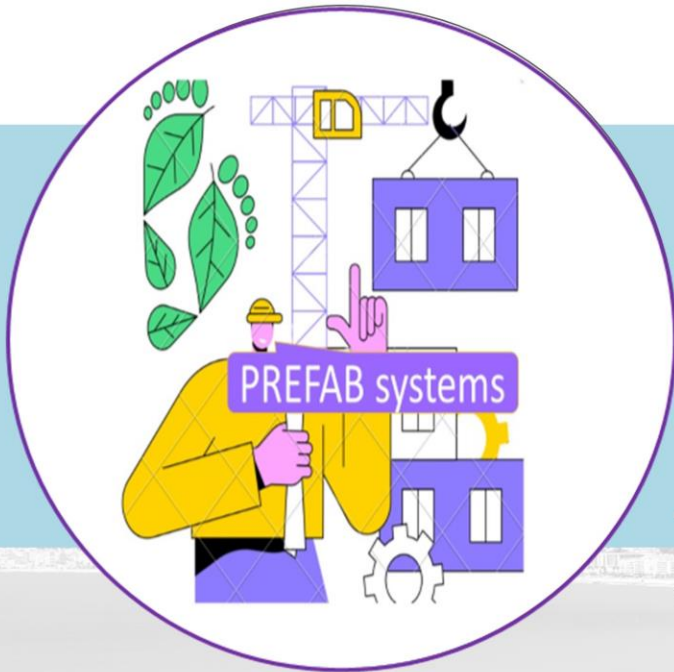




#SUSTAINABLEPLACES2022



PREFAB SYSTEMS

Off-site “Plug-and-Play” prefabricated opaque and transparent multi-functional envelop systems: Lessons and Visions

SEP. 6TH – SEP 9TH, 2022; NICE, FRANCE

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MÉTROPOLE NICE CÔTE D'AZUR



POWERSKIN PLUS

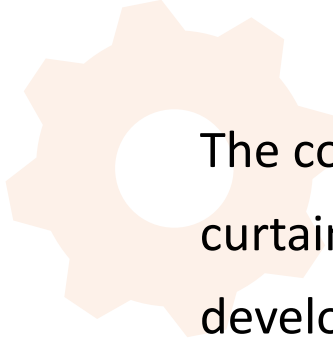
Highly advanced modular integration of insulation, energizing and storage systems for non-residential buildings

Speaker	Jorge Corker
Organisation	IPN – Instituto Pedro Nunes, Coimbra, Portugal
Start date, duration	October 2019, 4-year project
Funding	H2020 -NMBP-EEB-2019 - Integration of energy smart materials in non-residential buildings (IA) - Innovation action
Project website	powerskinplus.eu

Project partners



PROJECT OVERALL CONCEPT



The concept proposed by **POWERSKIN+** releases the untapped potential of curtain wall facades for a highly efficient energy valorization in buildings while developing a modular integrated approach consisting of several innovations whose technologies and added value intend to suppress available alternatives on the market.

A truly integrative smart curtain wall façade solution comprising:



Superinsulation and energy efficient elements

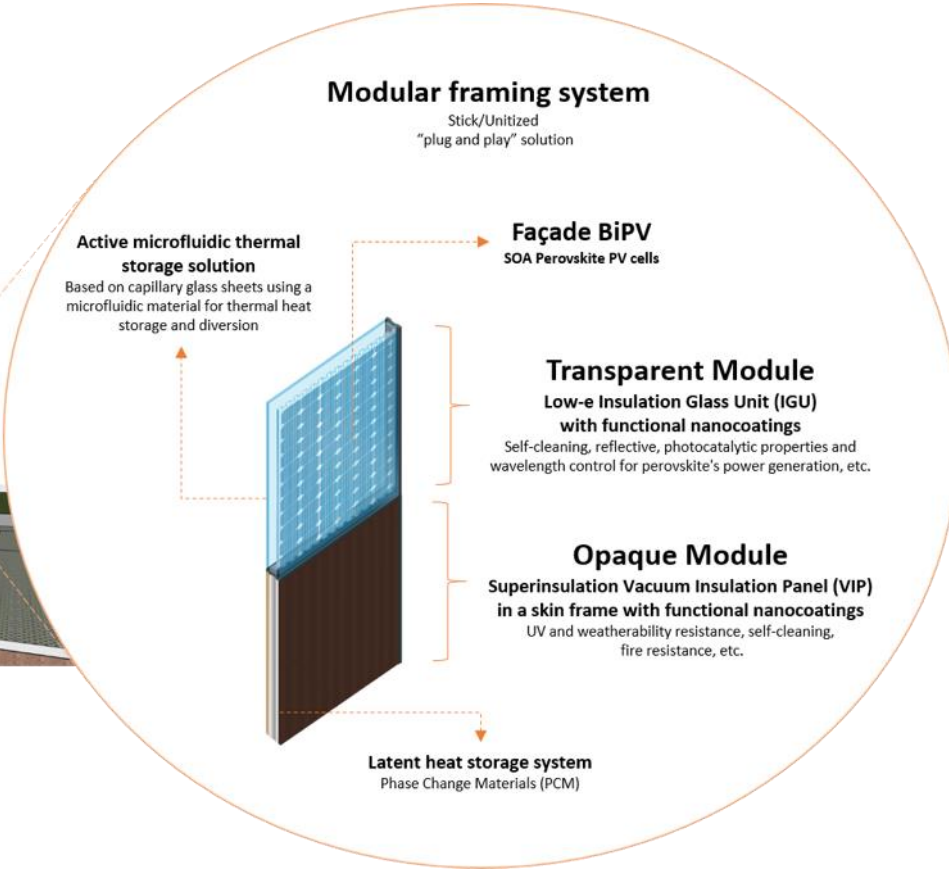


Solar energy harvesting components



Active and passive energy storage features

PROJECT OVERALL CONCEPT



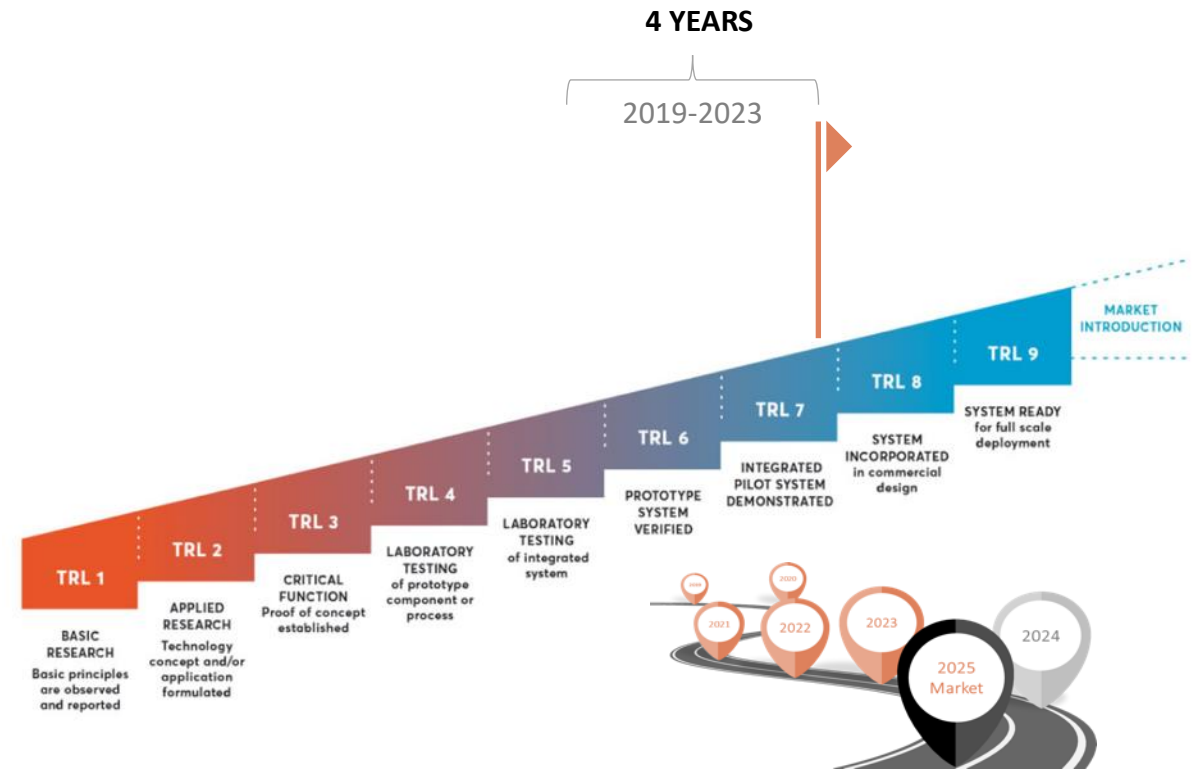
POWERSKIN+

"A true all-combined modular energy management turnkey package, following superior energy efficiency and sustainable eco-design standards, especially address for modern non-residential solutions"

PROJECT KEY OBJECTIVES



- Generate innovative hybrid-enabled systems enhanced with different multifunctional add-on features, for nZEB and Plus Energy Building Curtain Wall solutions
- Demonstrate true holistic façade solutions in an operational environment, treading the path for future exploitation of non-residential buildings as the primary entrance market
- Aim at new buildings but providing the retrofit market with highly adaptive multi-case energy efficient and management systems

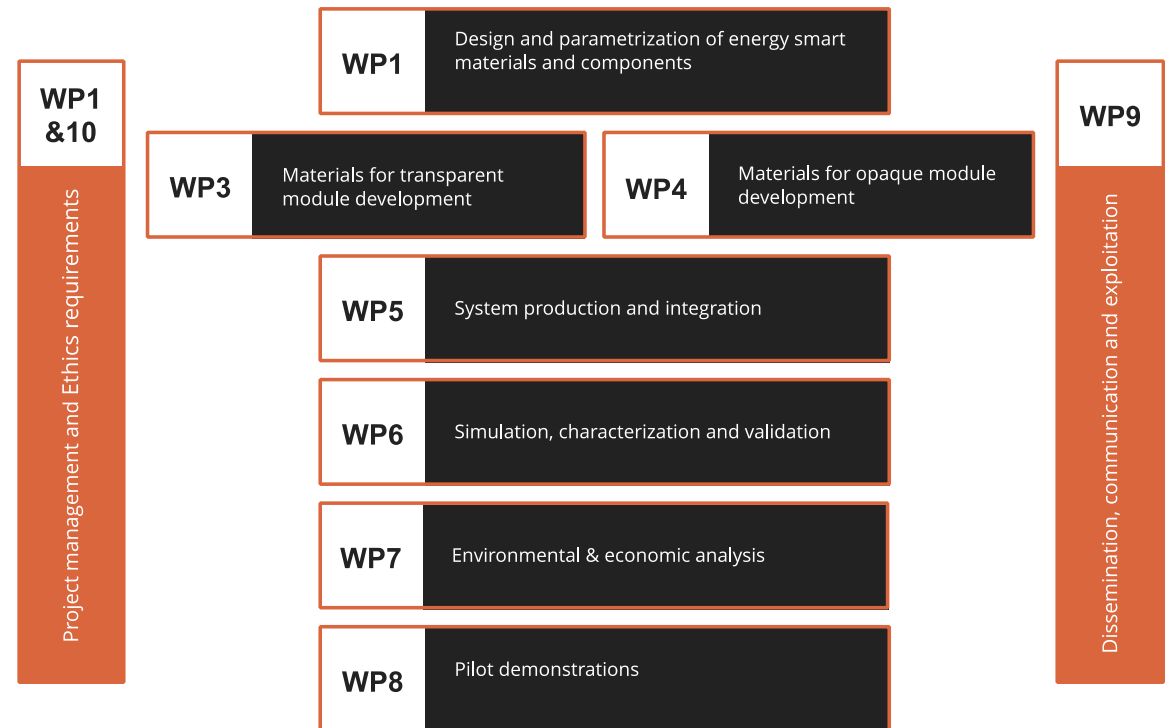


Set POWERSKIN+ from lab to operational environment (TRL7)



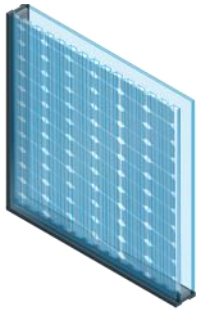
Combination of a wide number of state-of-the-art high energy-efficient **KETs development/piloting program**

- Superinsulation elements (IGU and VIP)
- Multi-functional nano-enabled coatings
- Active/passive PCM-driven latent heat storage elements and microfluidic thermal storage materials (RES)
- Solar energy harvesting components based on flexible perovskite solar cells (semi-transparent and opaque) (RES)
- Electrical BMS supported by second-life Li-ion batteries from electrical vehicles (BEMS)





TRANSPARENT MODULE



Standard
Low-e and reflective-coated triple-glazed Insulation Glass Unit IGU

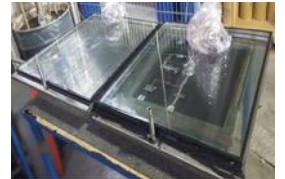
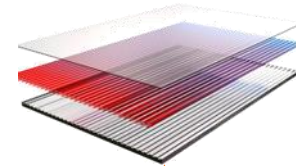


Add-on
Functional nanocoatings

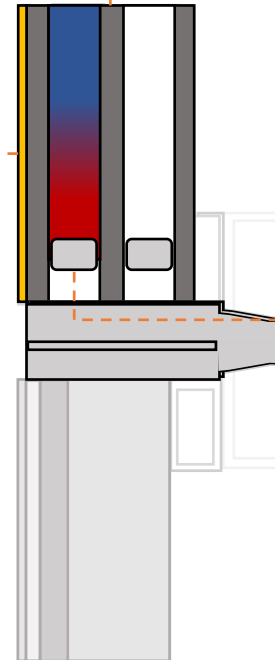
Self-cleaning, anti-reflective, photocatalytic properties and wavelength control for PV's power generation, etc.



Add-on
Capillary glass sheets for active thermal heat storage and diversion
Using microfluidic active thermal storage materials

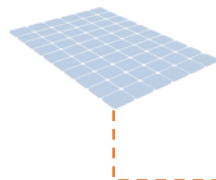


Modular framing system
Metal or composite stick/unitized "plug and play" installation system



Standard option

Premium options



Add-on



Façade BiPV
SOA Perovskite-PV

Add-on



Li-ion battery electric storage system

Autonomous electric storage system using e-car Li-ion batteries connected to the PVs and the grid





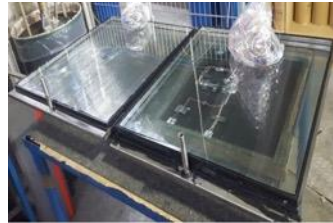
TRANSPARENT MODULES

Standard

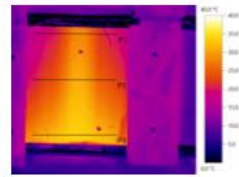


PS+ 1st generation opaque module prototype

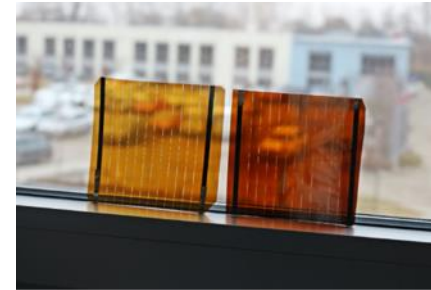
Add-on



Water flow distribution



PS+ semi-transparent microfluidic heat storage system prototypes



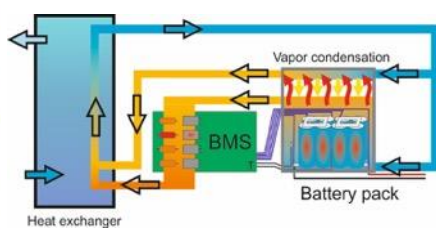
Add-on



PS+ semi-transparent PV pilot production/testing

PS + standard transparent module main features and properties

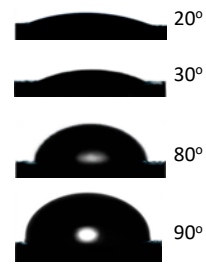
Material	Description
Glass	Soda-lime silicate float glasses melted from the following naturally occurring raw materials (main components, in mass percentage): Sand (SiO ₂ , 58 ma%); Soda (Na ₂ CO ₃ , 18 ma%); Dolomite (Ca(CO ₃) ₂ -Mg(CO ₃) ₂ , 15 ma%); Lime (Ca(CO ₃) ₂ , 5 wt%); Sulphate ([SO ₄] ²⁻ , 1 wt%)
Spacers	Thermally optimized spacers made of aluminium Other options possible (stainless steel, polymer/metal combinations, or containing organic materials)
Sealant	Butyl (other options possible) Secondary sealing (polyurethane, silicone)
Desiccant	Zeolites
Inert gases	Argon
Features	PS+ Triple-glazed standard IGUs (transparent) modules
Weight	10.8 kg (600 x 600 mm) 30kg/m ²
U-value	≤ 0.80 W/(m²K) (33.4% below the average of 1.2 W/(m ² K) for an air-filled double-glazed window with low-e coatings)
Dimensions	Up to 2000 x 3000 mm ²
PS+ premium capabilities	Ready for add-on integration



Add-on

PS+ Building electric storage system (piloting/cooling system)

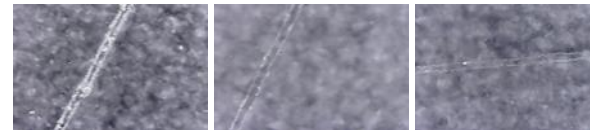
Add-on



t=0

t=5days

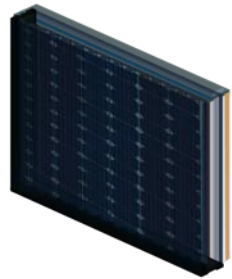
t=12days



Hydrophobic and self-healing capabilities of the PS+ transparent coatings



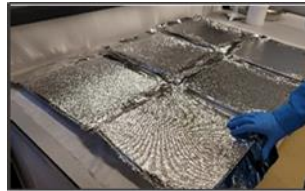
OPAQUE MODULE



Standard

Module skin panels
(Glass / Composite / Metal)

Superinsulation module
Vacuum Insulation Panels (VIPs)



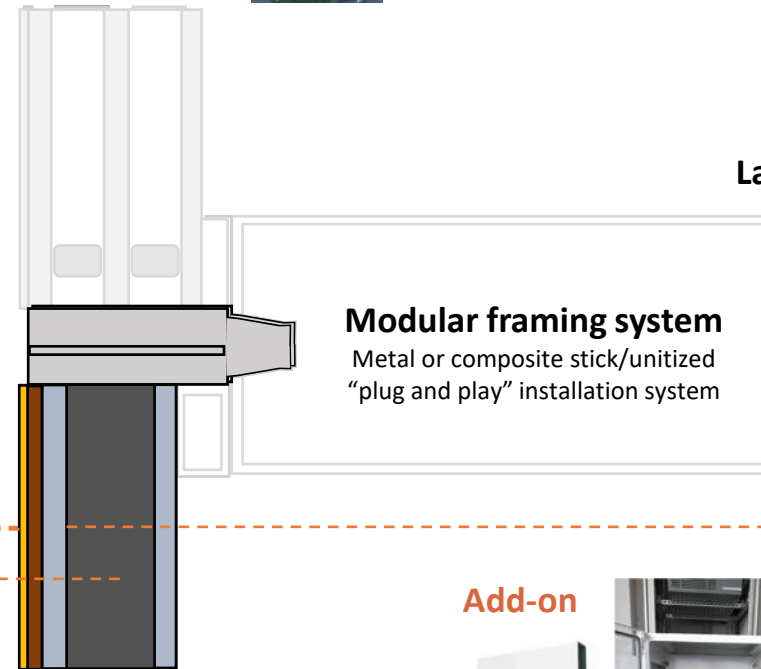
Add-on

Functional nanocoatings
UV weatherability, fire resistance, etc.



Add-on

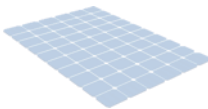
Latent heat storage system
Phase Change Materials (PCM)



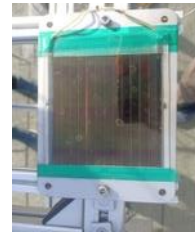
Modular framing system
Metal or composite stick/unitized
“plug and play” installation system

Standard option

Premium options



Add-on



Façade BiPV
SOA Perovskite-PV

Add-on



Li-ion battery electric storage system

Autonomous electric storage system using e-car Li-ion batteries connected to the PVs and the grid

PS+ MAIN MODULES AND ELEMENTS



OPAQUE MODULES

Standard



PS+ 1st generation transparent module prototype

Standard



PS+ VIP insulation prototype

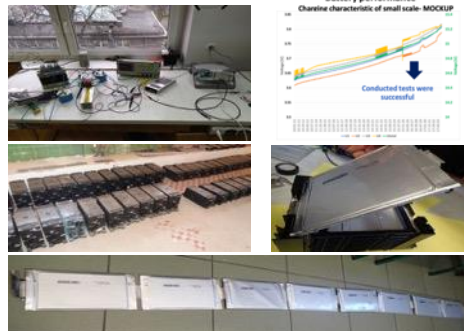


Add-on



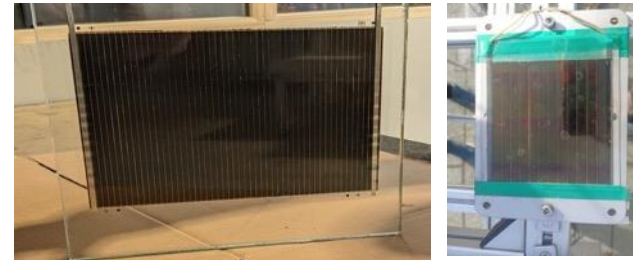
PS+ PCM 1st module

Add-on



PS+ Building electric storage system (piloting/testing)

Add-on



PS+ Opaque flexible perovskite PV prototype

Add-on



PS+ Opaque sprayable coatings and fire testing

PS + opaque module types, main features and properties

Parts	PS+ Standard Opaque Modules		PS+ Premium Opaque Modules
	Lightweight Standard Modules	Standard Modules	
Sketch			
Outer skin panel sub-module ¹	Ultra-light fibre-reinforced plastic (FRP)	Option 1: Fibre-reinforced plastic (FRP) w/ fire retardants Option 2: Opacified glass Option 3: Aluminium panel Option 4: Composite panel	Same options as standard modules
Insulation sub-module ²	Fibreglass VIP	Option 1: Fumed silica VIP core for superior service life Option 2: Recycled or renewable hybrid VIP core for superior sustainability	
Inner skin panel sub-module ³ (back panel)	Same as the outer skin	Same as the outer skin	
Inner frame sub-module ⁴ (optional)	Recycled polymer frame (optional)	Recycled polymer frame (optional) Option 2: conventional or thermally optimized spacers	
Skin panel coatings ⁵	Multifunctional coatings with intumescent flame-retardant paint	Multifunctional coatings available - Self-cleaning - Anti-fungal - Light reflective - Self-healing With intumescent flame-retardant paint (if required)	
Sealing	Tape (commercial)	Tape, butyl, polyurethane, silicone, etc. (Commercial)	
Energy storage add-on ⁶	-	-	PCM plus activating heating foil
Energy Harvesting add-on ⁷	-	-	Flexible opaque perovskite BIPV cells
Prototype Pictures			
Features	Variable RAL colours possible	Variable RAL colours possible	Variable RAL colours possible
Dimensions	Variable: 300X300 to 1000X600mm Nominal thickness (mm): ~ 21mm	Variable: 300X300 to 1000X600mm Variable thickness possible for the VIP up to 40mm	300X300 to 1000X600mm, variable thickness possible for the VIP up to 40mm
Applications	Special applications where lightweightness is ultimately required, VIP protection, special curtain wall façade spandrels, etc.	Curtain wall façades (opaque zones)	Curtain wall façades (opaque zones)
Weight (kg/m ²)	4,98 ^{1,2,3}	Variable	Variable
U-Value (W/m ² .K)	0.098	Variable	Variable

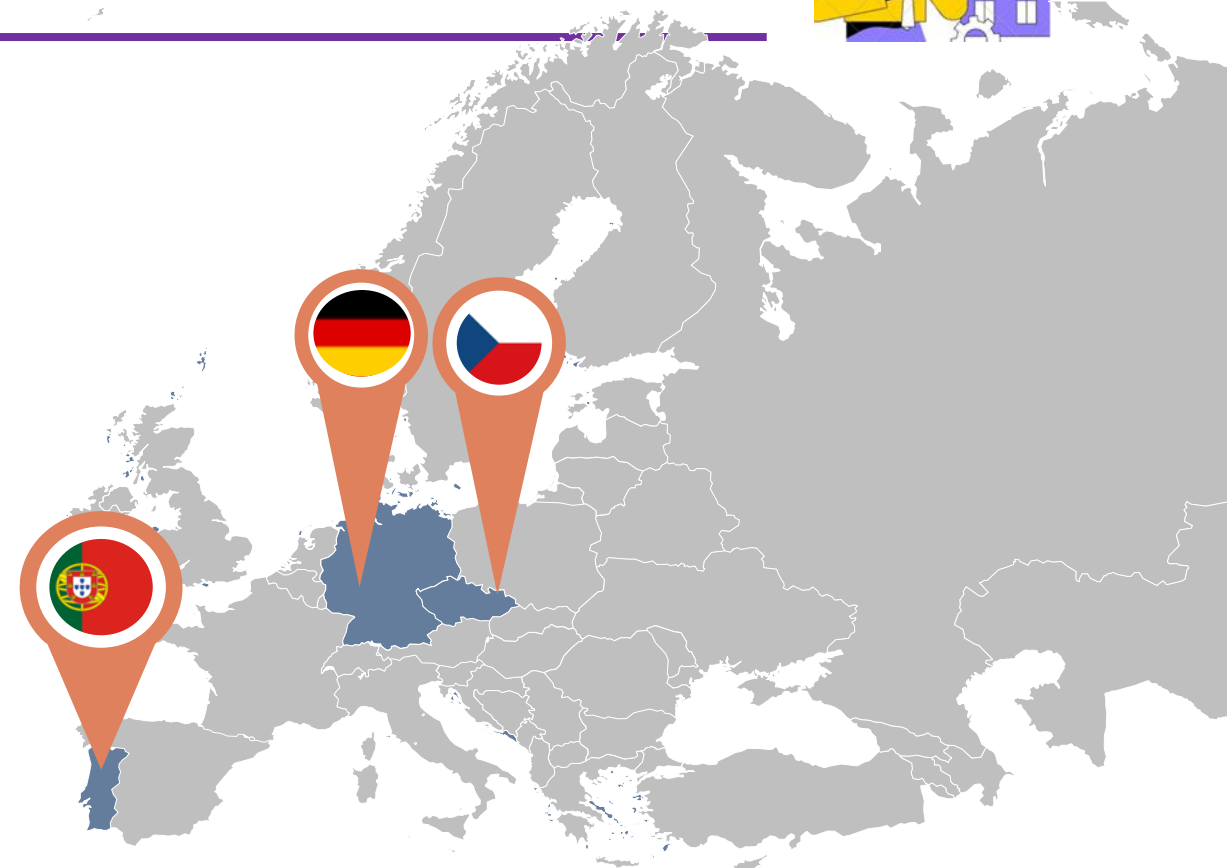
PILOTING DEVELOPED TECHNOLOGIES



POWERSKIN+ will **prototype** and **demonstrate** both **premium** and more **affordable solutions**, for non-load bearing curtain wall systems, based on high durability individual and system components.

POWERSKIN+ façade renovation system will be demonstrated and validated in an operational environment in **3 real-size non-residential buildings** located in 3 different European countries (Portugal, Germany and the Czech Republic).

The demo cases represent **2 different climates** (Csa - Hot-summer Mediterranean and Cfb - Oceanic in the Köppen climate classification), as well as different building practices characterizing and realising how the overall system will work in real conditions in the future.



PILOTING DEVELOPED TECHNOLOGIES



Future pilot demonstration at IPN

Main demo installation



IPN installation (Coimbra, PT)
Planned for Autumn 2022



POWERSKIN PLUS Mock-up



POWERSKIN PLUS outdoor test cells



May
Materials, integrated systems production and performance specification defined

March
POWERSKIN+ upgrade façade system (add-ons) integration attained and prototyped

February
POWERSKIN+ lab-scale experimental validation completed

September
First set of standard opaque and transparent prototype modules realized

October
Installation and full-year demonstration initiated in operational environment

August
POWERSKIN+ documents database and future market entrance guidelines produced including environmental and economic analysis



Financial & market barriers

- Costs of high-performance solutions
- Slow pace of the EU retrofitting action

Technical challenges

- Develop multi-price efficient and safe “plug-n-play” modular solutions for easier market acceptance
- Need to address a holistic full-cycle approach on product development to fully achieve decarbonization goals and a real transitioning to energy-efficient buildings

Technical barriers

- Highly diverse building and façade types, making it difficult to design universal and easily adaptable retrofitting solutions

Regulatory and other challenges

- Design a portfolio of standardized solutions capable of fulfilling different regulatory requirements
- Need to overcome bottlenecks that are still preventing a further industrial uptake of nanomaterials



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