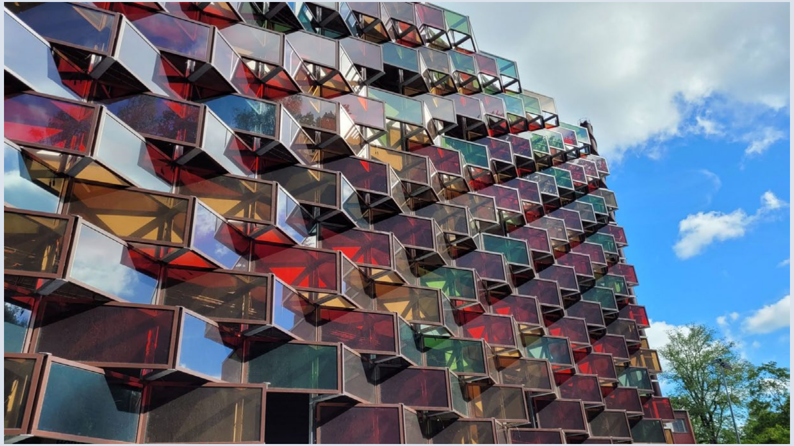




PROJECT DESCRIPTION	
LOCATION	Edmonton, Canada (53° 32' 31" N)
USE	Institutional
PV PRODUCER	Onyx Solar
ARCHITECT	DIALOG
ENGINEER	Howell-Mayhew Engineering
INSTALLER	Kuby Energy

PROJECT CHARACTERISTICS	
ANNUAL HORIZONTAL SOLAR IRRADIATION	1.3 MWh/m^2
KÖPPEN CLIMATE CLASSIFICATION	Humid continental- Dfb
BIPV APPLICATION	Skylight
TYPE OF CONSTRUCTION	Retrofit
PV TECHNOLOGY	Semi-transparent amorphous Si
BIPV ARRAY NOMINAL POWER	169 kW
ANNUAL ELECTRICITY GENERATION PER BIPV MODULE AREA	128 kWh/m^2
ANNUAL ELECTRICITY GENERATION	200 MWh

Gothenburg Garage



PROJECT DESCRIPTION	
LOCATION	Gothenburg, Sweden (57° 39′ 41″ N)
USE	Garage
PV PRODUCER	Advanced Solar Power
ARCHITECT	Liljewall arkitekter
ENGINEER	Fasadsystem (Soltech Energy Sweden subsidiary)
INSTALLER	Fasadsystem

PROJECT CHARACTERISTICS	
ANNUAL HORIZONTAL SOLAR IRRADIATION	790 kWh/m^2
KÖPPEN CLIMATE CLASSIFICATION	Humid temperate - Cfb
BIPV APPLICATION	Solar shading
TYPE OF CONSTRUCTION	New
PV TECHNOLOGY	Semi-transparent coloured CdTe
BIPV ARRAY NOMINAL POWER	60 kW
ANNUAL ELECTRICITY GENERATION PER BIPV MODULE AREA	21 kWh/m^2
ANNUAL ELECTRICITY GENERATION	16.9 MWh

BIPV Solar Shading

Franklin University

PROJECT DESCRIPTION	
LOCATION	Sorengo, Switzerland (45° 59' 52" N)
USE	Residence
PV PRODUCER	SUNAGE
ARCHITECT	Flaviano Capriotti Architetti
ENGINEER	Aziende Industriali di Lugano (AIL)
INSTALLER	Kummler + Matter, Poretti Gaggini Consortium

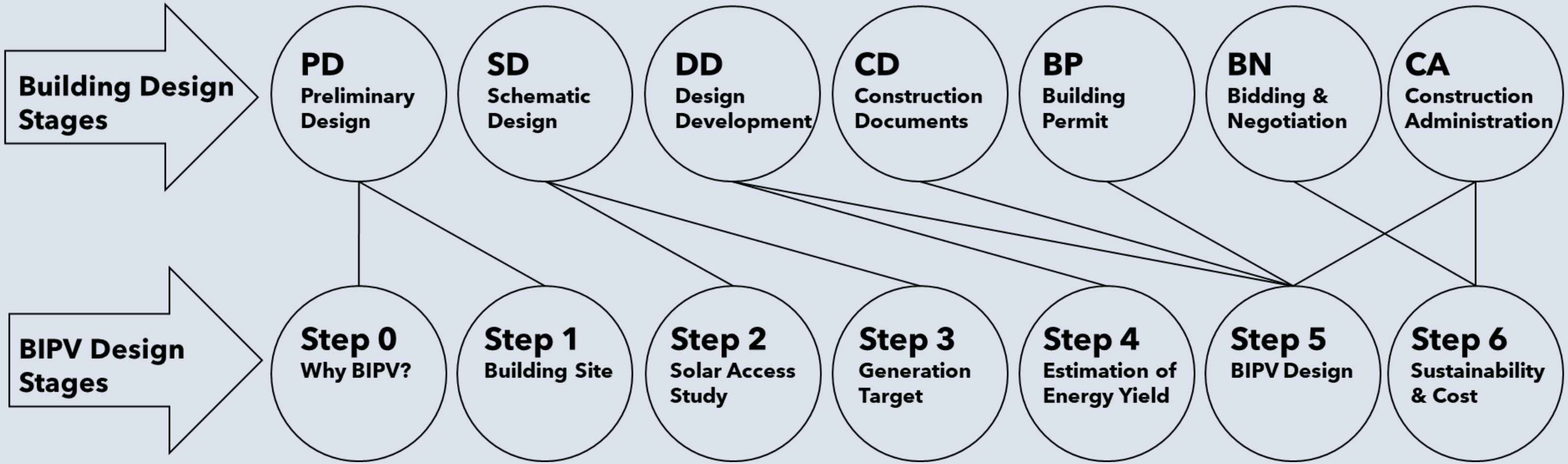
PROJECT CHARACTERISTICS	
ANNUAL HORIZONTAL SOLAR IRRADIATION	1.3 MWh/m^2
KÖPPEN CLIMATE CLASSIFICATION	Continental subarctic - Dfc
BIPV APPLICATION	Solar shading
TYPE OF CONSTRUCTION	New
PV TECHNOLOGY	Coloured opaque multi-Si
BIPV ARRAY NOMINAL POWER	18 kW
ANNUAL ELECTRICITY GENERATION PER BIPV MODULE AREA	102 kWh/m^2
ANNUAL ELECTRICITY GENERATION	18.7 MWh

Arrival Centre in Schönbrunn

PROJECT DESCRIPTION	
LOCATION	Vienna, Austria (48° 11′ 10″ N)
USE	Carport
PV PRODUCER	Ertex Solar
ARCHITECT	FCP Fritsch, Chiari & Partner ZT GmbH
ENGINEER	HESS Stahlbau & Montage GmbH
INSTALLER	Ertex Solar

PROJECT CHARACTERISTICS	
ANNUAL HORIZONTAL SOLAR IRRADIATION	1.3 MWh/m^2
KÖPPEN CLIMATE CLASSIFICATION	Continental subarctic - Dfc
BIPV APPLICATION	Solar shading
TYPE OF CONSTRUCTION	New
PV TECHNOLOGY	Coloured opaque multi-Si
BIPV ARRAY NOMINAL POWER	18 kW
ANNUAL ELECTRICITY GENERATION PER BIPV MODULE AREA	102 kWh/m^2
ANNUAL ELECTRICITY GENERATION	18.7 MWh

A Decision-Making Process for BIPV Design



A Decision-Making Process for BIPV Design

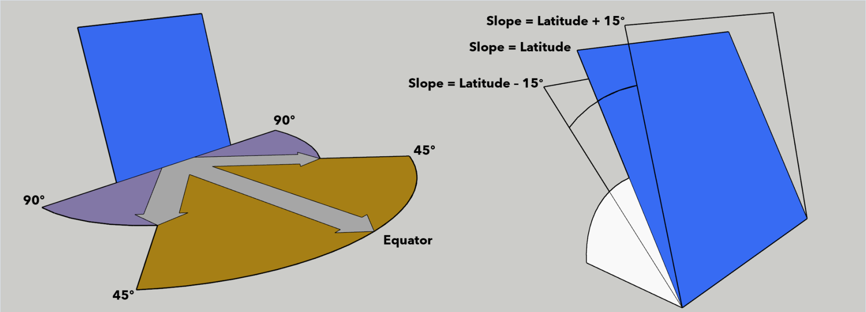
STEP 0 – WHY BIPV?

- Energy Generation & Savings
- Regulatory Compliance
- Enhanced Aesthetics
- Increased Property Value
- Corporate Green Status (if applicable)
- Renewable Energy Credits & Incentives (if applicable)

A Decision-Making Process for BIPV Design

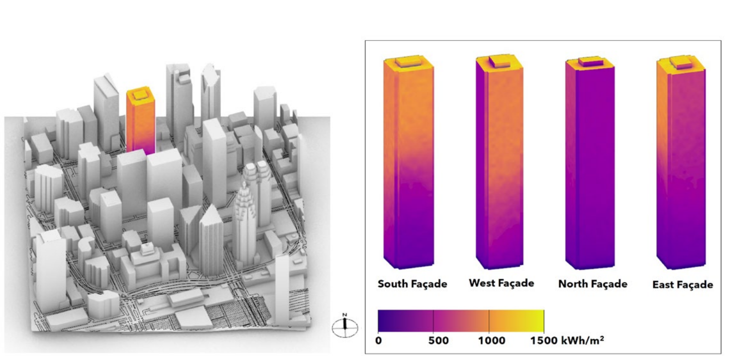
STEP 1 – ASSESS BUILDING SITE

- Orientation & Tilt Angle
- Utility Requirements
- Zoning Bylaws
- Is it a Heritage Designation?



STEP 2 – PERFORM A SOLAR ACCESS STUDY

- Solar Availability
- Solar Access Simulation Study



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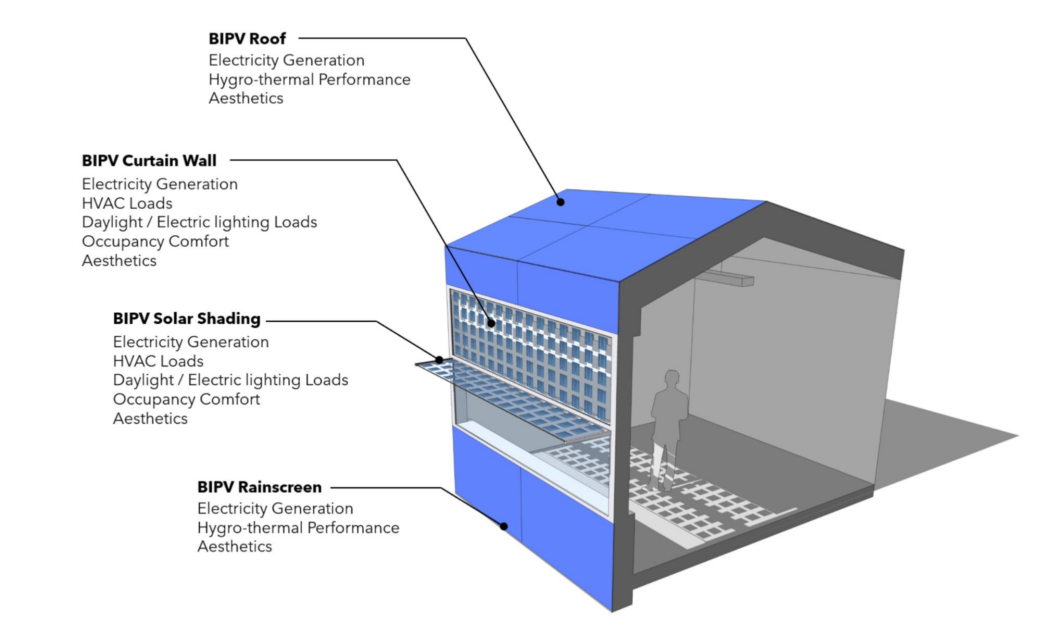
A Decision-Making Process for BIPV Design

STEP 3 – DETERMINE ANNUAL BIPV ENERGY GENERATION TARGET

- Partial Energy Offset Target
- Self-Consumption Target
- Net-Zero Energy Target
- Carbon Neutral Target



A Decision-Making Process for BIPV Design

STEP 4 – ESTIMATE BIPV INSTALLED CAPACITY AND ENERGY YIELD

- Shading
- Soiling, Snow & Ice

STEP 5 – DEVELOP THE BIPV DESIGN

- Modules
- Mounting System
- Strings and Arrays
- Balance of System
- Inverters
- Apply for Utility Interconnection

A Decision-Making Process for BIPV Design

STEP 6 – ASSESS SUSTAINABILITY, CIRCULARITY AND LIFE CYCLE COST

- Modules
- Non-Renewable Energy Payback Time
- Environmental Footprint
- Circularity
- Life Cycle Cost Analysis

STEP 7 – BUSINESS MODELS

- Feed-in Tariff
- Net-Metering
- Power Purchase Agreement
- BIPV-as-a-Service

Questions?
Feel free to reach out

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