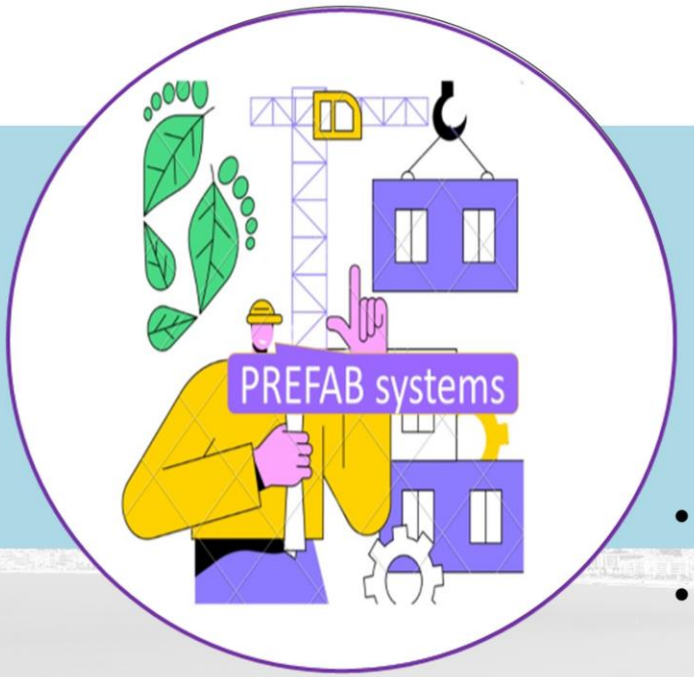
SUSTAINABLE PLACES 2022

PLURAL ENSNARE INFINITE BUILDINGRENOVATION DRIVE SWITCH2SAVE StepUP POWER SKIN+



#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

SUSTAINABLEPLACES.EU

VILLE DE NICE

MÉTROPOLE NICE CÔTE D'AZUR

Starts on	Durat (min)	Agenda Item	Speaker/Moderator
08:45	15	*"Connecting" /arrival of participants* *(tentative attendance: 5 physical presence, 14 online)*	
09:00	5	Welcome - Introduction	**M. Founti**
09:05	40	**PROJECT PRESENTATIONS** • **INFINITE:** Industrialised durable building envelope retrofitting by all-in-one interconnected technology solutions • **PLURAL**: Plug-and-Use renovation with adaptable lightweight systems • **ENSNARE**: ENvelope meSh aNd digitAl framework for building Renovation • **POWERSKIN+**: Highly advanced modular integration of insulation, energizing and storage systems for non-residential buildings • **SWITCH2SAVE:** Lightweight switchable smart solutions for energy saving large windows and glass facades • **StepUP**: Solutions and Technologies for deep Energy renovation Processes Uptake • **DRIVE0:** Engaging consumers for the decarbonization of Europe's buildings	**S. Avesani** **M. Founti** **F. Noris** **J. Corker** **M. Fahland** **A. Panchal** **J. van Oorschot**
09:45	45	**ROUND TABLE I: MAPPING and "CLUSTERING" OF TECHNOLOGIES DEVELOPED IN THE PROJECTS** • **Sum-up of H2020 Deep Renovation-Positioning paper**; conclusions and recommendations (John van Oorschot, 5 mins) • **Typologies of "Plug-and-Play" hybrid systems** (both opaque and transparent systems) based on passive and active systems and technologies that fulfill multifunctional and off-site prefabrication requirements. Circular technologies (10 min). • **Control/automation/IoT interactive systems/** collaborating with the Plug-and-Play hybrid technologies towards fulfilling energy, comfort and safety requirements (5 min). • **Wrap up** (F. Noris)	**Federico Noris (ENSNARE)** John van Oorschot (DRIVE 0) Jorge Cocker (Powerskin+) Matthias Fahland (Switch2Save)
10.30	15	Coffee Break	

Starts on	Durat (min)	Agenda Item	Speaker/Moderator
10:30	45	**ROUND TABLE II: HOW DO THE "CLUSTERED" TECHNOLOGIES PERFORM**? • **TOWARDS NZEB:** Which technologies can contribute to the NZEB / Positive Energy targets? Can we achieve energy positive deeply renovated residential buildings with Plug-and-Play hybrid systems? (10 min) • **Challenges and threats**: OPEN questions (such as safety, standardization, manufacturing, business models, market) (10 min) • **Wrap up** (S. Avesani)	**Stefano Avesani (INFINITE)**, Peru Elguezabal Esnarrizaga (ENSNARE) Amisha Panchal (StepUP) Constantinos Tsoutis (PLURAL, Powerskin+)
11:15	15	Workshop wrap up, next steps, close of meeting	**M. Founti (PLURAL)**

INFINITE BUILDINGRENOVATION

Industrialised durable building envelope retrofitting by all-in-one interconnected technology solutions

Speaker	**Stefano Avesani**
Organisation	**Eurac Research**
Start / end date of project	**01.11.2020 – 30.04.2025**
Funding	**H2020**
Project website	**https://infinitebuildingrenovation.eu/**

Project key objectives

To increase the market update of industrialised retrofit

O1 Tools

To enable easier management of Ren4.0

To better assist cost-efficiency & LowCarbon

O2 Technologies

To increase market appeal of industrialised all-in-one envelopes

O3 Business

To foster the activation of the Ren4.0 market

O4.1 Buildings

To facilitate the demand-side critical mass activation

O4.2 Stakeholders

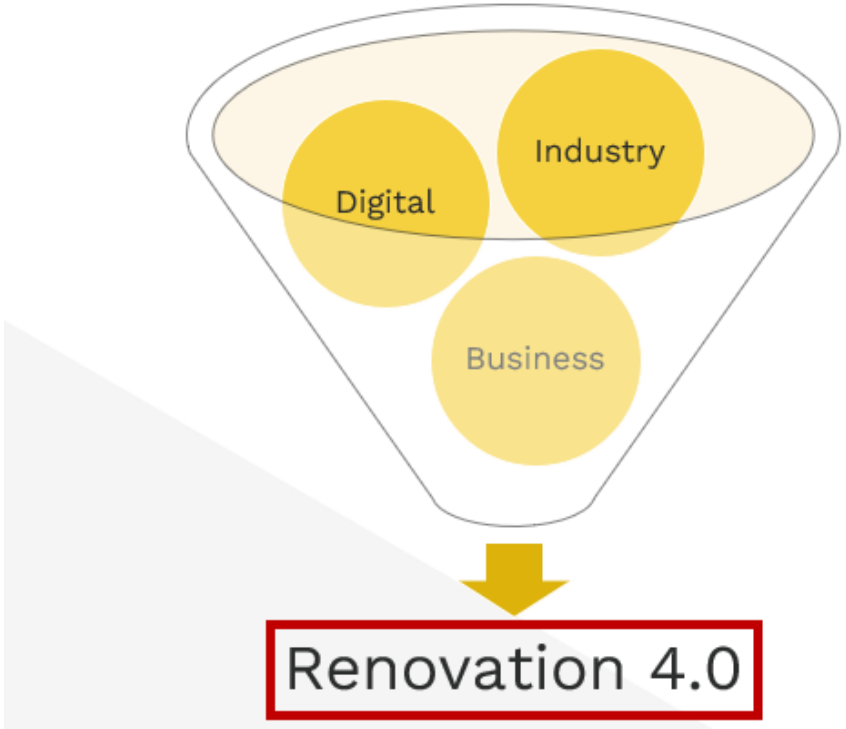
To increase acceptance of the Ren4.0 stakeholders

O5 Demonstration

To build-up a consensus for the Renovatio4.0 approach

Concept and Methodology

Industrialised renovation = RENOVATION 4.0



Concept and Methodology

Industrialised solutions triggering DEEP RETROFIT renovation offering

- ✓ nZEB target based on
  - High indoor comfort
  - Electrification
- ✓ Stakeholders-centered development
- ✓ LCA / LCC & DfA/DfD optimised
- ✓ Appealing buildings
- ✓ Flexibility meeting different architectural visions (e.g. plaster VS ventilated façade)

The solutions

Technologies developed

PASSIVE ECO-COMPATIBLE & GREEN ENVELOPE KIT 1B 1A

ENERGY AND FRESH AIR DISTRIBUTION KIT 2

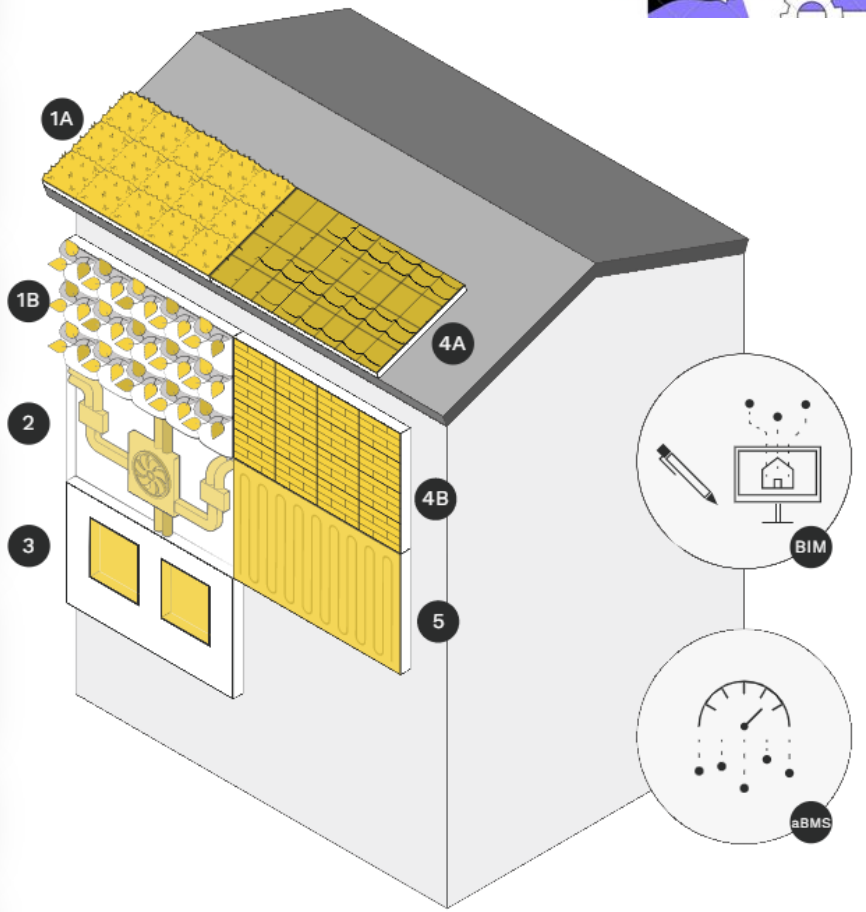
SMART WINDOW KIT (SMART GLAZING) 3

ENERGY GENERATION BIPV KIT 4B 4A

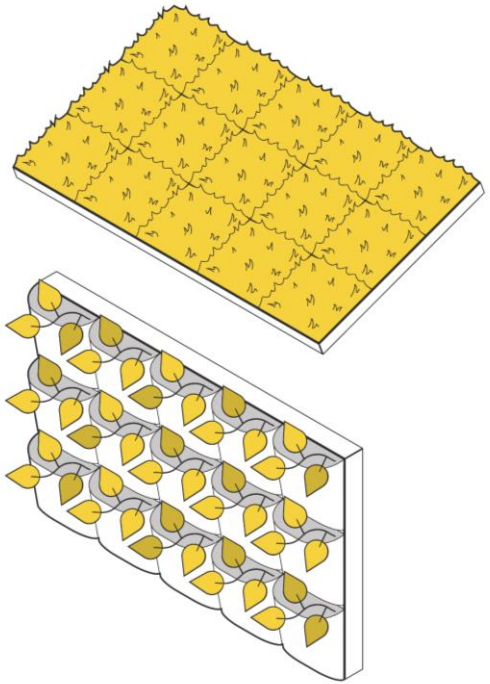
SOLAR-THERMAL GENERATION KIT (BIST) 5

ADAPTABLE BMS aBMS

BIM PLATFORM BIM



Plug-and-Play solutions of the project



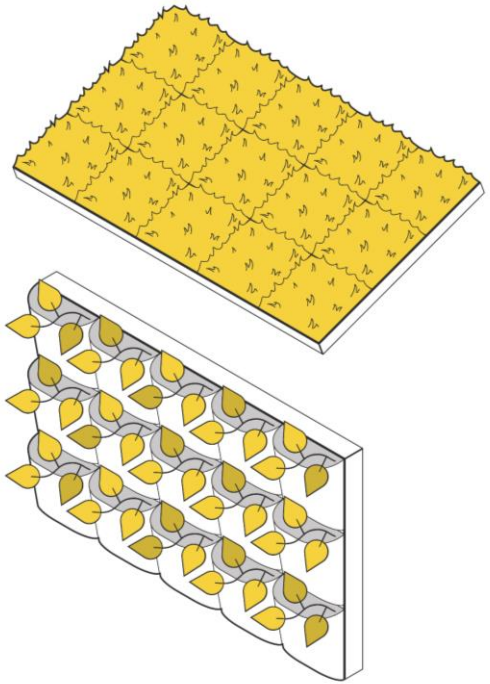
<u>GREEN ROOF and FACADE KIT</u>

- Timber based prefab **<u>façade and roof</u>**
- Around 16-20cm rockwool insulation (60kg/m³)
- Possibility to **<u>prefabricate different greening systems</u>**

(from climbing plants to living walls)

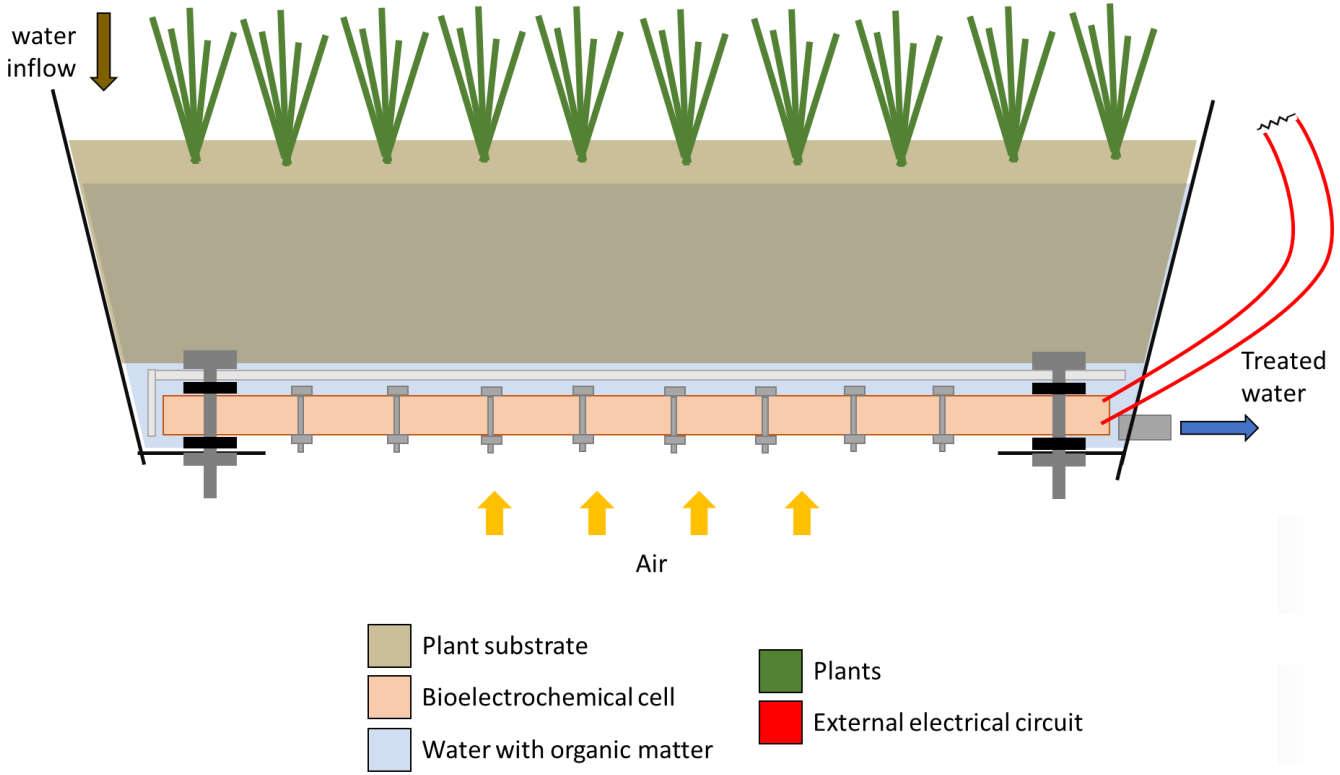
- **<u>Rainwater</u>** irrigation system

Plug-and-Play solutions of the project

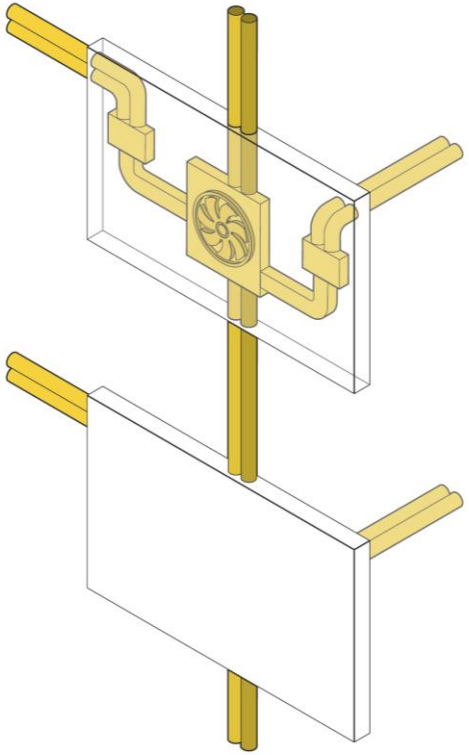


GREEN ROOF and FACADE KIT

- **Greywater BioElectricalSystem** to power sensors for irrigation control

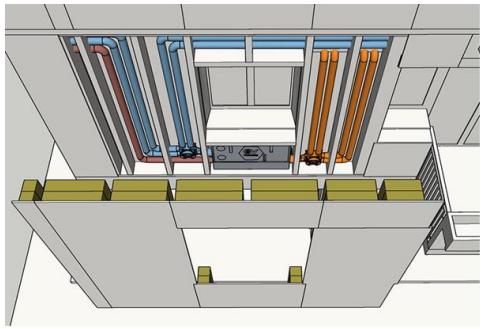


Plug-and-Play solutions of the project

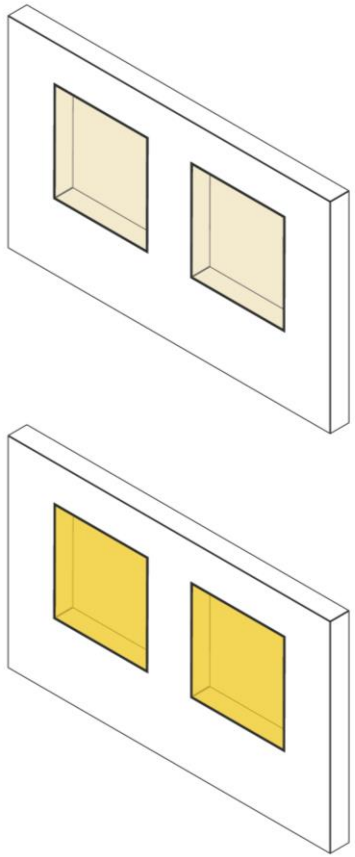


FRESH AIR, H&C KIT

- Timber based prefab **façade**
- Around 20cm rockwool insulation (60kg/m³)
- **Accessible prefabricated decentralized ventilation machine** (and accessories as plenum, ducts, control unit)
- Innovative machine: **fresh air & heating & cooling** supply
- **Two possible integrations:**
  - Under the window
  - As parapet/on the balcony

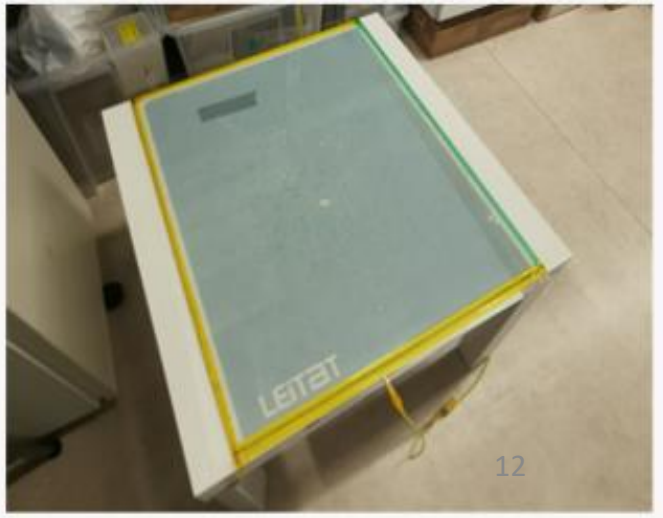


Plug-and-Play solutions of the project

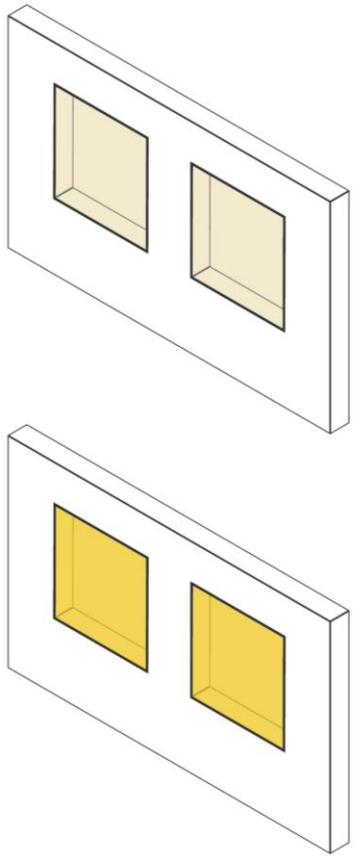


SMART WINDOW KIT

- Prefab window and shading
- Sun shading techs:
  - ✓Traditional curtains, lamellas
  - ✓Commercial elechtrochromic glazing
  - ✓Plasmachromic glazing

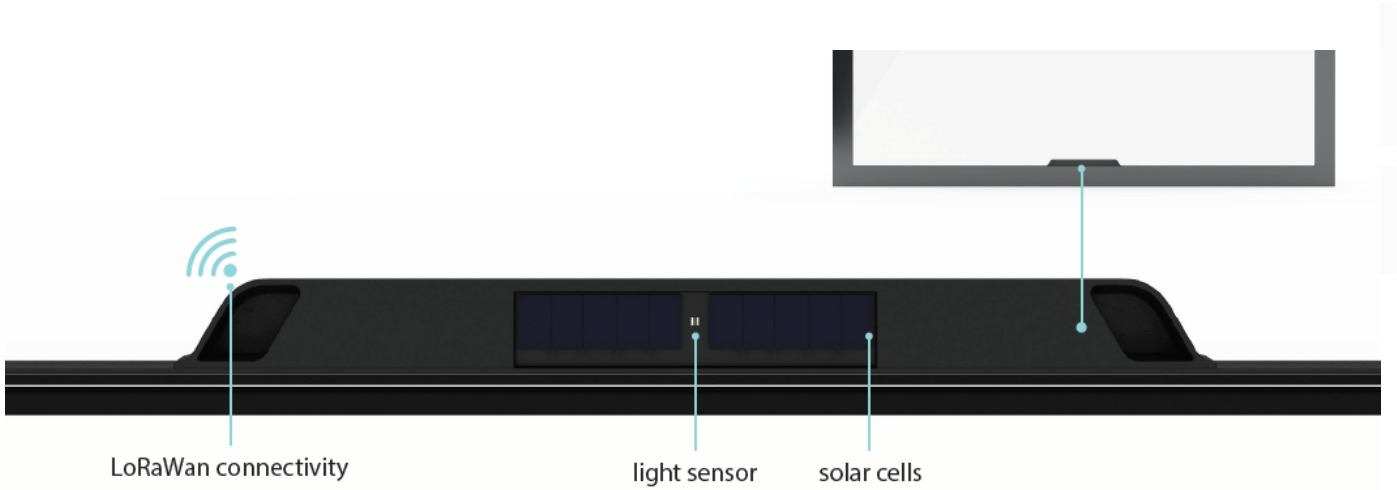


Plug-and-Play solutions of the project

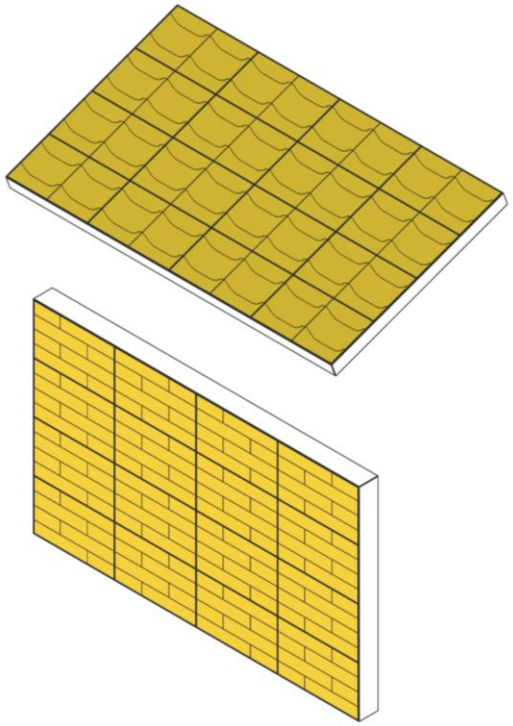


SMART WINDOW KIT

- Smart measure and control system
  - ✓SENSE bar
  - ✓Remote server for real time optimisation



Plug-and-Play solutions of the project

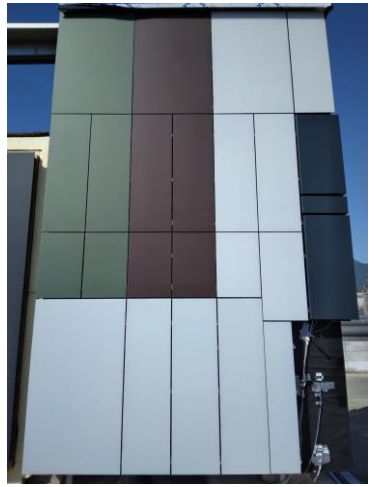
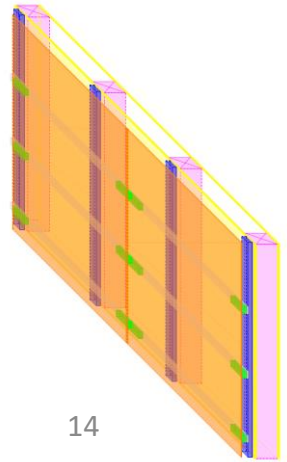


BIPV KIT

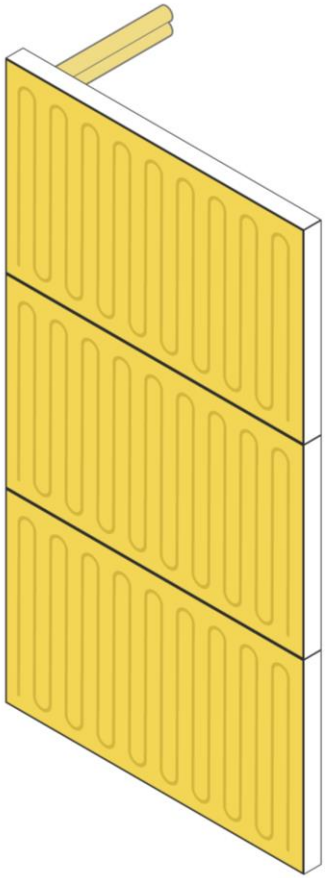
- Coloured glass-glass PV modules (with dynamic selection tool)
- Structured cover glass (Satin, 3d-shaped, smooth, texture)
- Optimised module sizes and Tailor-made
- Glued or Hybrid or Mechanical anchoring





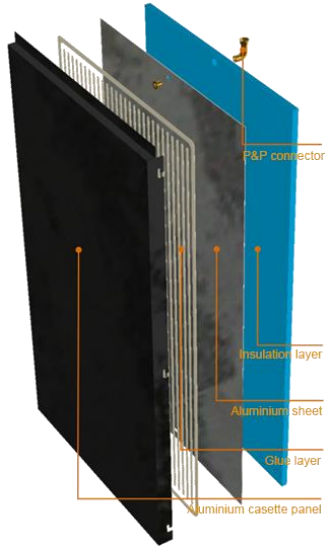



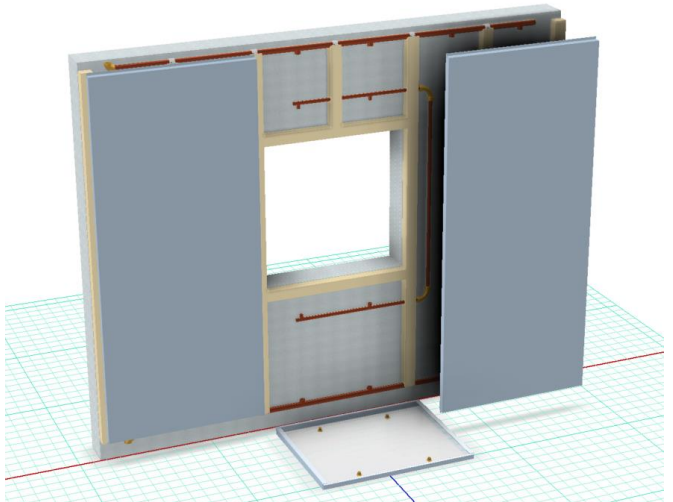
Plug-and-Play solutions of the project



BIST KIT

- Full solution including windows, sun protection, final cladding, etc.
- Prefabricated in the factory
- P&P Hydraulic connection
- Weather resistant (long life)
- Quick installation (time saving)
- Architectural integration (aesthetics)





Key barriers - Challenges

MARKET UPTAKE

- Investment cost of the DEEP RENOVATION
- Investment cost of the ALL-IN-ONE PREFAB SOLUTION
- Weight of timber-frame envelope modules

CHALLENGES

- Industrialisation to drive DEEP RENOVATION
- ALL-IN-ONE envelope requirements not standardized

Consortium

Coordinator

eurac research

Project Partners

HUYGEN INGENIEURS & ADVISEURS

GreenDelta

EDERA

GRÜN STATT GRAU

one team

nobatek INEF4 INSTITUT POUR LA TRANSITION ENERGETIQUE

BOUYGUES CONSTRUCTION

RUBNER holzbau

LEITAT managing technologies

IRI UL Institute for Innovation and Development of University of Ljubljana

GENERALITAT VALENCIANA Vicepresidencia Segunda y Conselleria de Vivienda y Arquitectura Bioclimática

IVE INSTITUTO VALENCIANO de la EDIFICACIÓN

PHYSEE

SYNAGE

Aramis PANEL

VORTICE

CASA SPA

PolyOuvrages Groupe PolyLogis

Stanovanjskopodjetje

PLURAL

PLURAL: Plug-and-use Renovation with adaptable lightweight Systems

Speaker Maria Founti, Coordinator

Organisation National Technical University of Athens

Start date 01 October 2020, 48 months

Funding H2020 - LC-EEB-04-2020:- Industrialisation of building envelope kits

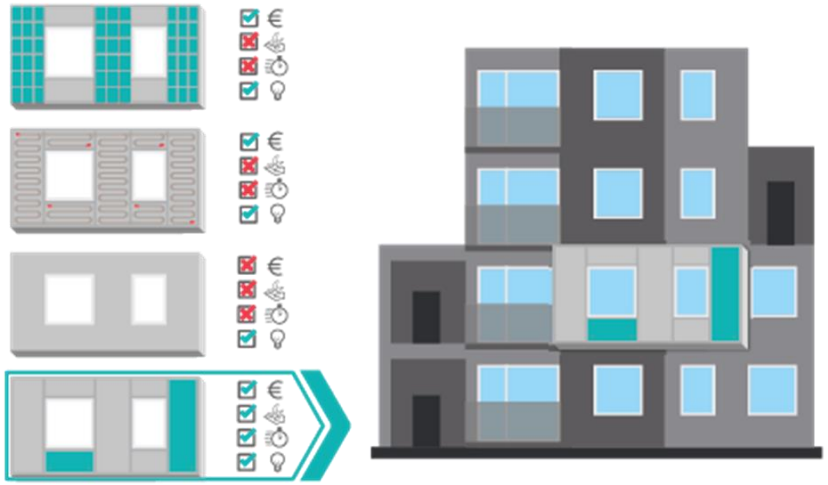
Project website https://www.plural-renovation.eu/

PLURAL key objectives

PLURAL aims to design, validate and demonstrate a palette of versatile, adaptable, scalable, **off-site prefabricated Plug-and-Use (PnU) kits**.

The key is to understand how to select and integrate various renewable energy technologies, incorporate them in **prefabricated façade components** and optimize their performance for different building types, climates and socio-economic conditions.

PLURAL demonstrates the integration of **hybrid passive and active systems into one kit** and their ability to work together in **synergy** for façade retrofitting, reaching NZEB.



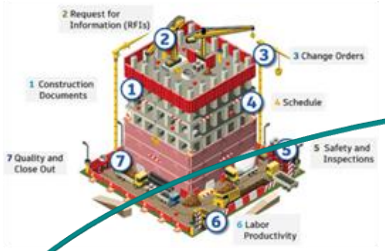
Key Objectives

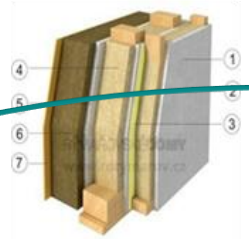
1) **Near zero energy consumption of buildings renovated with PnU kits**
2) **Cost-effective renovation**
3) **Fast-track renovation**
4) **Environmentally-friendlier deep renovation**
5) **Flexibility – Adaptability**

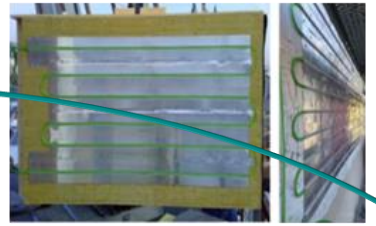
PLURAL Concept

- Three PnU kits: the **SmartWall, the ConExWall** (external Wall Heating and Cooling kit) and the **HybridWall** (external texTILES constructive system with Advanced Heat and Cool recovery kit)
- Six demonstration sites implementing the PnU kits
- Enhancement of occupant satisfaction via a **user centric approach** that implements learning based control methods and strategies.
- A **Building Information Modelling** (BIM) based **data handling platform** and a **Decision Support Tool** (DST) will be developed to enable the optimal component selection, and integration, best PnU kit design, faster and low-cost manufacturing and installation.
- PLURAL focuses on how to manufacture the PnU kits minimizing energy use and material waste (implementing **lean manufacturing principles-F.Q.Ps**).
- Develop **training tools** for main stakeholders (planners, installers, building owners and end users);
- Improve the **life cycle based (LCA, LCC) performance standards** applied in the building sector.

PLURAL Methodology







KPIs Definitions Requirements

Development / Optimization of PnU kits

Testing of PnU kits

Manufacturing

Validation in real and virtual demonstrations

Development of LYSIS & MODEST IT Tool

Achieved M1-M24

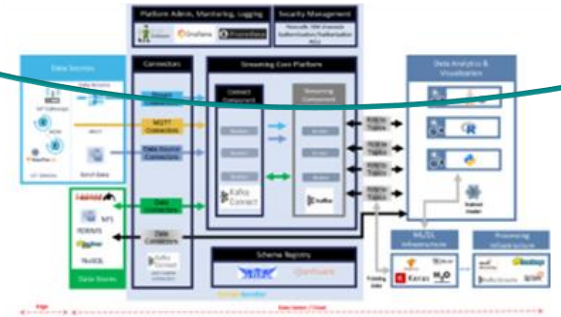
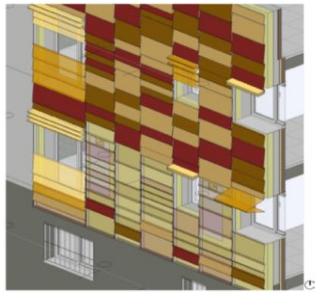


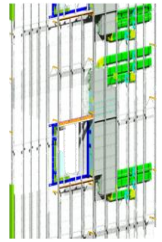
Figure 1.21 – Big data Platform - Streamhandler

The solution – Technologies developed

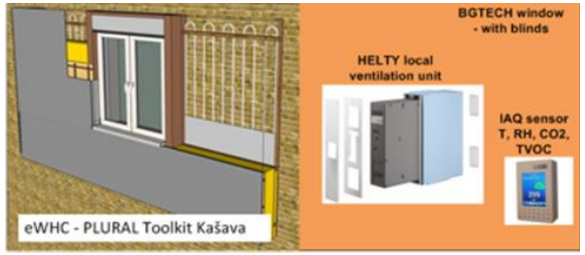
The SmartWall PnU

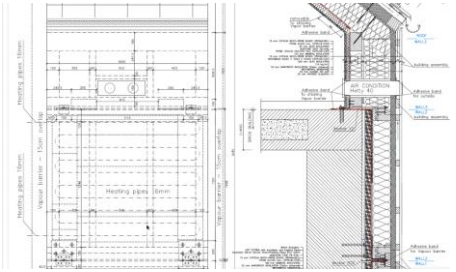
The ConExWall PnU





The HybridWall PnU

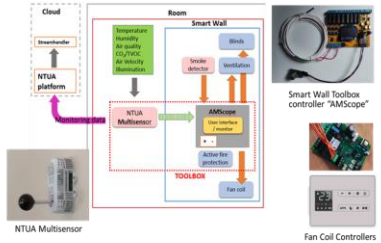




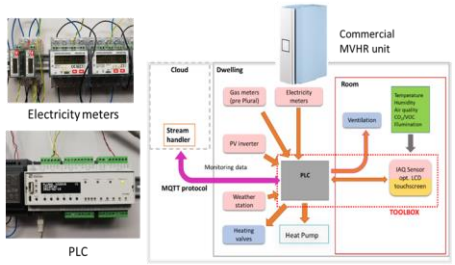
The solution – Technologies developed

The smart windows

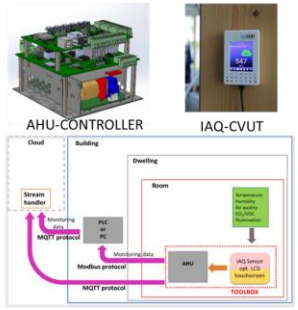
The toolboxes /supervisory control strategies



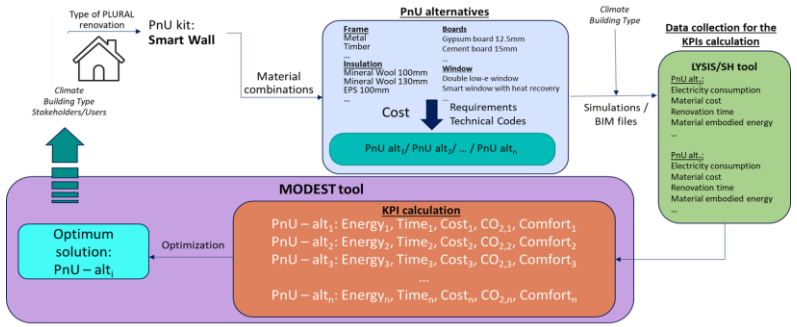
The SmartWall toolbox for Voula



The Kasava toolbox for the eWHC PnU



The IT and decision support tools: LYSIS and MODEST



The solution – Demonstration

Pilot validation and demonstration

- Three real demo cases/ Monitoring- **pre** and post retrofitting; modelling
- Three virtual demo cases; modelling
- Technical, **environmental**, and financial viability; Ensure NZEB status; Validate cost and renovation time

Mediterranean climate (hot summer)
2 of 10 flats - "SmartWall".

Greek demonstrator in Vari-Voula-Vouliagmeni (VVV)

Mediterranean climate (mild summer)
1 block of 2 – "eAHC".

Spanish demonstrator in Terrassa

Continental climate (warm, humid)
Whole building-eWHC

Czech demonstrator in Kasava

Alpine climate
"eWHC"

Virtual demonstrator in Bern

Continental climate
"SmartWall".

Virtual demonstrator in Berlin

Boreal climate
"eWHC"

Virtual demonstrator in Väsby

The solution – KPIs

KPI	Performance Value	Target value	Achieved value M18
NZeB	U-value (W/m^2K)	0.23 W/m^2K	PnU designed with U-value matvhing nZEB; Preliminary results: Voula 1.35 W/m^2K^2 , Terrassa N/A, Kasava 0.29 W/m^2K^2
	Primary Energy consumption	<60 kWh/m^2 (depends on country)	Preliminary results: Voula 178 kWh/a, Terrassa 76 kWh/m^2 Kasava 93 kWh/m^2
Cost-effectiveness	Renovation Costs	58% less than conventional renovation	Parameters influencing costs have been defined.
Fast-tract renovation	Time required for deep renovation	At least 50% reduction	Parameters influencing renovation time have been defined
Environmental impact	CO_2eq/m^2	0.5 tCO_2eq/m^2	Verification to be done
	Recyclability	70% material recyclability	90% of SmartWall materials are recyclable. To be confirmed for the other 2 PnUs (WP8).
Adaptability		System combinations	4 variants of SmartWall defined. To be confirmed for the other 2 PnUs.

Key barriers - Challenges

- Continuous increase of energy and diesel prices might affect production capacities and eventually production costs of PnU kits.

- Shortages on raw materials, high tech components, chemical compounds, etc., are already noticeable. At the moment, handled by PLURAL manufacturers

- Worldwide and/or European possible future lockdowns might affect businesses, infrastructures, organizations, commercial companies etc. and affect production of PnU kits.

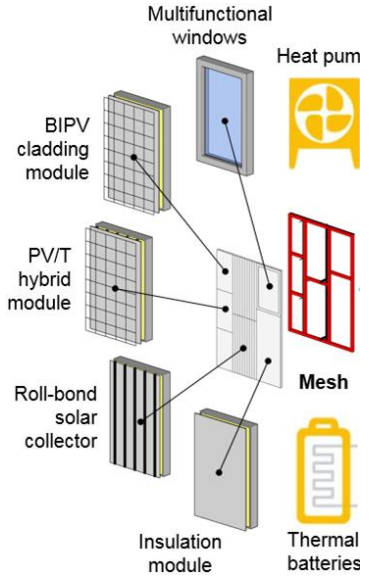
ENSNARE: ENvelope meSh aNd digitAl framework for building REnovation

Speaker	Federico Noris
Organisation	R2M Solution
Start date, duration	01/01/2021 - 49 months
Funding	H2020 - 7.99M€
Project website	https://www.ensnare.eu/

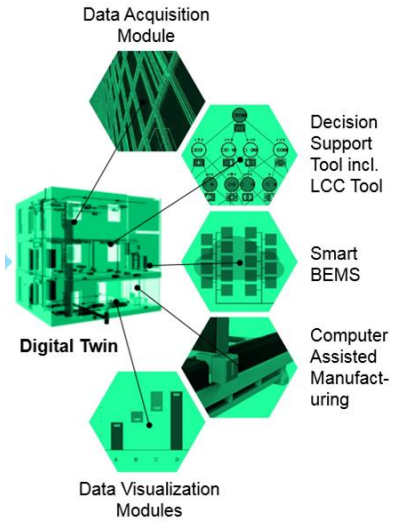
ENSNARE key objectives

The main goal of ENSNARE is to boost the implementation of NZEB renovation packages in Europe by providing a systemic methodology combining products, systems and solutions. This is done via the development of **2 key structures**:

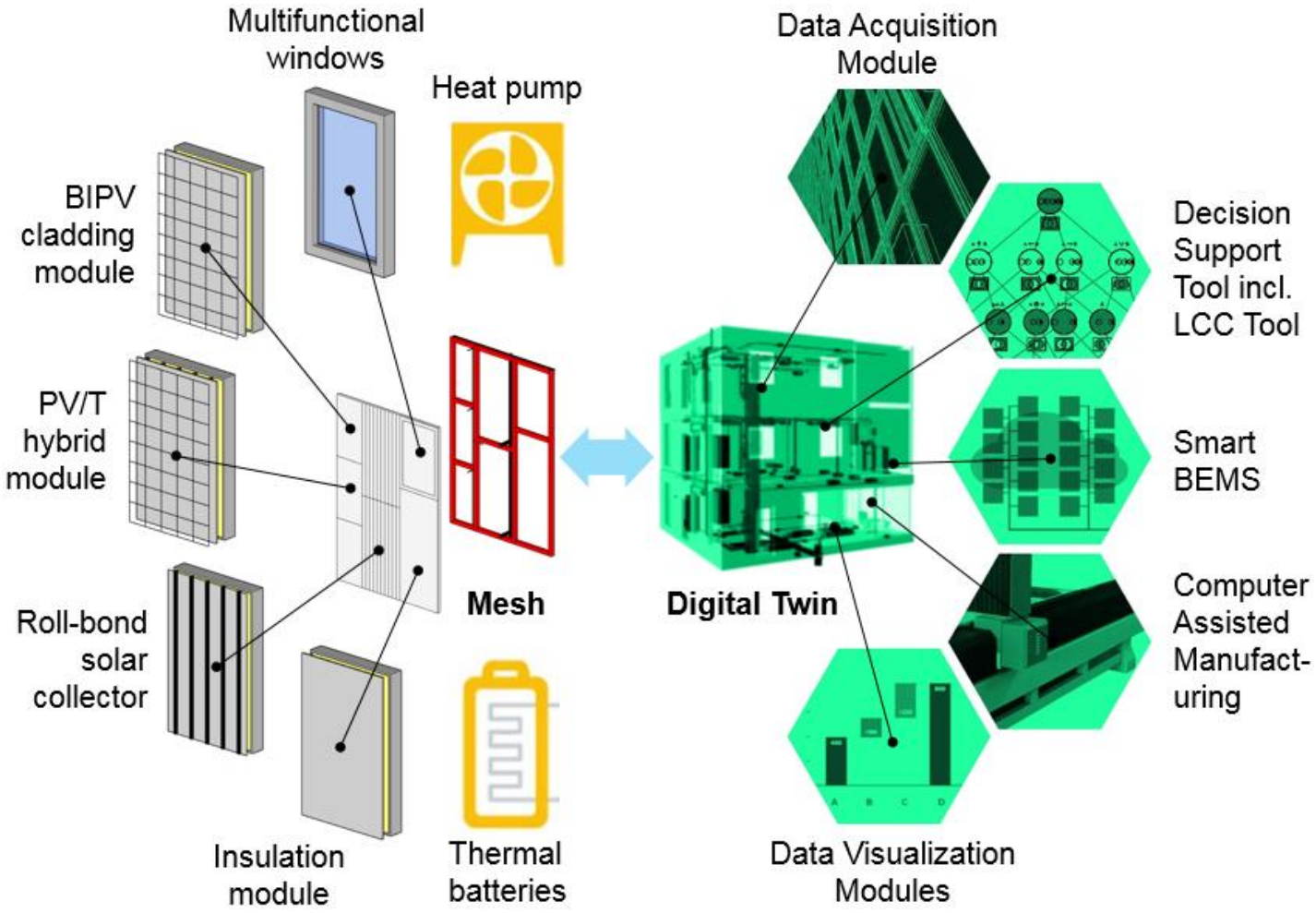
- **Modular envelope mesh** facilitating mechanical assembly & interconnection



- A **Digital platform** supporting all renovation stages leveraging a digital toolbox



ENSNARE Concept



The solution – Technologies developed

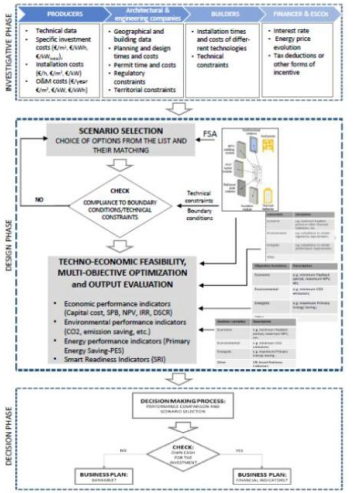
For Building Components (**Mesh**)

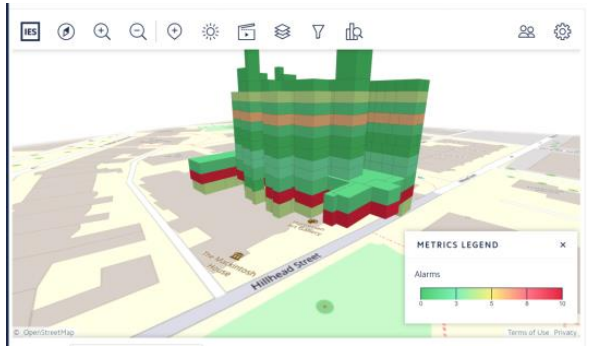
- Industrialized modular façade panels. Aluminium.
- Integrated renewable solar systems (PV, ST, PVT).
- Smart window
- Heat pump coupled to PCM storage

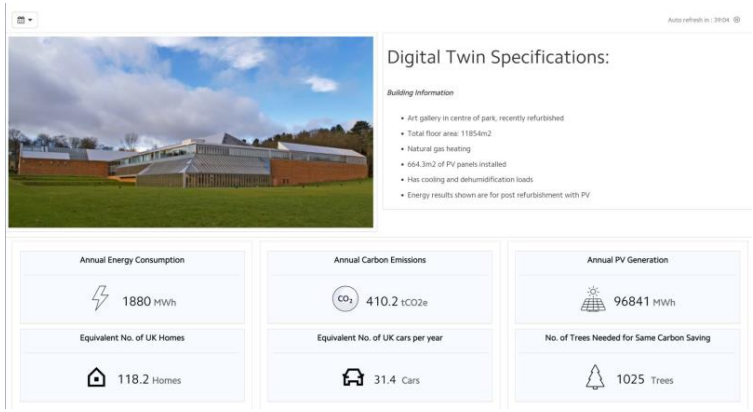
The solution – Technologies developed

For Digital solutions (**Platform**)

- Early decision support tool
- Automated data acquisition tool
- Smart BEMS
- Digital Twin







Key barriers - Challenges

- Achieve smooth and effective interconnection between both worlds: the digital and the physical one
- Get a synergetic interaction of the combined technology packages in highly efficient and reliable solutions
- Feasibility of the systems and adequate performance to be applied in the renovation sector.

Powerskin+
walls energizing buildings

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	IPN Instituto Pedro Nunes; Navodnik kemijski inženiring, d.o.o.; ams Advanced Management Solutions; Oxford Brookes University; Fenix TNT; Brunel University London; Fraunhofer ICT; Friedrich-Schiller-Universität Jena; Politecnico di Torino; Politechnika Warszawska; Flach Glas Partner – Einfach gutes Glas.; Saule Technologies; Saule Research Institute; CTU

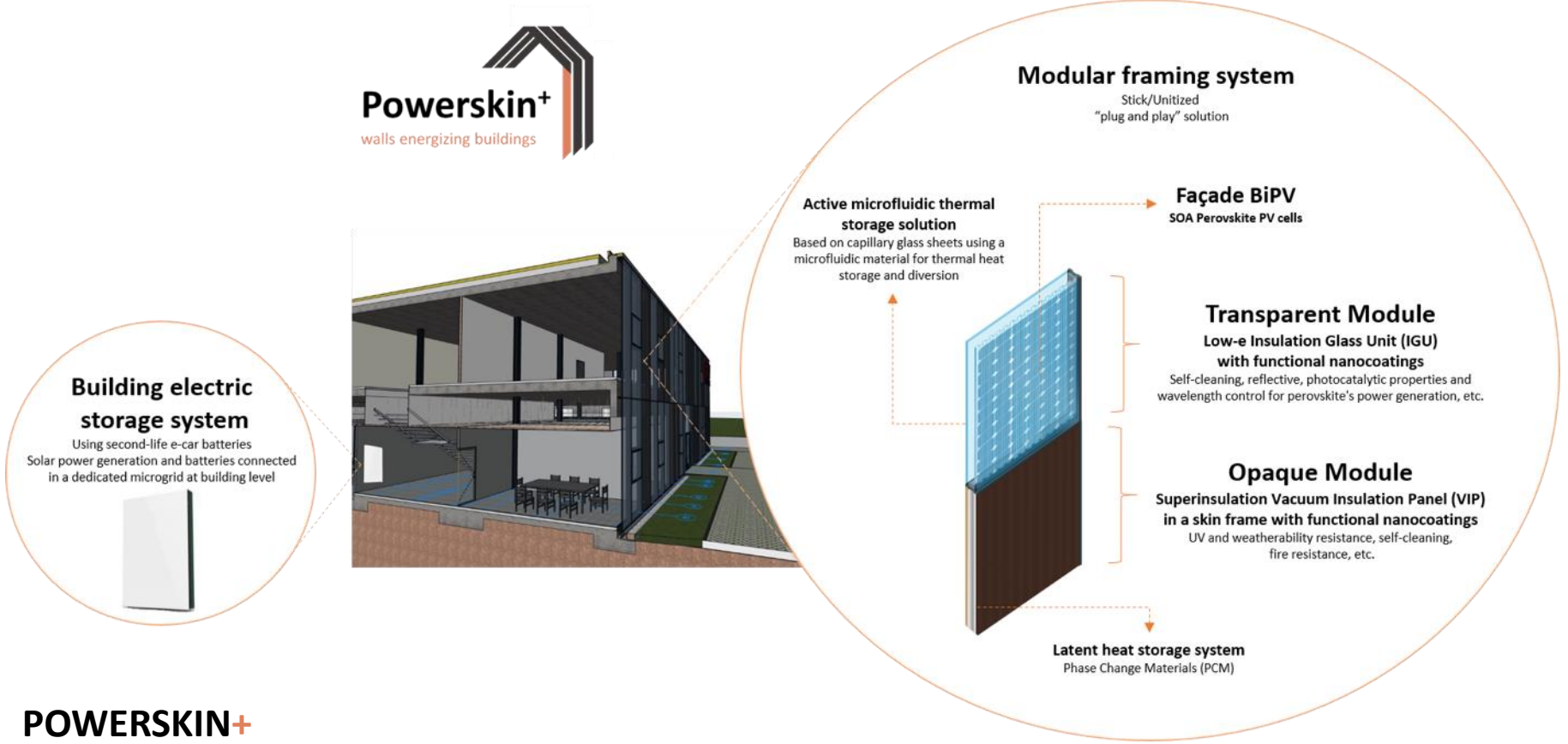
PROJECT OVERALL CONCEPT

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+

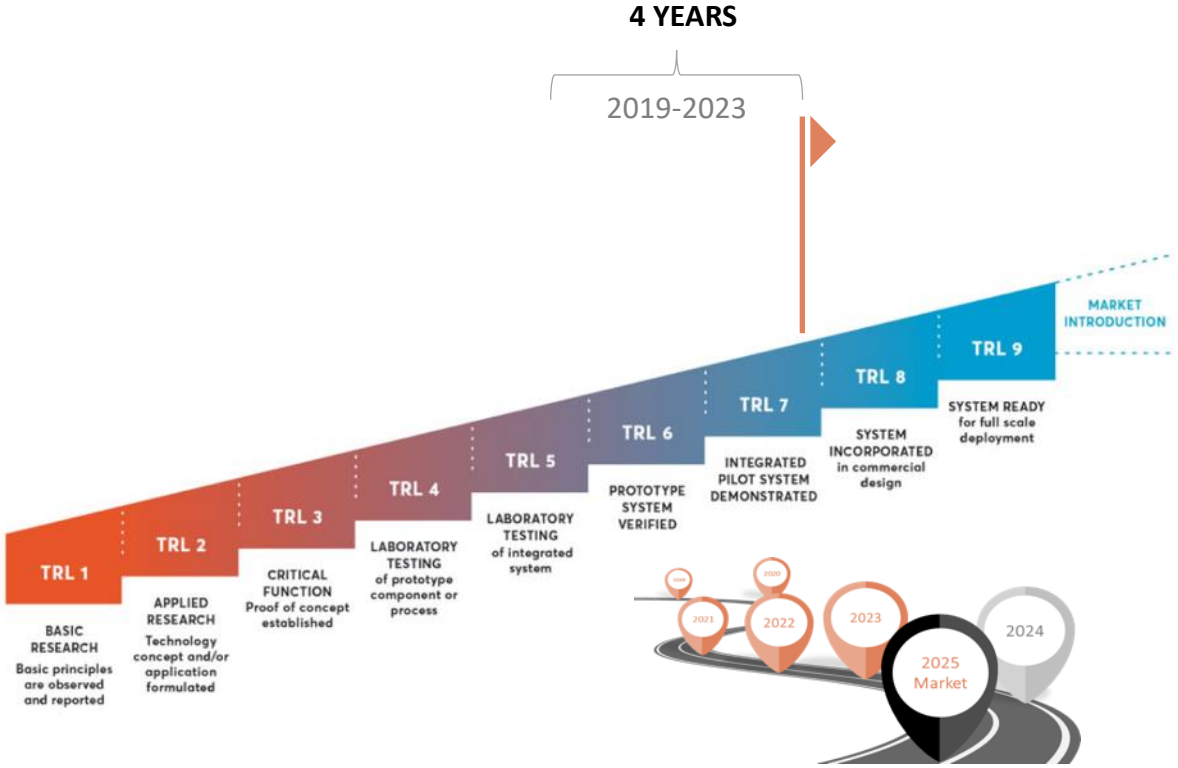
"A true all-combined modular energy management turnkey package, following superior energy efficiency and sustainable eco-design standards, especially address for modern non-residential solutions"

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

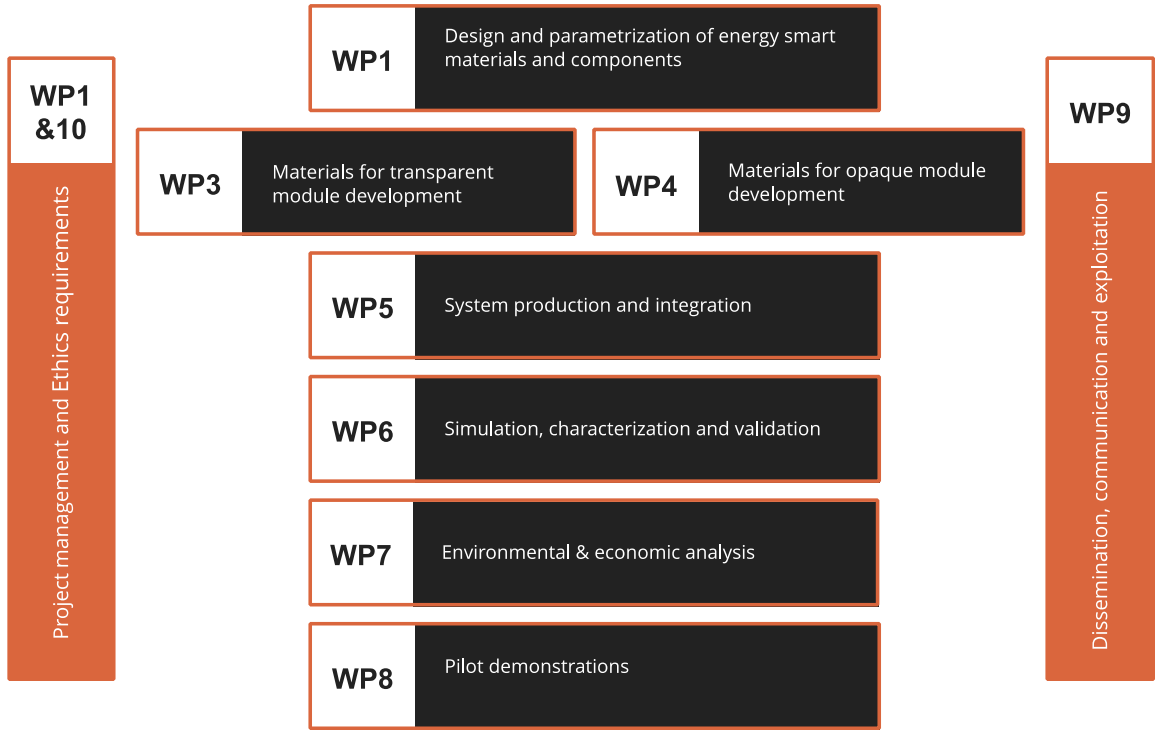


Set POWERSKIN+ from lab to operational environment (TRL7)

PROJECT METHODOLOGY

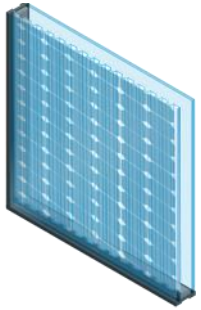
Combination of a wide number of state-of-the-art high energy-efficient KETs development/piloting program

- 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)



PS+ MAIN MODULES AND ELEMENTS

TRANSPARENT MODULE



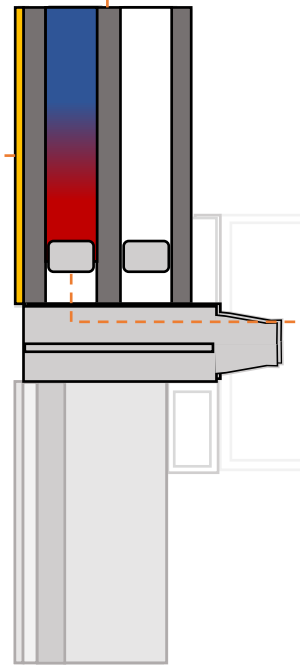
Standard

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

Add-on

Functional nanocoatings

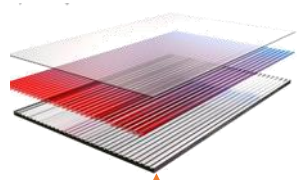
Self-cleaning, anti-reflective, photocatalytic properties and wavelength control for PV's power generation, etc.

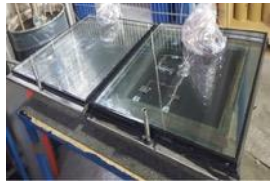


Add-on

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

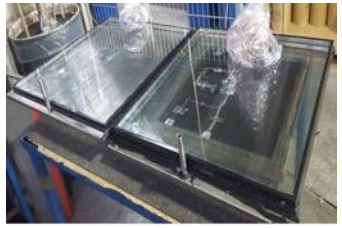
PS+ MAIN MODULES AND ELEMENTS

TRANSPARENT MODULES

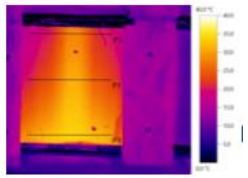
Standard

PS+ 1st generation opaque module prototype

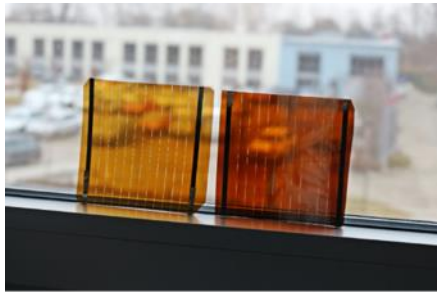
Add-on



Water flow distribution



PS+ semi-transparent microfluidic heat storage system prototypes

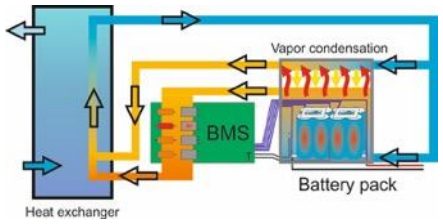


Add-on

PS+ semi-transparent PV pilot production/testing

PS + standard transparent module main features and properties

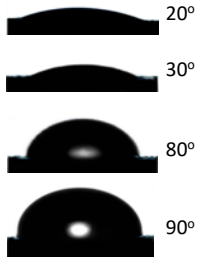
Material	Description
Glass	Soda-lime silicate float glasses melted from the following naturally occurring raw materials (main components, in mass percentage): Sand (SiO_2, 58 ma%); Soda (Na_2CO_3, 18 ma%); Dolomite ($Ca(CO_3)_2$-$Mg(CO_3)_2$, 15 ma%); Lime ($Ca(CO_3)_2$, 5 wt%); Sulphate ($[SO_4]^{2-}$, 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/m²
U-value	≤ **0.80** W/(m²K) (33.4% below the average of 1.2 W/(m²K) for an air-filled double-glazed window with low-e coatings
Dimensions	Up to 2000 x 3000 mm²
PS+ premium capabilities	Ready for add-on integration



Add-on

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

Add-on



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

PS+ MAIN MODULES AND ELEMENTS

OPAQUE MODULE

Standard

Module skin panels
(Glass / Composite / Metal)

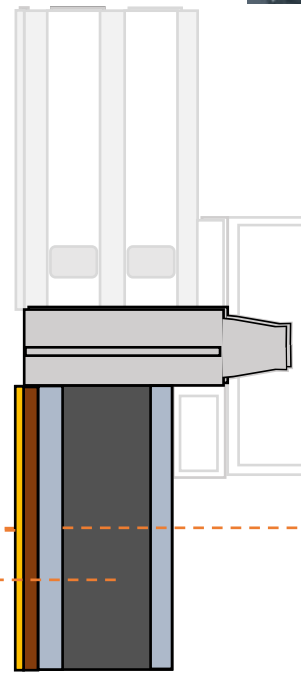
Superinsulation module
Vacuum Insulation Panels (VIPs)

Add-on

Functional nanocoatings
UV weatherability, fire resistance, etc.

Add-on

Latent heat storage system
Phase Change Materials (PCM)

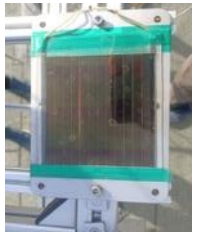


Modular framing system
Metal or composite stick/unitized
"plug and play" installation system

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

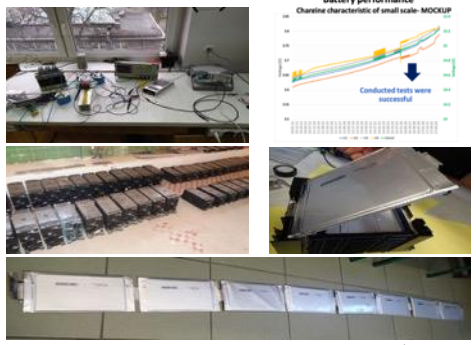
PS+ VIP insulation prototype

PS+ VIP pilot production/testing

Add-on

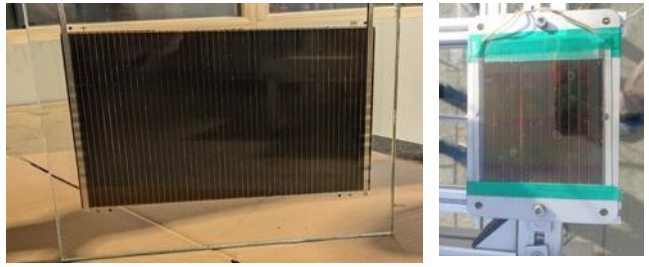
PS+ PCM 1st module

Add-on



PS+ Building electric storage system (piloting/testing)

Add-on

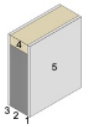
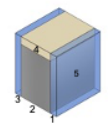
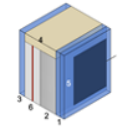


PS+ Opaque flexible perovskite PV prototype

Add-on

PS+ Opaque sprayable coatings and fire testing

PS + opaque module types, main features and properties

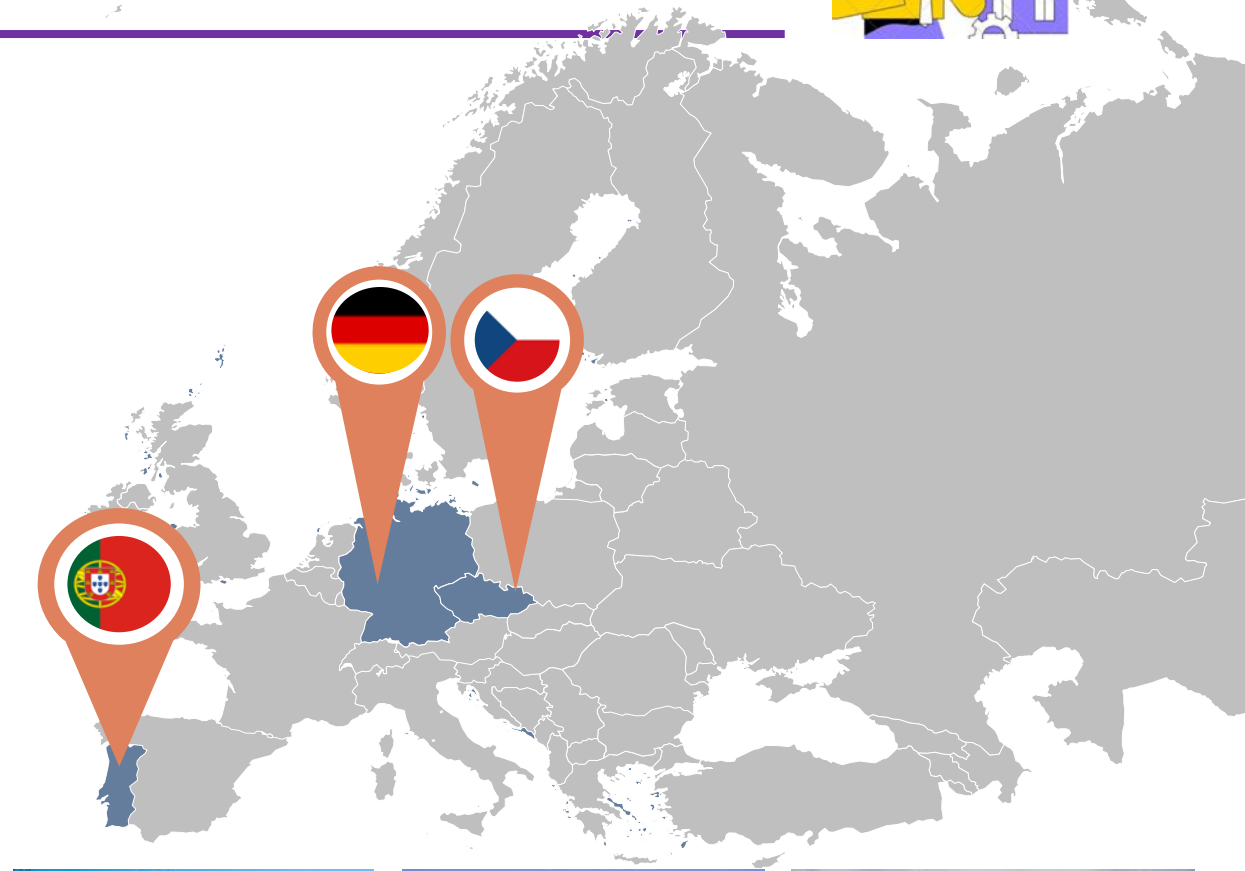
Parts	PS+ Standard Opaque Modules		PS+ Premium Opaque Modules
	Lightweight Standard Modules	Standard Modules	
Sketch			
Outer skin panel sub-module [1]	Ultra-light fibre-reinforced plastic (FRP)	Option 1: Fibre-reinforced plastic (FRP) w/ fire retardants Option 2: Opacified glass Option 3: Aluminium 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]	Recycled polymer frame (optional)	Recycled polymer frame (optional) Option 2: conventional or thermally optimised 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			
Color	Variable RAL coulors 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/m²)	4,98 [1,2,3]	Variable	Variable
U-Value (W/m²·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).

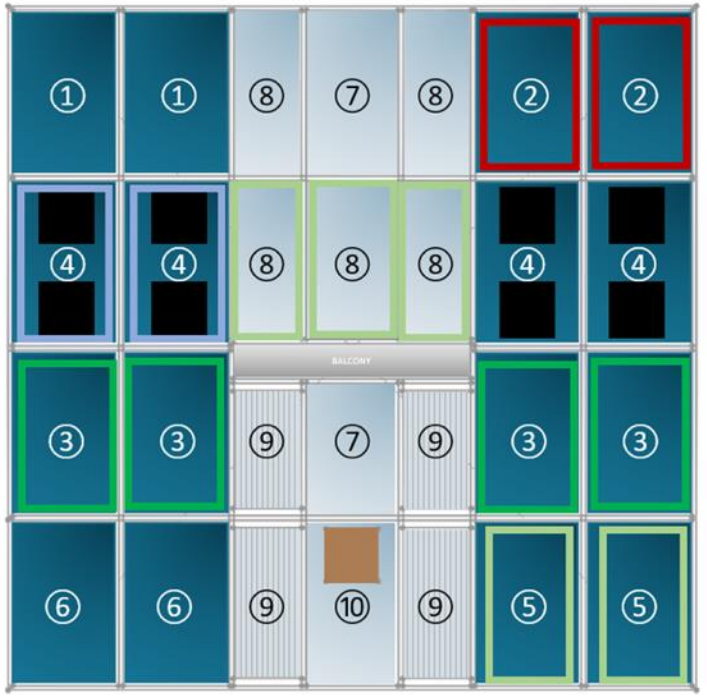
The demo cases represent **2 different climates** (Csa - Hot-summer Mediterranean and Cfb - Oceanic in the Köppen climate classification), as well as different building practices characterizing and realising how the overall system will work in real conditions in the future.



PILOTING DEVELOPED TECHNOLOGIES

Future pilot demonstration at IPN

Main demo installation



IPN installation (Coimbra, PT)
Planned for Autumn 2022

TIMELINE TO RESULTS

POWERSKIN PLUS Mock-up

POWERSKIN PLUS outdoor test cells

2021

May
Materials, integrated systems production and performance specification defined

September
First set of standard opaque and transparent prototype modules realized

2022

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

October
Installation and full-year demonstration initiated in operational environment

2023

February
POWERSKIN+ lab-scale experimental validation completed

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

KEY BARRIERS - CHALLENGES

Financial & market barriers

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

Technical barriers

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

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

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

CONTACTS

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THANKS FOR YOUR ATTENTION

Please visit our website

www.powerskinplus.eu

Contact us via e-mail

info@powerskinplus.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869898.

Lightweight switchable smart solutions for energy saving large windows and glass facades

Speaker	**Matthias Fahland**
Organisation	**Fraunhofer FEP**

Start / end date of project	**1st October 2020- 30th September 2023**
Funding	**H2020**
Project website	**https://switch2save.eu**

Fraunhofer ISC

ChromoGenics

Fraunhofer FEP

AMIRES

UNIVERSITY OF WEST BOHEMIA

AGL Technologies

FASADGLAS

ΓΕΝΙΚΟ ΝΟΣΟΚΟΜΕΙΟ ΝΙΚΑΙΑΣ ΠΕΙΡΑΙΑ "ΑΓΙΟΣ ΠΑΝΤΕΛΕΗΜΩΝ" 2η Υ.ΠΕ. ΠΕΙΡΑΙΩΣ & ΑΙΓΑΙΟΥ

E²ARC Energy Efficient Architecture Renovation Cities

Project key objectives

- Improved energy efficiency of buildings by smart windows
- Low weight → easy integration into existing buildings
- Reasonable price → affordable integration into existing buildings

Smart Windows
Next generation technology for transparent building envelops

→ SWITCH2SAVE →

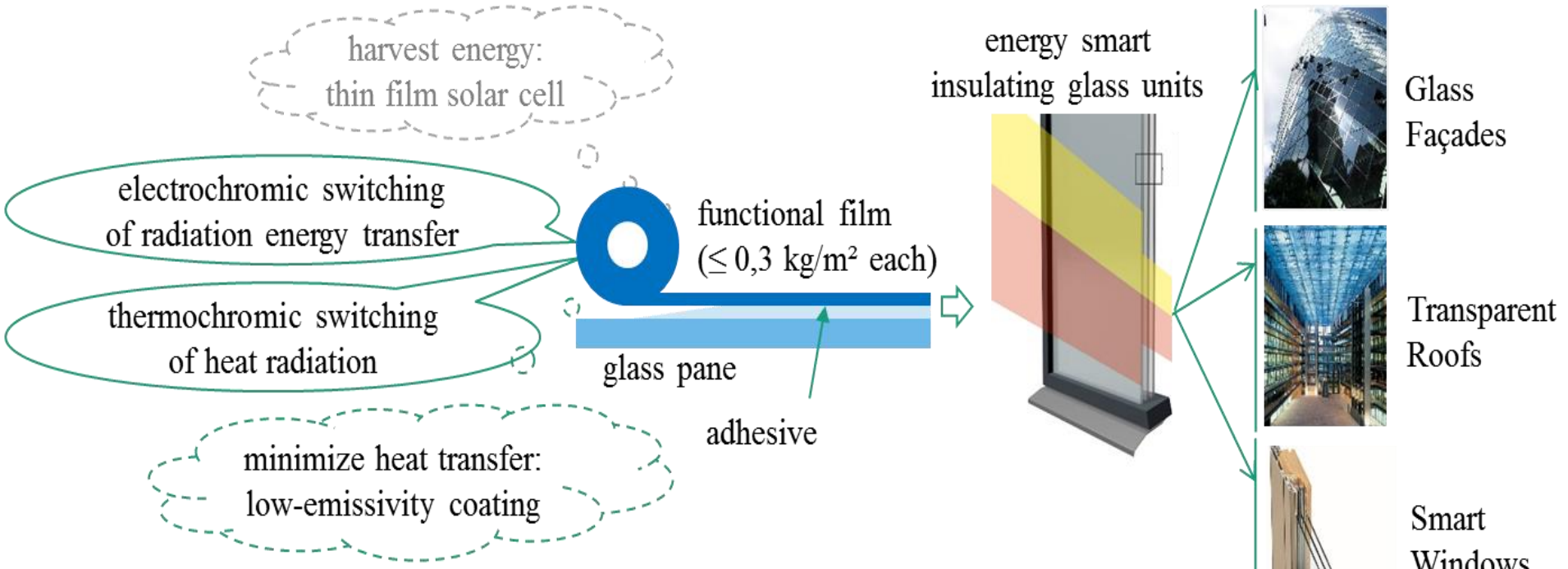
Electrochromic windows
(reacting to control by humans or control systems)

Thermochromic windows
(reacting to window temperature)

Concept and Methodology

source: Vasakronan

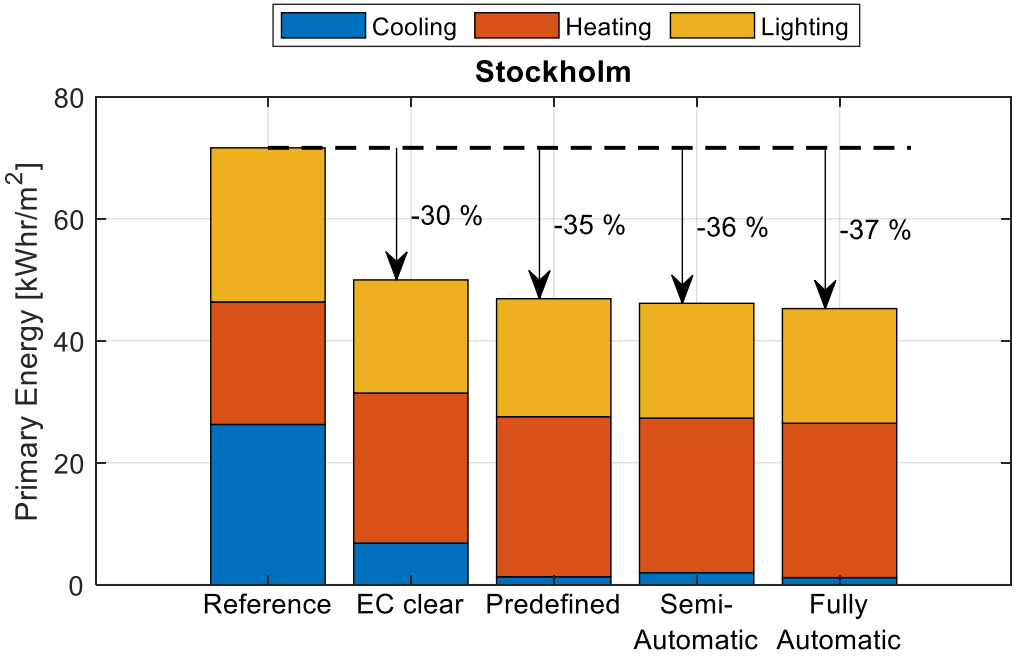
source: General Hospital of Nikaia

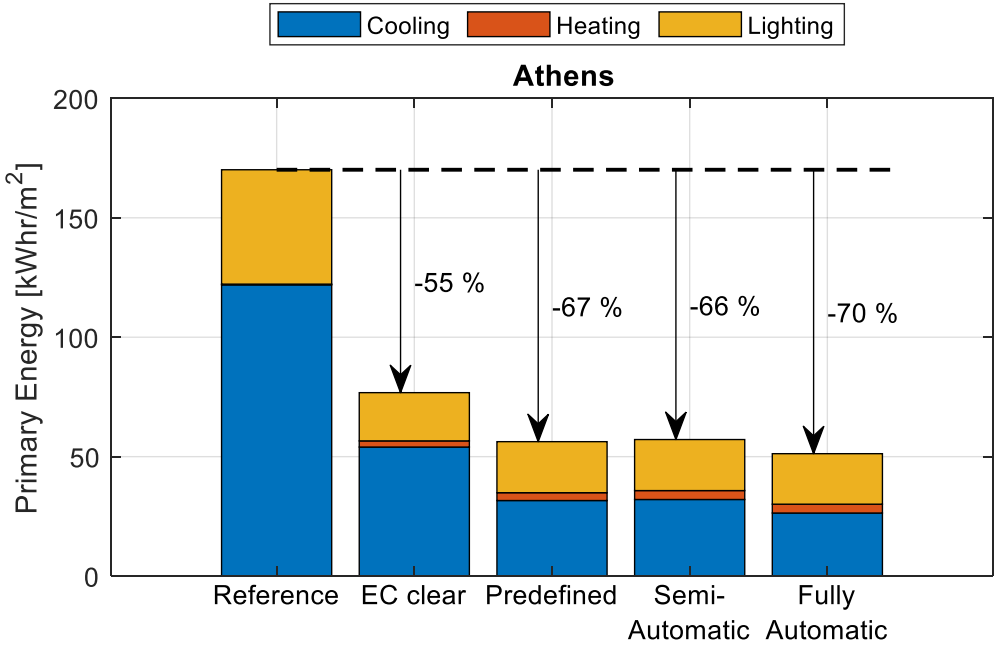


Energy Smart Material → Functional film and Integration technology → Building Components → Low-Carbon Zero Energy Buildings

The solution – Technologies developed

- Improved electrochromic and thermochromic coatings
- Projection of achievable energy savings

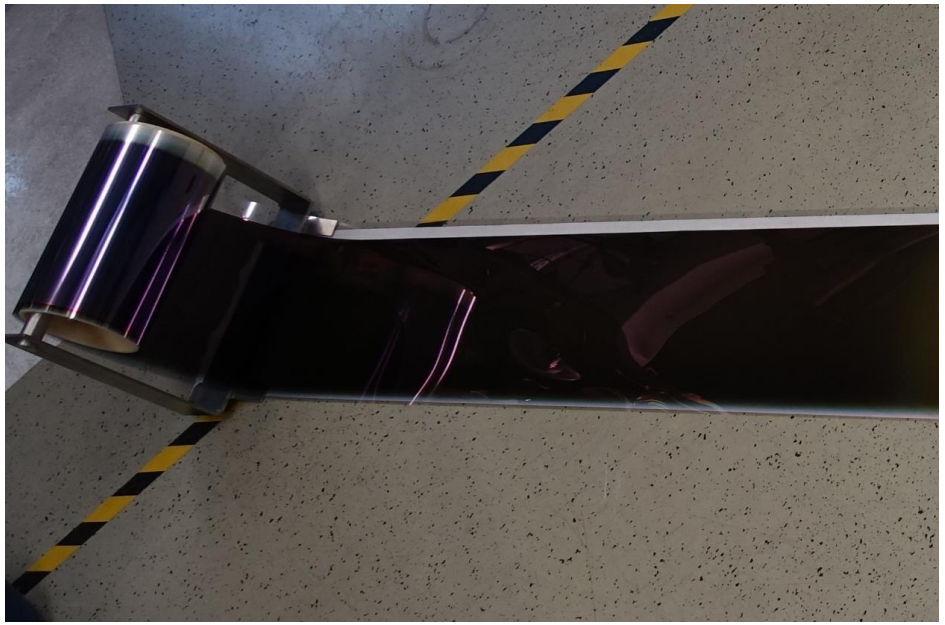




Plug-and-Play solutions of the project

- Smart window components ready for the integration in buildings and mockups

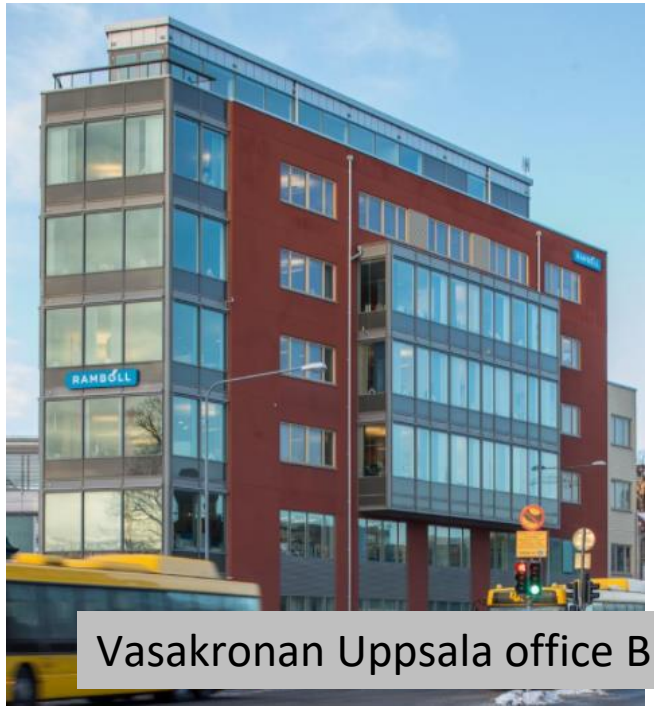
large area electrochromic demo
(IGU 4.42 m^2)



large area thermochromic demo
(30 cm wide continuous roll)

Plug-and-Play solutions of the project

- integration in pilot buildings and mockups (different latitudes, for keeping places warm (EC) and cold (EC+TC))



Vasakronan Uppsala office Building

NTUA Athens Mockup Buildings

Plug-and-Play solutions of the project

- Affordable solution: effective large scale manufacturing tested!

Electrochromic materials (roll-to-roll equipment)

Thermochromic materials (VON ARDENNE equipment)

Key barriers - Challenges

- Manufacturing costs
- Installation costs
- Lifetime expectations in building industry (experimental & pilot buildings with reduced requirement ?)

StepUP: *Decarbonisation of the EU building stock: innovative approaches and affordable solutions changing the market for buildings renovation*

Speaker **Amisha Panchal**

Organisation **IES**

Start / end date of project **01.08.2019 to 31.10.2023**

Funding **H2020**

Project website www.stepup-project.eu

Logos of project partners:

Project key objectives

Make renovation more attractive and reliable with a new methodology based on near-real time data intelligence.

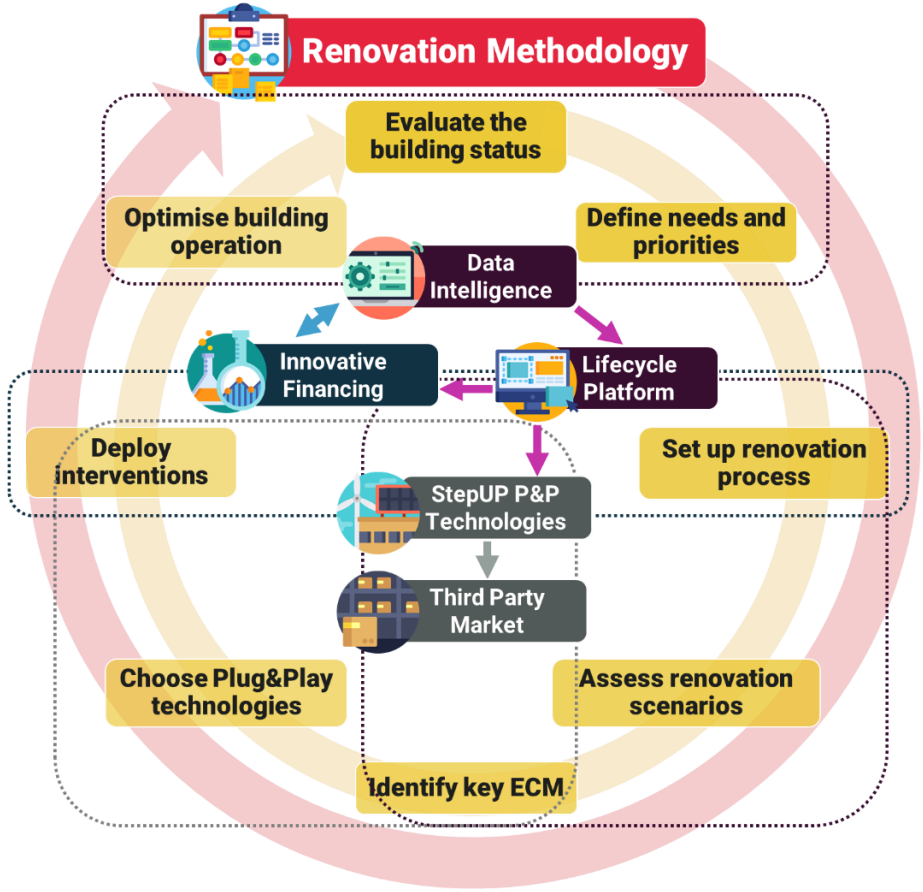
Reduce the performance gap to 10% difference between design and operations by developing an integrated life-cycle software platform.

Optimize renovation investments by developing innovative financing models for integrated optimization of energy

Minimise time on site to 40% of current renovation onsite work by advancing innovative passive and active technologies to a market-ready modular renovation package of Plug & Play Technologies.

Accelerate the renovation market via an interoperability protocol for renovation solutions, enabling compatibility with the StepUP solutions to allow the integration of third party market products, fostering an open Plug&Play technological environment accessible to innovative SMEs.

Concept and Methodology



An iterative and holistic methodology

- Methodology for a systematic whole building renovation, incorporating the **stakeholders' needs** at the centre.
- **StepUP** methodology, based in Data Intelligence, has the objective to deliver affordable deep renovation technologies, another step towards EU building decarbonisation.

> *"At the core of the StepUP project relies an **incremental, iterative renovation methodology** aimed to cover every phase of the renovation process to make each step more effective"*

Concept and Methodology

Methodology followed to realise it:

3D RELIEF

PULL OUT TEST

DESIGN OF THE STRUCTURAL REINFORCEMENT

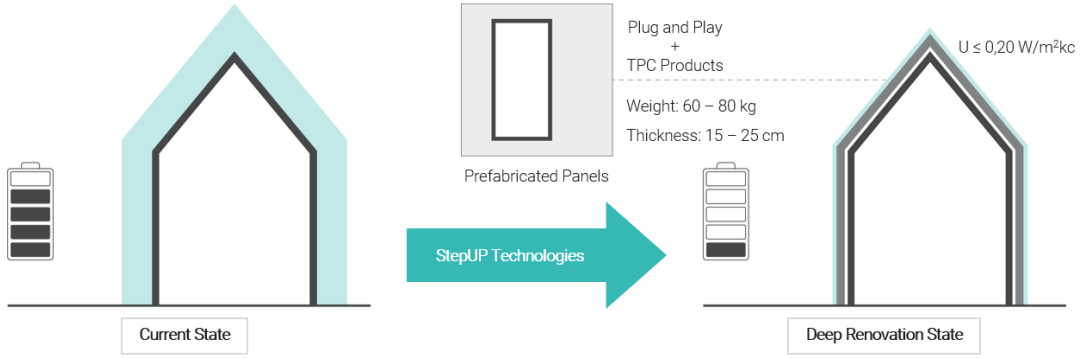
DEFINITION OF THE FACADE PARTS THAT WILL BE INSTALLED WITH THE P&P MODULE AND THE AREAS IN WHICH CONVENTIONAL SOLUTIONS ARE REQUIRED

DESIGN OF THE P&P MODULES ACCORDING TO THE FACADE PLAN PREPARED BY ARCHITECTURE STUDIO IN CHARGE OF THE PROJECT

PRODUCTION

The solution – Technologies developed

1. **Non disruptive and modular system.** The P&P module is installed outside of the building envelope and increase the thermal performance of the building
2. **Plug&Play hybrid system.** Offers the capability to integrate different subcomponents (active and passive systems) such as windows, different finishes, solar protection
3. **Performance monitoring.** Real-time data collection through sensors incorporate into the P&P module to validate the energy performance through different iterations of building renovations.
4. **Offsite preassembly system.** Reduction of installation errors and onsite work by applying P&P preassembled solutions. The disruption in residents' life is reduced significantly.
5. **Highly customized industrialized P&P module.** The developed modules will be adaptable to different building configurations and local scenarios.
6. **Improvement in the energy performance of the buildings.** Solution for deep renovation in buildings with high energy consumption. The solution offers tools to reach NZEB buildings.



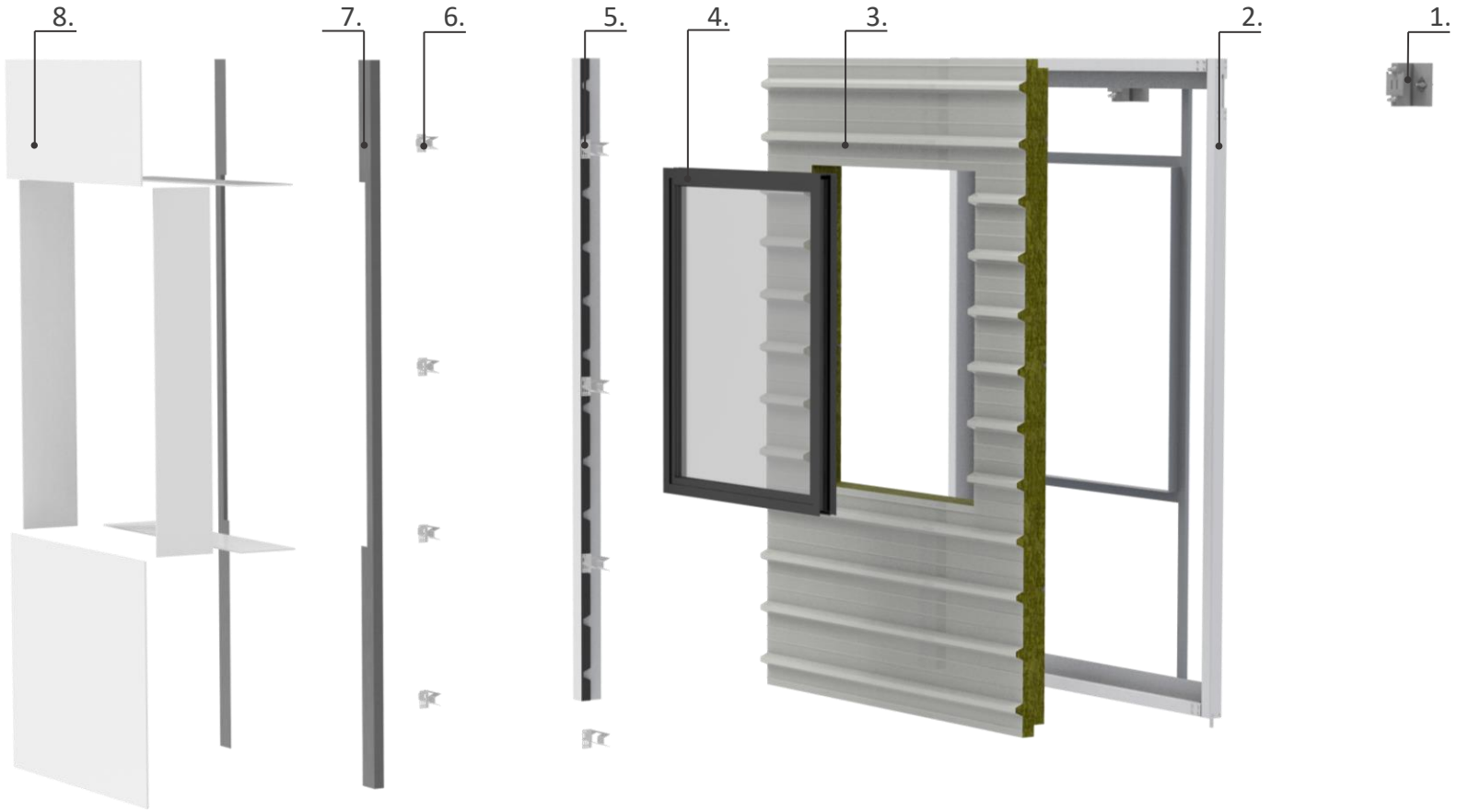
Plug-and-Play solutions of the project

INDEX:

1. Module components
2. Module types
3. Technical details
4. Possible integration
5. Installation Sequence

Plug-and-Play solutions of the project

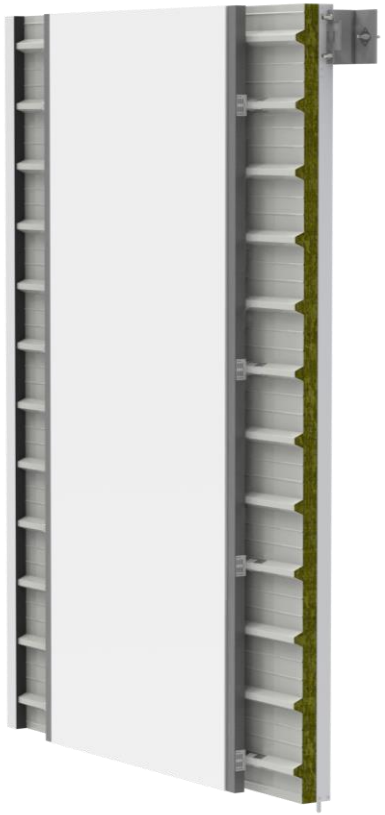
Module components

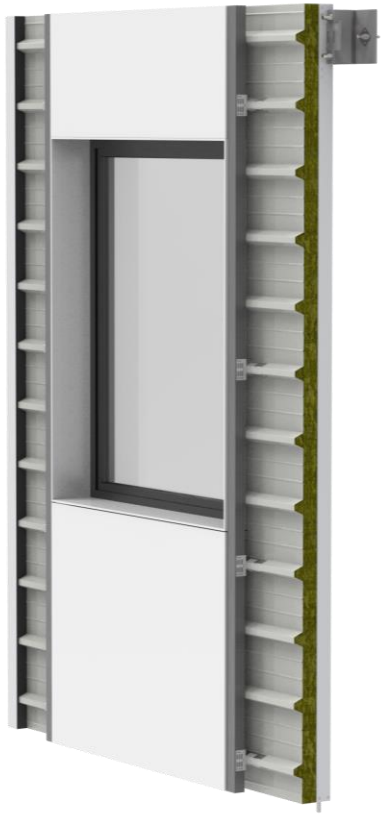


1. Anchor system
2. 3-mm galvanized steel structure
3. Mineral wool or polyurethane sandwich panel
4. Windows
5. Flashings and protection elements
6. Brackets
7. L or T profiles in aluminium/steel for the installation of external cladding
8. Façade panel

Plug-and-Play solutions of the project

Module types



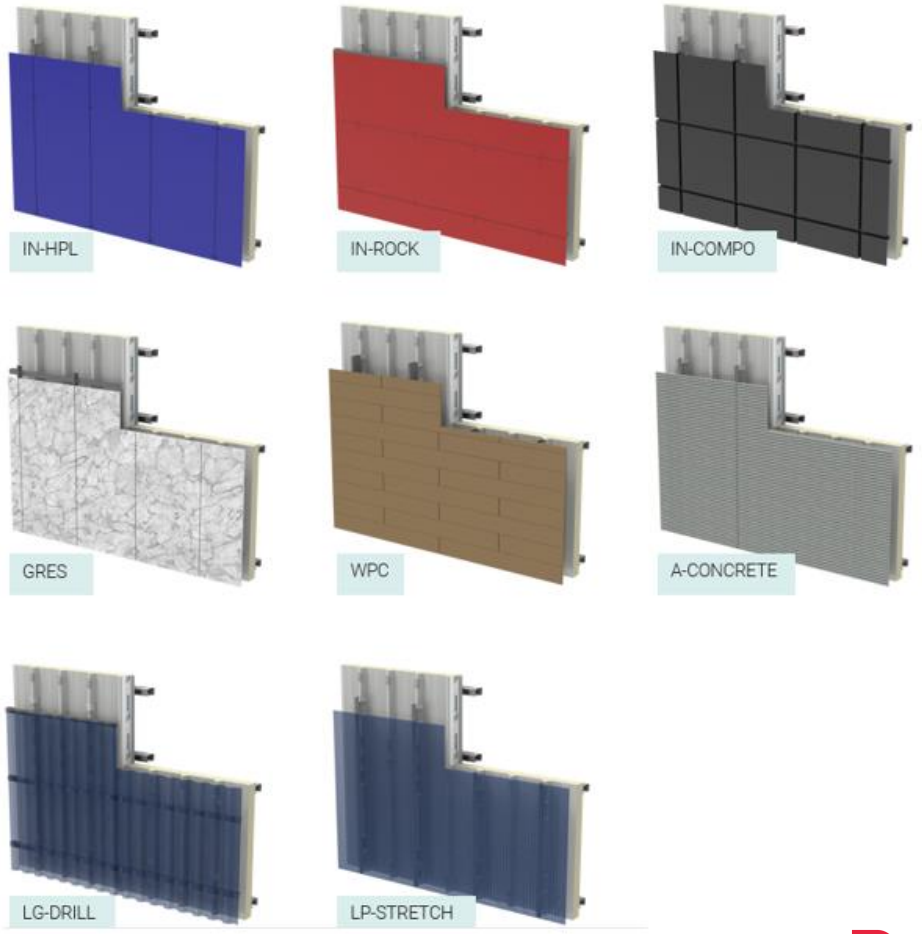


Plug-and-Play solutions of the project

Technical details

Features	Parameters
Available insulating materials	- Mineral Wool (MW) - Polyurethane foam (PU)
Sandwich panel's U value*	- 0,50 – 0,20 W/m2 K (MW) - 0,28 – 0,15 W/m2 K (PU)
Sandwich panel's Thickness	- 80 – 200 mm (MW) - 80 – 150 mm (PU)
Module's Thickness	- 175 – 390 mm (MW) - 175 – 340 mm (PU)
Module's Width	1300 – 2000 mm
Module's Height	3000 – 4000 mm
Module's Weight	250 – 400 kg/module
Bracket's Resistance	Up to 20 kN
Wall Resistance	The minimum value is not defined, a depends on many factors (such as dimen and weight of the P&P module and the sp project requirements of the existing buildin
Available materials for external finishing	- HPL - Rock-fibre compressed Panel (PFRI - Composite - Ceramic - Wood-Polymer Composite (WPC) - Composite fibre cement - Metal sheets (perforated and stretc
Fire Reaction and Fire Resistance	The values need to be evaluated based o local requirements and on the characteristi the project

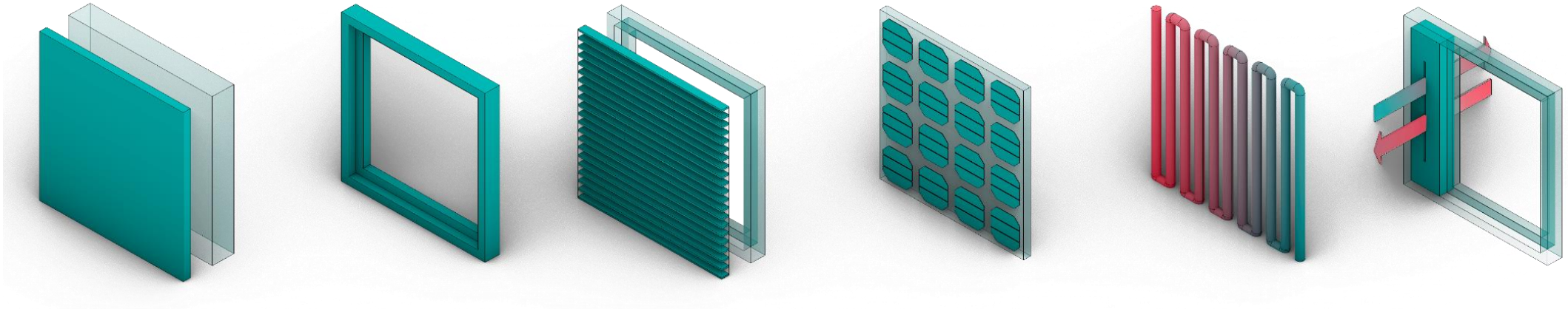
* The U-Value of the overall P&P module can be considered improved by 20% thanks to the air gap ventilation



Plug-and-Play solutions of the project

TPC integration

The integration of passive and active systems in to the P&P module has been taken into consideration.



External Layer | High Performance Windows | Solar Protection | Sun Shading | PV | ST Panels | Heating | Cooling Systems | Demand Controlled Ventilation

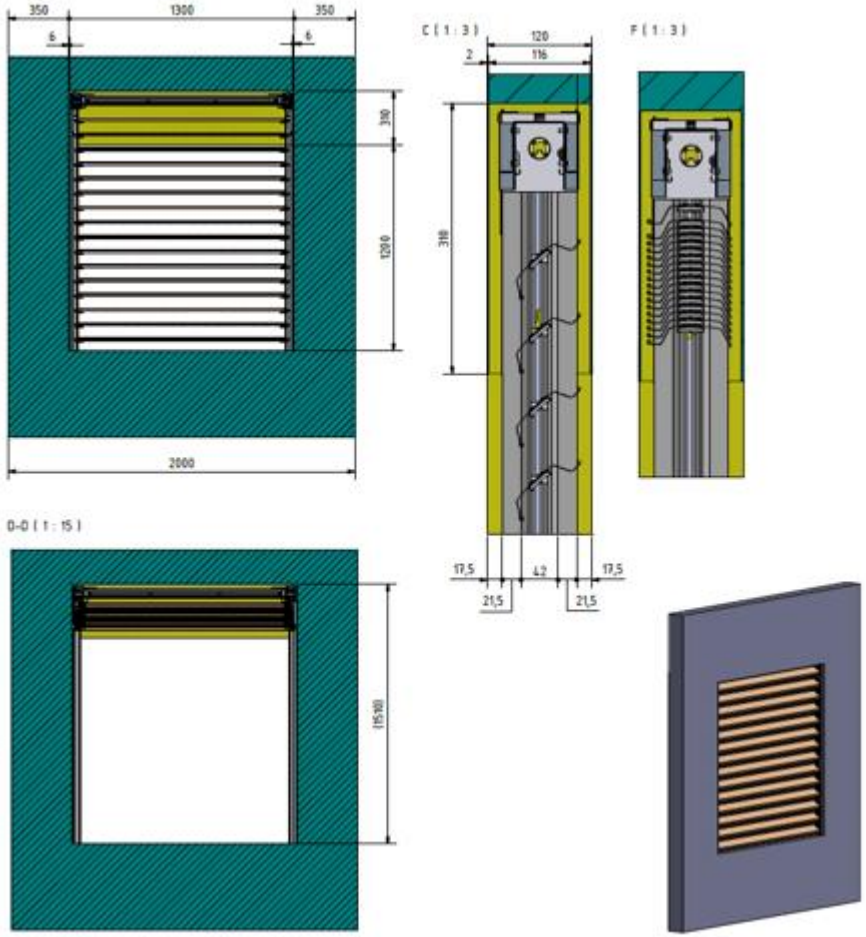
TPC Passive Technologies

TPC Active and Monitoring Systems

TPC = Technology provider cluster

Plug-and-Play solutions of the project

Possible integration



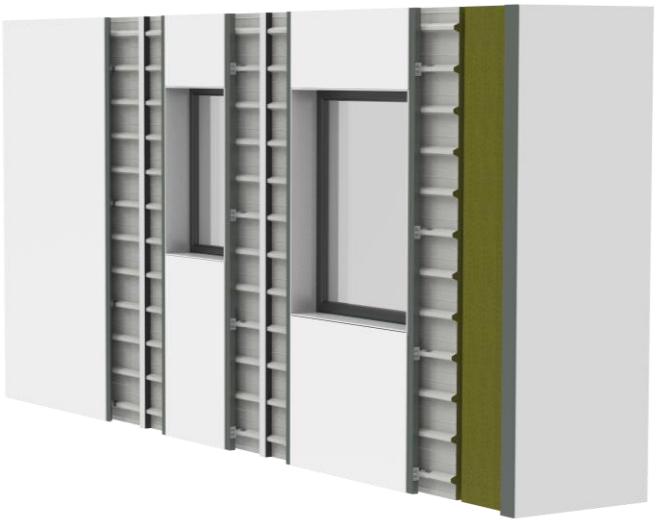
The integration of passive systems in to the P&P module has been taken into consideration.

Foldable and adjustable blinds by Gradhermetic can be integrated in the façade.

This kind of solution consists of slats which can be oriented from 0° to a maximum of 115° and can be moved up and down, until achieving a total closure.

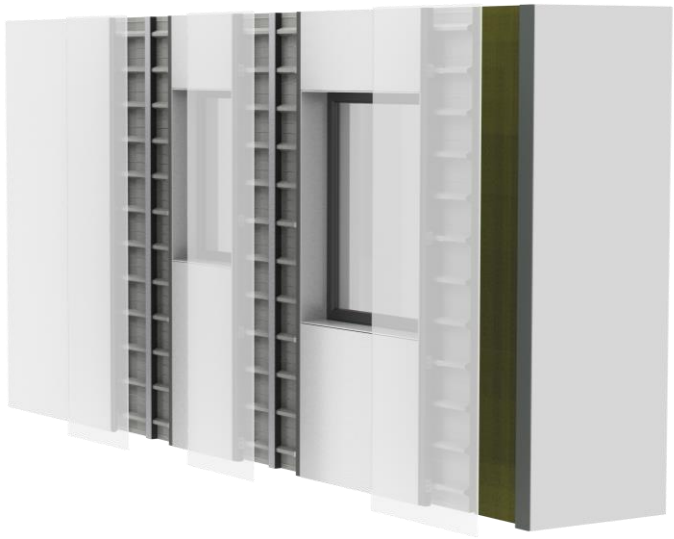
Plug-and-Play solutions of the project

Installation Sequence



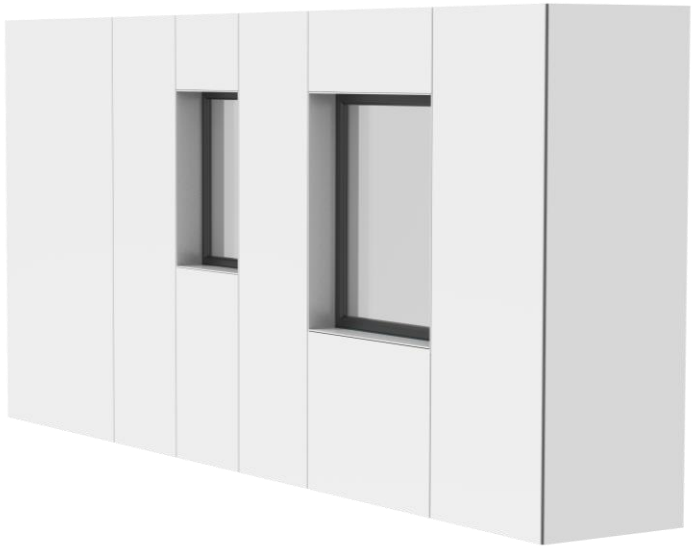
1.

Positioning and installation of Plug&Play modules on the existing façade



2.

Positioning of jolly modules

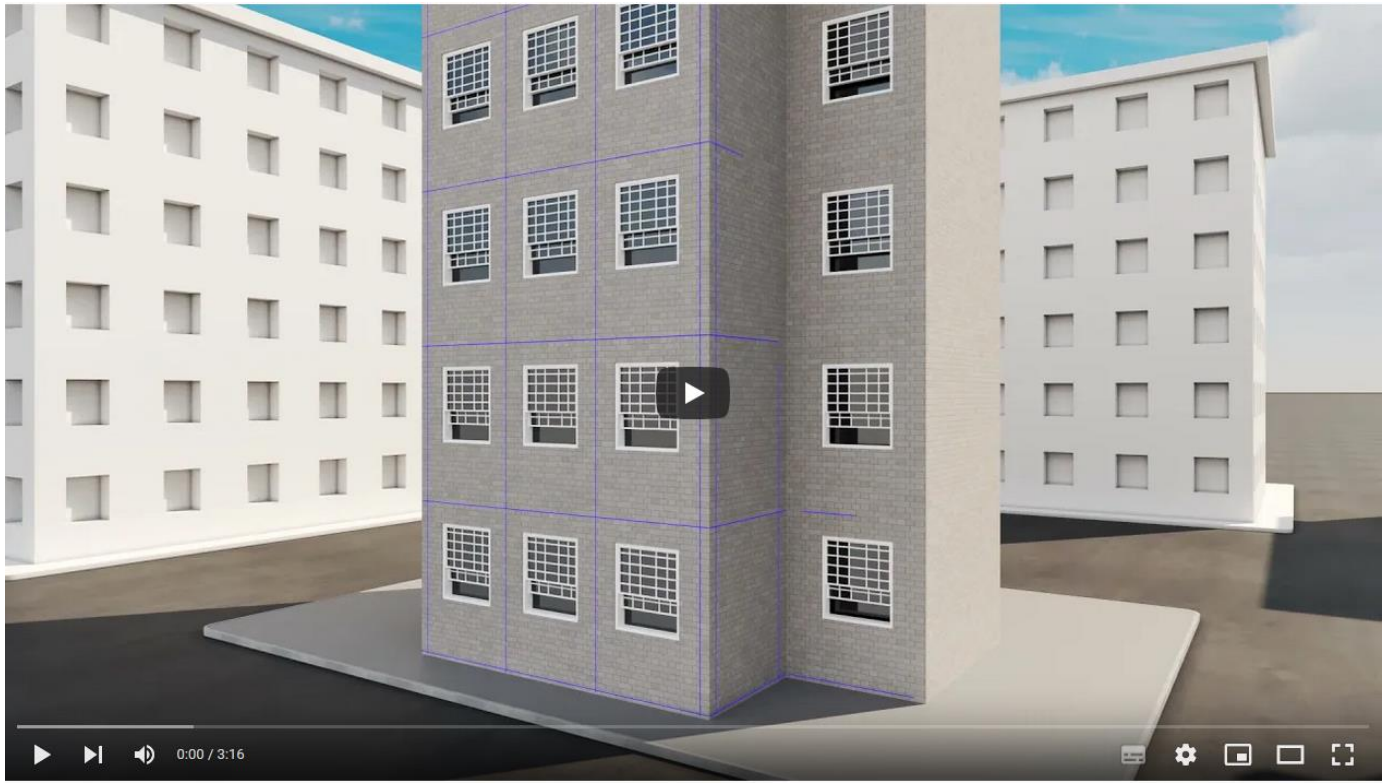


3.

Fixing of the jolly modules to complete the facade

Plug-and-Play solutions of the project

Installation Sequence



- 6 modules (2000x3700 mm)
- 2 workers for the construction of the modules
- 48 working hours to construct the modules
- 5 hours to install 48 mq on site

Key barriers - Challenges

- The integration of more **third-party products** should be further developed .
- **Installation in a real case pilot** to collect information for future improvements.
- **Monitoring the energy performance** to validate the implementation of the P&P module towards nZEB.
- **Hesitation from installers** and contractors as the technology is new

Q&A

Tank you!

DRIVE

DRIVE 0

Speaker	John van Oorschot, PhD. MSc.
Organisation	Zuyd University
Start date, duration	Oct 1, 2019 – Sept 30, 2023
Funding	H2020 – EU.3.3
Project website	https://www.drive0.eu/

Zuyd Research

Project key objectives

- DRIVE 0 aims to come to a decarbonization of the EU building stock and to accelerate deep renovation processes by enhancing **a consumer centred circular renovation process** in order to make deep renovation more attractive for consumers and investors, more environmental friendly.
- The objectives are:
  1: To develop proven Plug & Play prefab deep renovation solutions
  2: To provide consumers and potential investors with attractive and understandable information of real total performances
  3: To demonstrate circular renovation solutions in combination with local drivers in live demonstration cases.
  4: To foster new consumer centred business models for circular circular renovation concepts.
  5: To roll out the concept on a wider EU scale by involving EU interest groups

DRIVE Project Concept

DRIVE Project Methodology

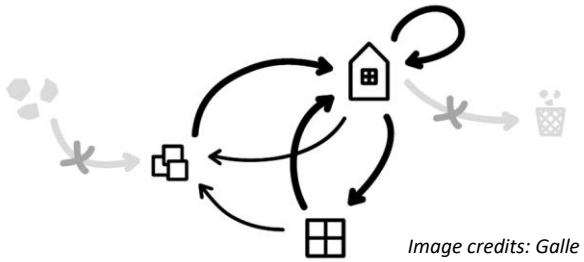
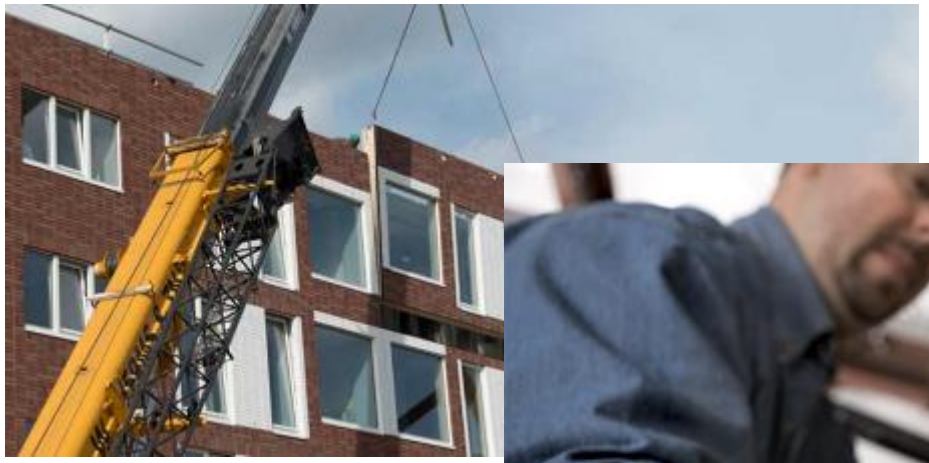


Image credits: Galle W., De Temmerman N., Vrije Universiteit Brussel

1. Market ready renovation products & concepts
   → *circular renovation products & concepts:*
   - Based on local availabiilty;
   - Use of bio based materials and components;
   - Emphasis on modular plug & play prefab solutions for building envelope elements and services;
   - Automated BIM controlled production processes.
2. Developing attractive *consumer centred business models* based on circular renovation concepts.
3. Providing occupants with *attractive and understandable* information on building performances in use.
4. Providing relevant stakeholders evidence of performance of the developed DRIVE 0 solutions by *local study and demonstration cases* initiated by ‘local drivers’.

Zuyd Research ZUYD

DRIVE The solution – Technologies developed



WEBO

ab construction

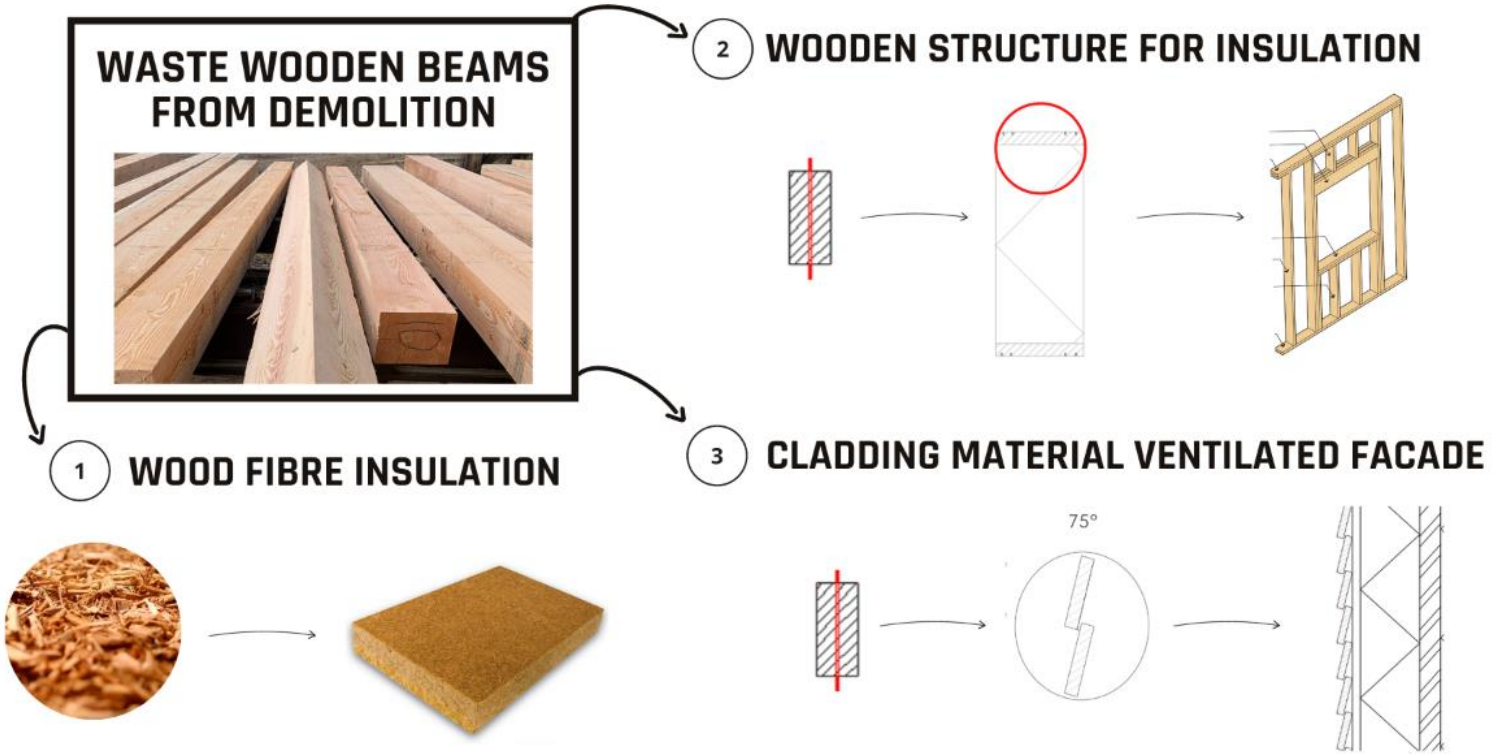
Factory 0 compact installation kits

ALIVA Alucovering facade

Zuyd Research

ZUYD

DRIVE The solution – Technologies developed



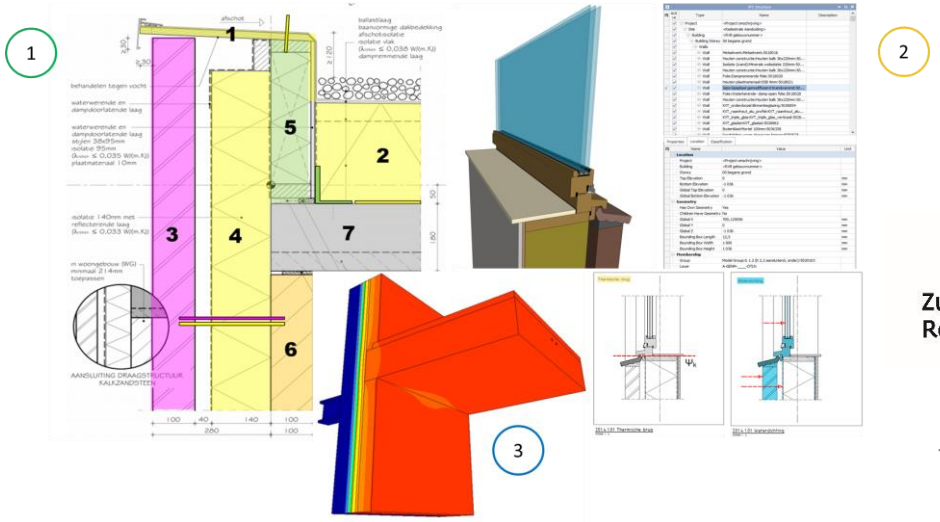
Zuyd Research

DRIVE The solution – Technologies developed

Compact building services (HVAC) kits

Prefabricated 3D extensions
(https://www.emergo.nl/producten-en-oplossingen/woonmodules)

Interfaces



Zuyd Research

ZUYD

DRIVE The solution – Technologies developed

Accenture-Circular-Advantage-Innovative-Business-Models-Technologies-Value-Growth.pdf

Zuyd Research

Key barriers - Challenges

Barriers:

- **Legal & regulatory barriers** due to rigid building, product regulations, guarantees
- **Lack of interest & trust** in circular modular building components from home-owners

Challenges:

- **Financial, legal & operational risk** increase in circular business models & therefore challenges in circular value chain creation
- **Low market price of virgin materials** compared to recycled materials

Positioning paper:

Boosting the renovation wave with Zero Energy Renovation Kits: mapping challenges, barriers and strategies

John van Oorschot

DRIVE

Speaker	John van Oorschot, PhD. MSc.
Organisation	Zuyd University
Start date, duration	Oct 1, 2019 – Sept 30, 2023
Funding	H2020 – 841850
Project website	https://www.drive0.eu/

Zuyd Research

Positioning paper: key findings

Positioning paper:

Boosting the renovation wave with Zero Energy Renovation Kits: mapping challenges, barriers and strategies

Zero Energy Renovation Kits:

- Are defined as integrated solutions which includes the envelope, the technical building systems and elements, the appliances, the energy production systems which allow the delivery of a net zero energy consumption building (Saheb, 2016)
- Typically characterized by a one-to-one mapping between functions and physical subsystems and have standardized, decoupled interfaces (Ulrich, 1995)

Zuyd Research ZUYD

Positioning paper: key findings

- Despite its potential many related innovations seem to fall into a chasm after they have been adopted by early adopters and subsequently fail to be adopted at large scale
- What is missing are context specific, empirical studies unravelling the barriers and interventions strategies innovators have to deal with developing and introducing industrial and modular Zero Energy Renovation Kits.

Which technological, market, financial, legal and institutional barriers hinder the market uptake of modular and industrial Zero Energy Renovation Kits, and which strategies could overcome these challenges and barriers?

Zuyd Research

Positioning paper: key findings

INFINITE BUILDINGRENOVATION

DRIVE

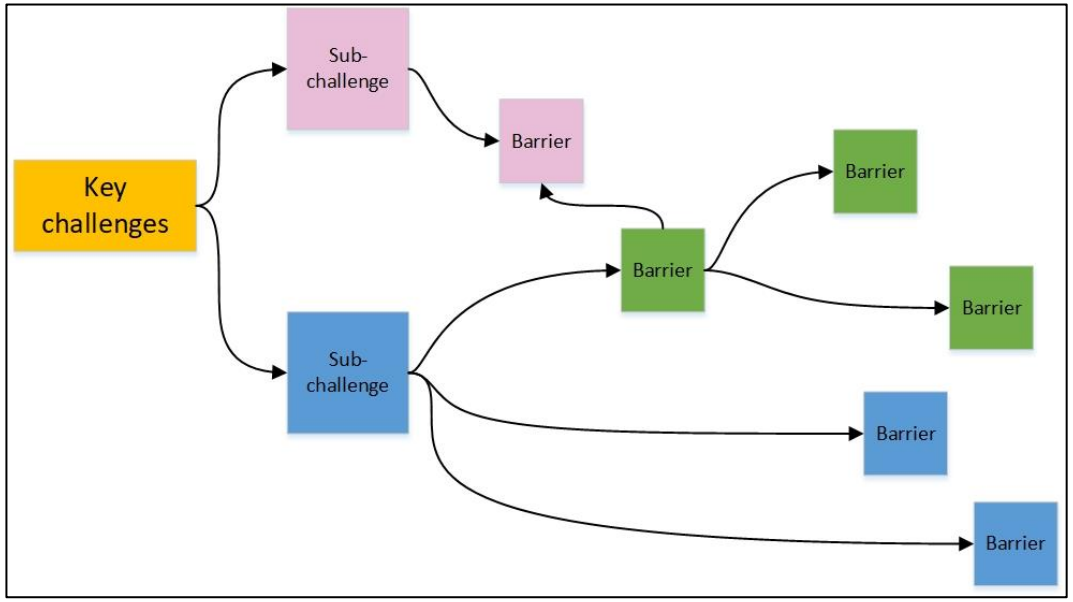
ENSNARE

StepUP

PLURAL

proGETonE

[SP workshop - Industrialization of building envelope kits, Online Whiteboard for Visual Collaboration (miro.com)]



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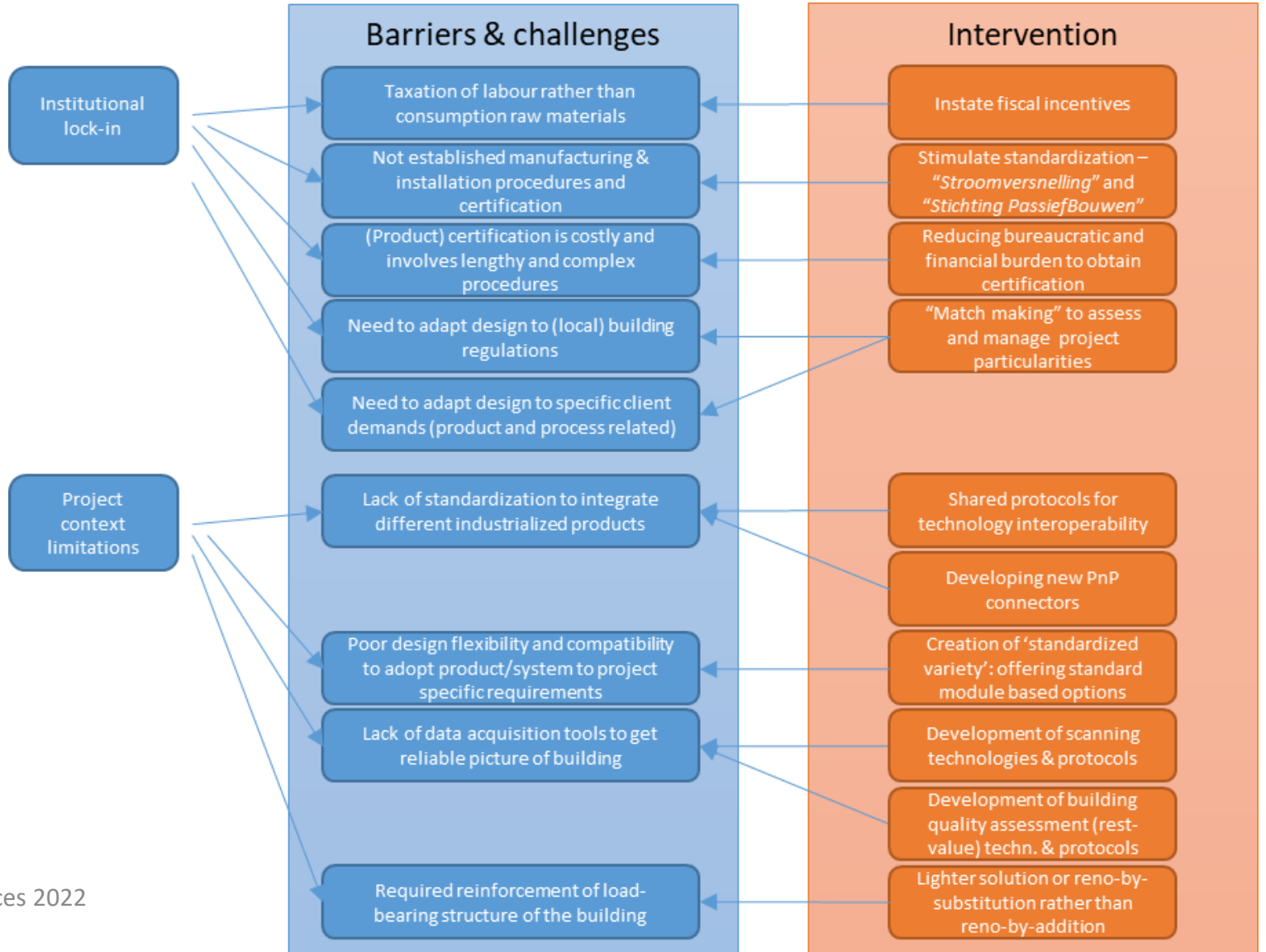
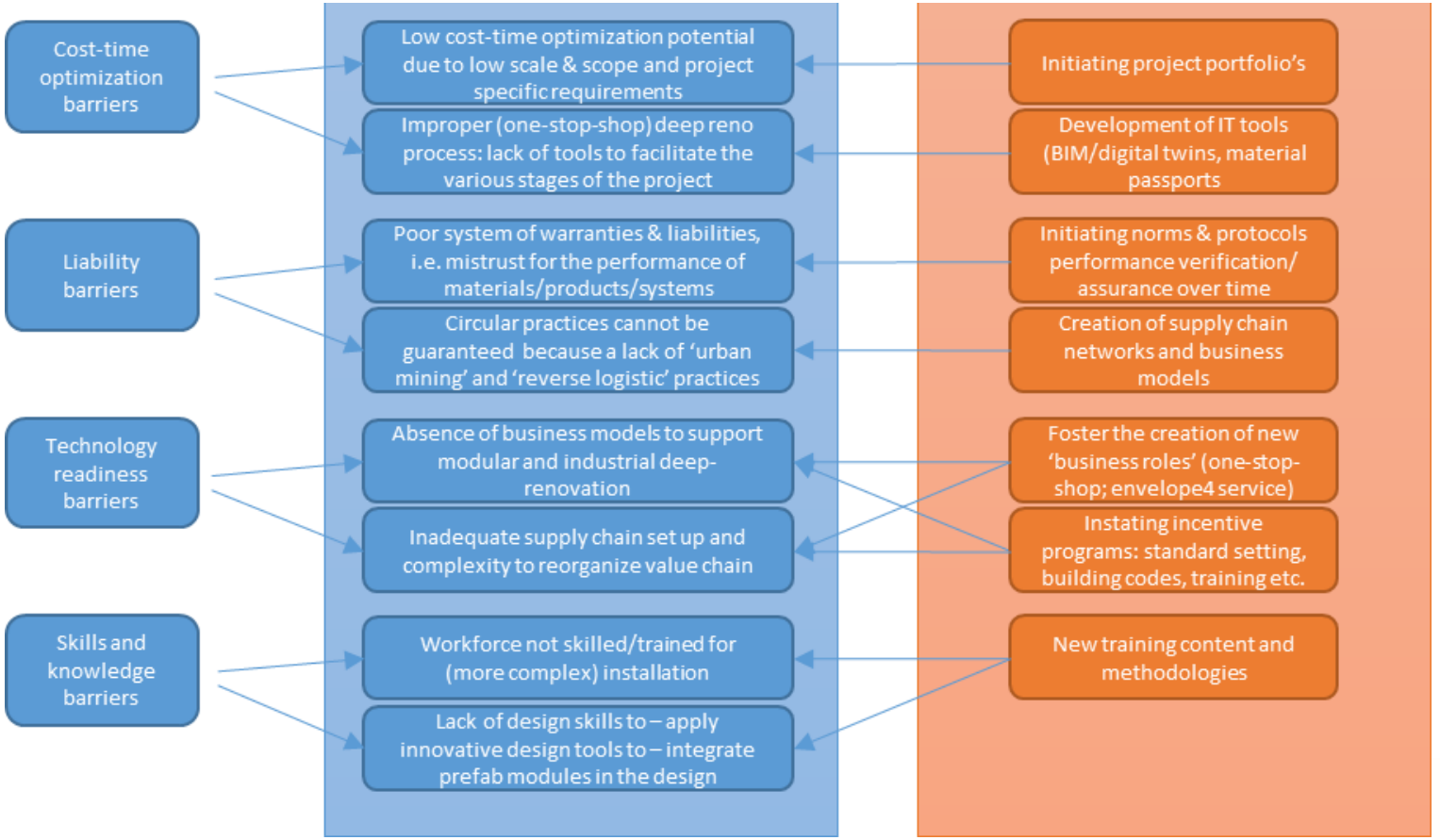
Positioning paper: key findings



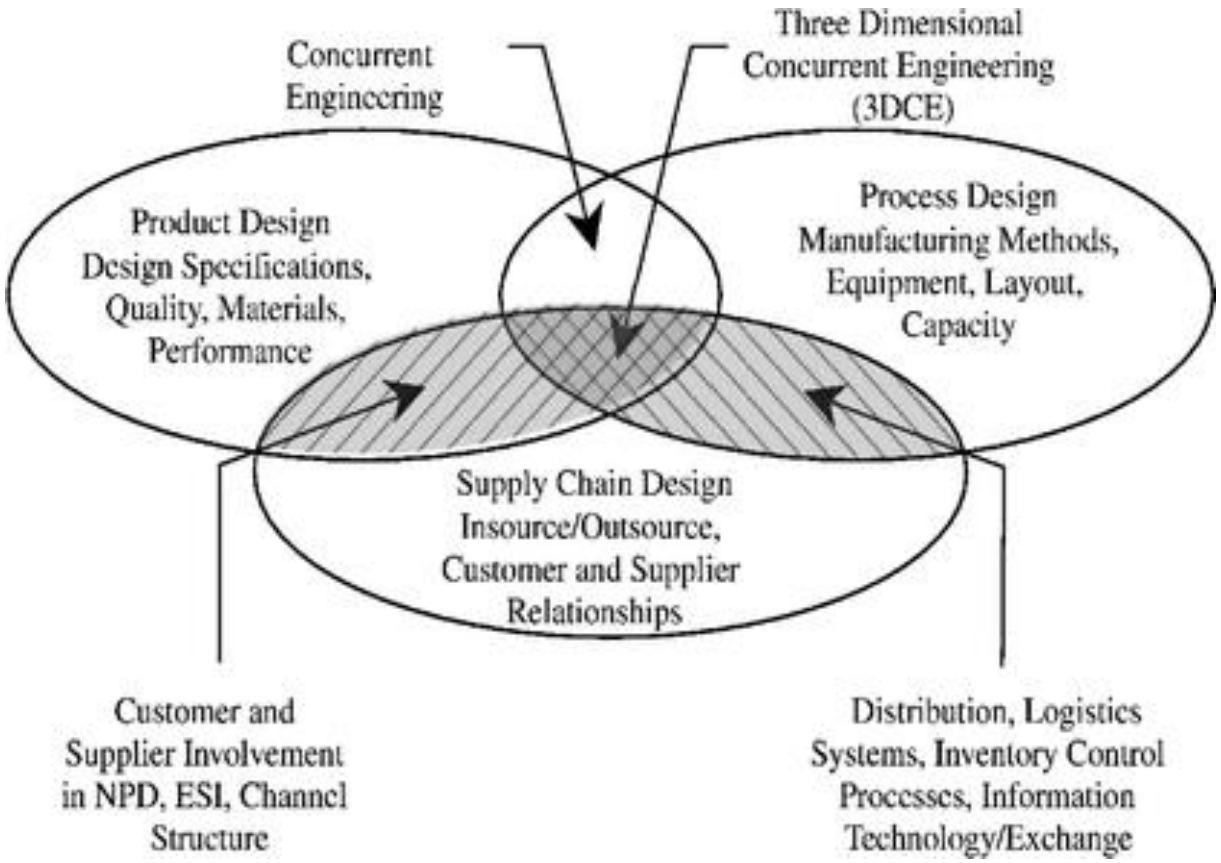
Zuyd Research

Positioning paper: key findings



Zuyd Research

Positioning paper: key findings



Source: Ellram et al. (2007) Ellram, L., Tate, W. and Carter, C. (2007), "Product-process-supply chain: an integrative approach to three-dimensional concurrent engineering", *International Journal of Physical Distribution & Logistics Management*, Vol. 37 No. 4, pp. 305-330.

Positioning paper: key findings

Thank you for your attention!

John.vanoorschot@zuyd.nl

Further read (published open source):

van Oorschot, J. A., Halman, J. I., & Hofman, E. (2021). The adoption of green modular innovations in the Dutch housebuilding sector. Journal of Cleaner Production, 319, 128524 https://doi.org/10.1016/j.jclepro.2021.128524

Zuyd Research

ROUND TABLE I:

MAPPING and “CLUSTERING” OF TECHNOLOGIES DEVELOPED IN THE PROJECTS

Stefano Avesani

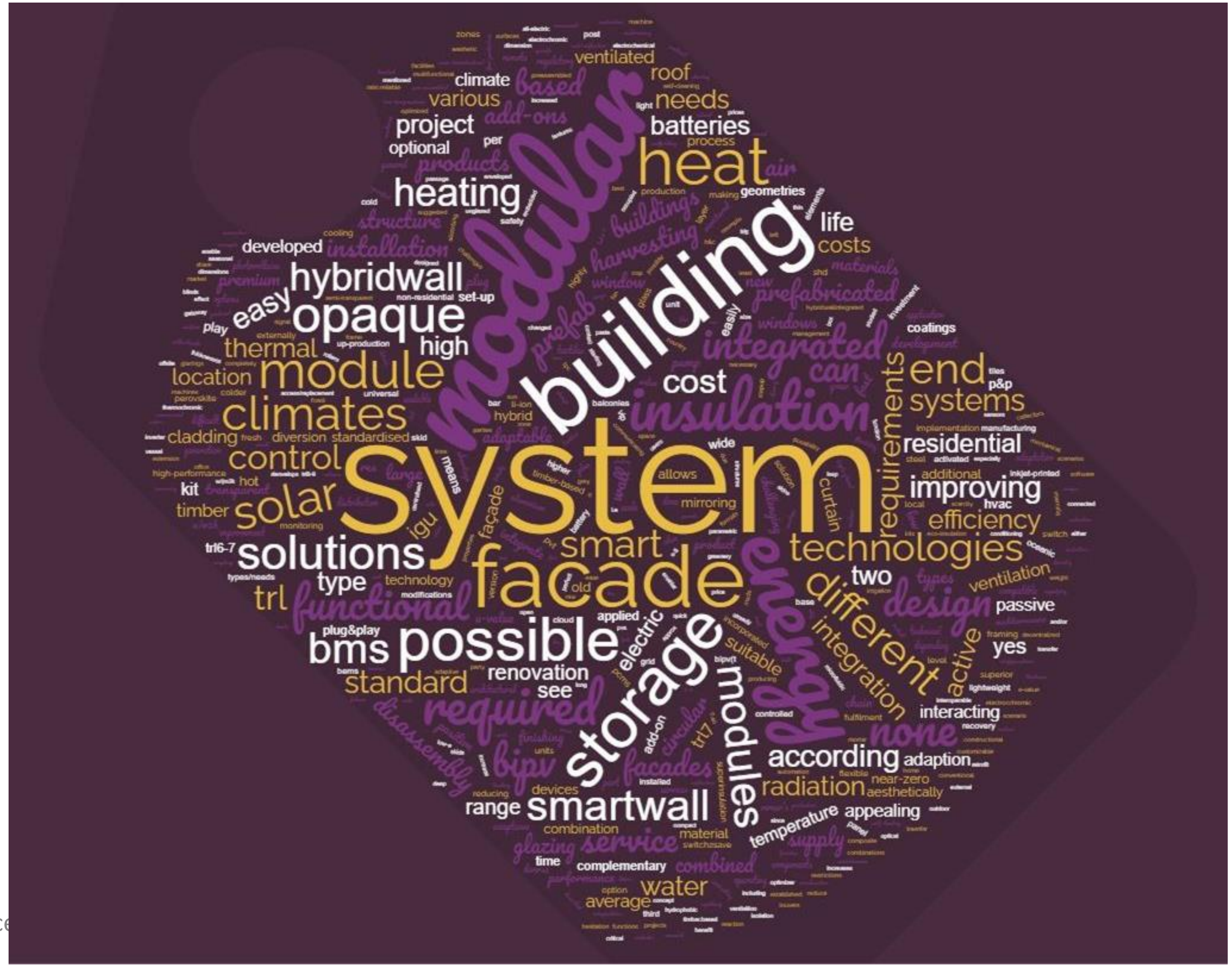
Federico Noris

Project	Technology (TRL)	**Active** (e.g., RES, lighting, HVAC, BEMS, others)	**Passive** (e.g., insulation, windows, passive ventilation, others)	**Short descr.**	**Building typology target** (e.g., by use, by type, by shape, by size)	**Climate & external factors enabling**	**Potential synergies between technologies**	**Potential benefits/issues tackling**	**Potential challenges for deployment & commercialisation**	**Control & automation**
ENSNARE	**Modular facade (TRL6)**	integrated solar system with PV, ST, PVT	insulation	modular prefabricated aluminium based frame with plug&play standardised technologies	residential	All climate and	see active column	quick installation, customizable, no scaffolding, easy access/replacement of technologies	Challenging for some geometries, additional costs, additional weight, maintenance	none of the modular structure, but yes of active elements
POWERSKIN +	**Standard PS+ transparent Modules** (Average TRL at the end of the project - 8)	None (Integration possible, see premium version)	IGU insulation Ug Value ≤ 0.80 W/(m²K)	Conventional triple-glazed low-e IGU with optional multifunctional coatings possible (anti-reflective, hydrophobic, self-cleaning and self-healing) (TRL8-9)	Curtain wall facades Residential and non-residential buildings	-	?	Superior insulation Modular system Additional functional coatings	None (established technology)	None
	Premium PS+ transparent Modules (Average TRL at the end of the project - 7)	**RES** Yes, two options: 1 – Thermal harvesting and storage system add-on 2 – BiPV **BEMS** Yes, 1 option to be combined with BiPV: 3 - Electric storage BMS	See standard	Standard module adaption plus: 1 – Capillary microfluidic heat storage diversion system add-on (thermal harvesting combined with a heat pump). (TRL6-7) 2 - Semi-transparent inkjet-printed perovskite BiPV modules (TRL7) 3 - BMS with scalable battery units operating with post EV or new Li-ion batteries. Compatible with the electric grid (TRL6-7)	Curtain wall facades	Solar radiation and temperature	?	Different add-ons possible to be integrated (heat storage diversion, energy harvesting and storage) for near-zero or positive energy building solutions Functional modular system design according to the type of building, location and functional needs Modular system (easy disassembly at the end of service life)	Costs of high-performance solutions Scale up-production Highly diverse building and façade types/needs making it difficult to design universal and easily adaptable solutions Add-ons framing adaption Shortage of material supply (batteries) Service safety requirements (batteries) Fulfilment of different regulatory requirements	Required
	Standard PS+ Opaque Modules (Average TRL at the end of the project - 7)	None (Integration possible, see premium version)	VIP superinsulation solutions U-value stating from 0,098 W/m²K for the lightweight standard opaque module	Opaque module with different optional skins (composite, opacified glass, aluminium) and a wide range of VIP thicknesses depending on thermal requirements (TRL7)	Curtain wall facades	-	?	Superior insulation for the least thickness Modular system (easy disassembly at the end of service life)	Cost (superinsulation) Dimension restrictions	None
	Premium PS+ Opaque Modules (Average TRL at the end of the project - 7)	**RES** Yes, two options: 1 – Activated PCMs storage		Standard module adaption plus: 1 – Heating foil activated PCMs heat storage system (TRL7)				Different add-ons possible to be integrated (heat storage, energy harvesting and storage) for near-zero or positive energy building	Costs of high-performance solutions Scale up-production Highly diverse building and façade types/needs making it	

Project	Technology (TRL)	**Active** (e.g., RES, lighting, HVAC, BEMS, others)	**Passive** (e.g., insulation, windows, passive ventilation, others)	Short descr.	**Building typology target** (e.g., by use, by type, by shape, by size)	Climate & external factors enabling	Potential synergies between technologies	Potential benefits/issues tackling	Potential challenges for deployment & commercialisation	Control & automation
PLURAL	**SmartWall systems (TRL5)**	**SmartWall**: PVs, Solar heating systems, energy storage, smart monitored and controlled	**SmartWall**: eco-insulation, high efficiency windows with shaving rollers and low e-value glazing, IR reflective and/or absorbing coatings, innovative low u-value thermal paste (mortar), active and passive fire-protection system.	**SmartWall**: modular flexible system which can integrate a range of technologies according to building and owner's requirements.	**SmartWall:** Facades of the building (can be installed either externally or internally in the building)	**SmartWall:** all climates but more suitable to Mediterranean and Oceanic climate zones. Technical modifications required for colder climates.	**SmartWall**: A very wide range of commercial materials, products components can be integrated into the system.	**SmartWall:** improving energy efficiency, centralised control of HVAC system, ease of installation, reduction of cost. Different add-ons possible to be integrated (heat storage, energy harvesting and storage) for near-zero or positive energy building solutions	**SmartWall:** Challenging for some geometries. Some HVAC technologies are not suitable for installation on cold climates (e.g. fan coils), increased materials costs due to energy crisis	**SmartWall:** Integrated smart control system at local, remote and cloud level.
	HybridWall	**Hybridwall**: Air renovation, PV photovoltaics, monitored and controlled.	**Hybridwall:** Isolation, ventilated facade, high efficiency windows, louvers, light solution.	**HybridWall:** Modular flexible system which can integrate a range of technologies according to building and owner's requirements. Based on the new hybrid texTILES constructive system developed by Denvelops..	**HybridWall:** Facades of the building installed externally with large formats very fast to install.	**HybridWall:** All climates but more suitable to Mediterranean and Oceanic climate zones. Technical modifications required for colder climates	**HybridWall:** Open modular system made of small components which means that a wide range of finishing materials and PV tiles can be incorporated to the system.	**HybridWall:** Light solution perfect for new and renovation projects. Modular solutions 100% done with CNC parametric machines which means low cost for customising project dimensions. Fast installation to reduce cost. System based on hybrid texTILES which means architectural finishes with cladding tiles solutions.	**HybridWall:** Challenging for some geometries (balconies) which increases the cost.	**HybridWall**Integrated smart control Unit Ventilation system at local, remote and cloud level.
	ConExWall	External facade heating, PV, PVT, decentralized ventilation with heat recovery	Thermal insulation, Windows	Prefabricated facade modules with heating layer on the opaque part which heats the building through the old facade. Including further optional functions like mentioned on the left.	Medium and large size buildings with high share of opaque surface and old facade with U-value of approx. >1 W/m2K (possibly after removing old insulation)	All climates, but especially for cold climates	Can be combined easily with third parties products	Fast building renovation and switch to low-temperature heat distribution system while building is occupied (switch from fossil to heat pump).	Unusual concept of heating building through facade (acceptance, constructional details). Long reaction time of heating system (if room temperature should be changed).	Required
SWITCH2SAVE	**Electrocchromic glazing (EC, TRL:6-7) Thermochromic glazing (TC, TRL: 4)**	EC: active control by electric signal TC: passive control by ambient temperature	EC: Improvement of window insulation TC: improvement of window and roof panel efficiency	Thin layer system in an IGU for adaptive change of optical glass properties	non-residential (in Switch2Save) general: no restriction	Both TC and EC: Energy for heating and air conditioning	Switch2Save: EC and TC combined ; other combinations are possible as well	Benefit: improving energy efficiency of buildings; challenges tackled: price /performance ratio,reliable manufacturing, readiness for retrofit	implementation in manufacturing lines, cost for installation; usage of critical materials	for EC: done for TC: not necessary

DRIVE 0	**2D facade elements (TRL 7)**	None, but application of BIPV(t) possible	Timber or steel based structure with insulation and various types of cladding	Five different circular and modular prefabricated based structures with plug&play standardised technologies, various types of cladding possible	Residential	All climates	Can be applied in combination with the other two modular products systems developed	Functional modular system design according to the type of building, location and functional needs Modular system (easy disassembly at the end of service life)	Development of complementary process and supply chain set-up mirroring the circular and modular design of the product system	None
	3D extension modules (TRL 5-6)	None, but application of BIPV(t) possible	Timber or steel based structure with insulation and various types of finishing	Depending on the context per country, various circular and modular prefabricated based concepts with plug&play standardised technologies, various types of cladding possible	Residential	All climates	Can be applied in combination with the other two modular products systems developed	Functional modular system design according to the type of building, location and functional needs Modular system (easy disassembly at the end of service life)	Development of complementary process and supply chain set-up mirroring the circular and modular design of the product system	None
	Prefab building services (HVAC) skids (TRL 5)	Photovoltaics part of the system	-	The prefab building services skid is best described as a compact, completely integrated energy module. The skid includes all the devices required for an all-electric home in The Netherlands: - Air to water heat pump - Hot water vessel (150 or 200 liters) - Solar inverter (optional) - Ventilation with heat recovery - Smart Energy Management o Energy meters o Gateway with software for monitoring and controlling all connected devices.	Residential	Needs adaptation per climate zone	Can be applied in combination with the other two modular products systems developed	Functional modular system design according to the type of building, location and functional needs Modular system (easy disassembly at the end of service life)	Development of complementary process and supply chain set-up mirroring the circular and modular design of the product system	Required
Step UP	**Pre-assembled enveloped panel**	None but integration is possible in two scenarios: 1.- Integration in the P&P façade module (It should be future studied, for exemple PV panels) 2.- In a deep renovation scenario, when the active systems are not located in the facade, the system allows the passage of the facilities throug.	P&P Module: Insulation incorporated in the module (U value starting from 0,40) Other passive integrations: Integration of Blinds for sun protection and High performance windows	Plug and Play modular and offsite preassembled envelope system. The P&P module designed in the StepUp project, is a hybrid module that allows different configurations, i.e. opaque and transparent systems, and also allows the implementation of passive and active solutions in the module.	General renovation market, not specific to a building type.	All climates but more suitable to climates with high solar radiation since the Plug and Play module is a ventilated façade.	TPC protocol to enable adaptation with other plug and play technology, or third party products	Reducing time on site, improving energy performance, interoperable with other technologies	Hesitation from installers and increase in raw material costs leading to higher production and installation prices	No control and automation but monitoring technology

Word Cloud


system
building
modular
facade
storage
energy
possible
insulation
heat
heating
module
opaque
climates
hybridwall
solutions
smartwall
integrated
required
functional
different
technologies
improving
efficiency
residential
end
systems
solar
control
cost
smart
bms
modules
according
radiation
batteries
needs
roof
ventilated
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average
complementary
integration
design
passive
yes
active
interacting
adaption
appealing
temperature
two
ventilation
requirements
curtain
life
costs
coatings
high
electric
suitable
none
service
combined
facades
bipv
disassembly
harvesting
prefabricated
prefab
installation
structure
products
add-ons
based
air
can

ROUND TABLE II:

HOW DO THE “CLUSTERED” TECHNOLOGIES PERFORM?

Stefano Avesani

Part 2, nZEB: objectives

HOW DO THE "CLUSTERED" TECHNOLOGIES PERFORM? Roundtable discussion with members of the project consortia and workshop attendants to assess the technology potential to contribute towards NZEB and positive energy targets. Indicative questions to be answered:

- **TOWARDS NZEB: Which technologies** can contribute to the NZEB / Positive Energy targets? Can we achieve energy positive deeply renovated residential buildings with Plug-and-Play hybrid systems?
- **Challenges and threats:** OPEN questions (such as safety, standardization, manufacturing, business models, market)

Part 2, nZEB: expected outcomes

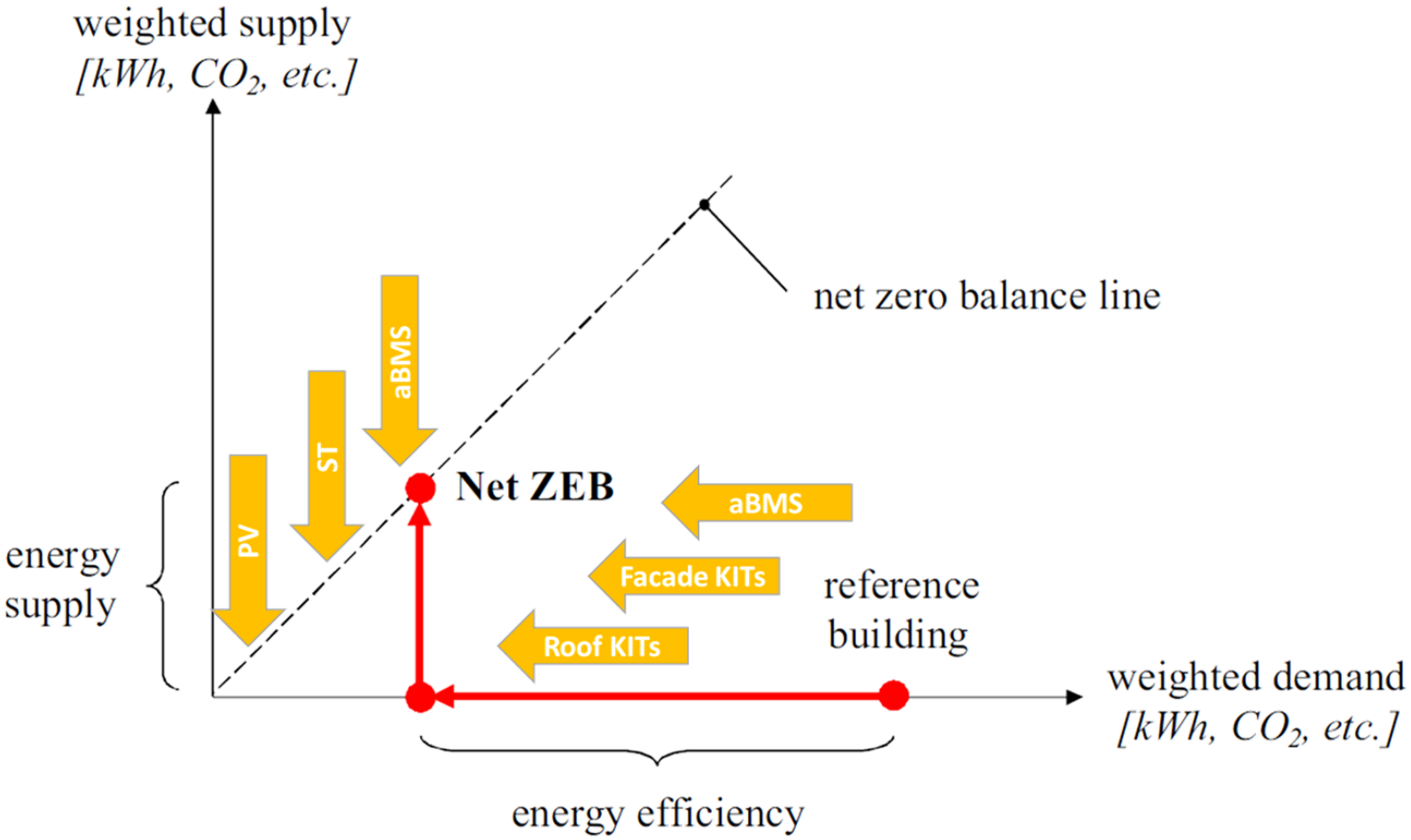
Answer to the overall question: how do techs performs in nZEB vision?

- List of possible KPIs
- Methodologies to calculate them

Thanks to our common discussion we will be able to work offline in mapping that figure of performances for each project technologies / categories

Part 2, nZEB: Possible visual outcomes

- Impact on the whole building energy balance (e.g. primary energy, CO2 eq,…)
- PRO: directly linked to nZEB
- CONS:
  - complex standardization to be able to compare diff solutions
  - How to visulise costs?



Source: H2020 INFINITE project

Part 2, nZEB: Possible visual outcomes

- Impact on the whole building energy balance maybe with a reference building?

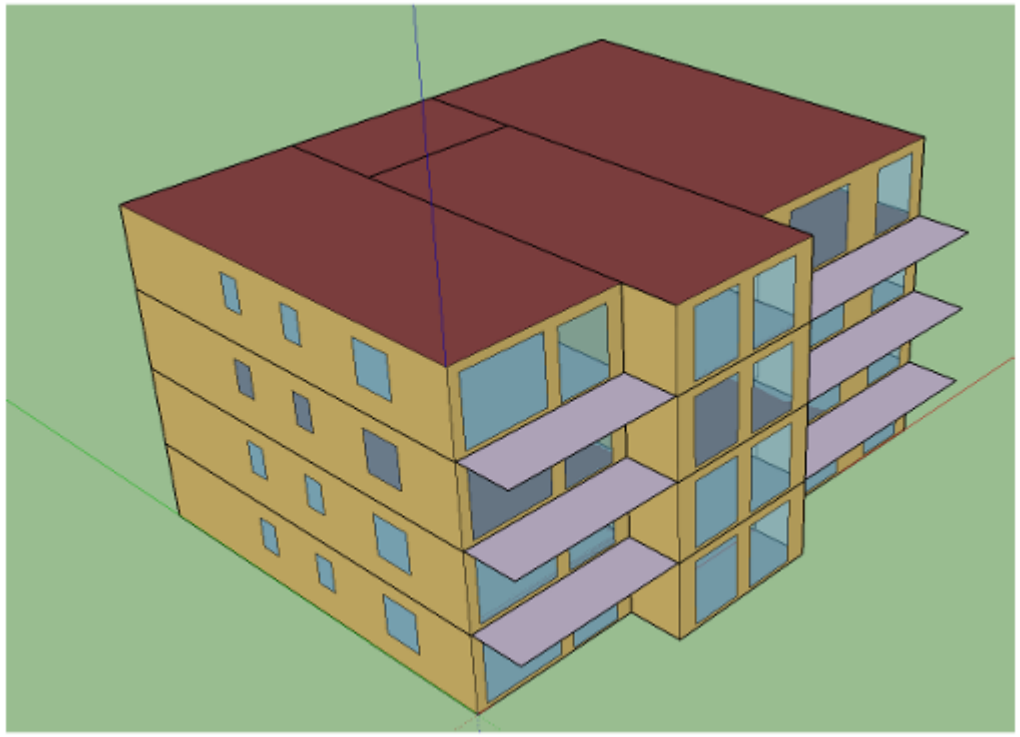


Figure 6: Illustration of the case study Parkcarré; screenshot from SketchUp Make.

https://www.cravezero.eu/wp-content/uploads/2020/05/CRAVEzero_D42_Optimized%20Solution%20Sets.pdf

Part 2, nZEB: Possible visual outcomes

- Table format and solutions adopted in different contexts (project).. Maybe highlight with color different nZEB levels reached (in terms of yearly balance?!)

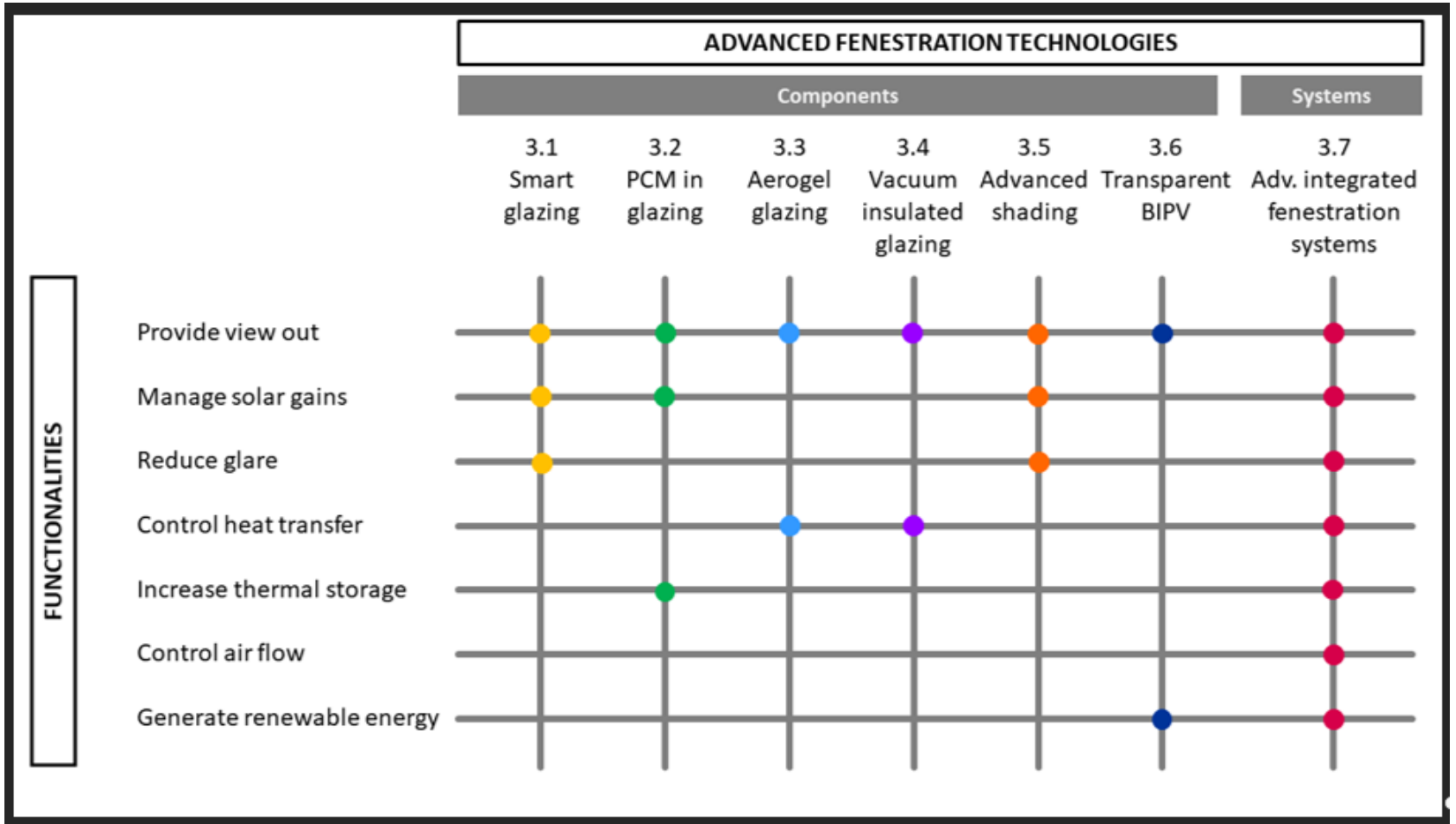
https://www.conzebs.eu/images/D5.1_Solution%20sets%20and%20Technologies%20in%20NZEBs%20-%20FinalVersion.pdf

Table 3.1: A summary of technologies used in national solution sets.

	Text	DK-typ	DK-SS1	DK-SS2	DK-SS3	DK-SS4	DK-SS5	DE-typ	DE-SS2	DE-SS3	DE-SS7	DE-SS8	IT-typ	ITR-SS1	ITR-SS2	ITR-SS3	ITR-SS4	ITT-SS1	ITT-SS2	ITT-SS3	ITT-SS4	ITT-SS5	SI-typ	SI-SS1	SI-SS2	SI-SS3	SI-SS4
Envelope	Autoclaved aerated concrete													x	x	x	x	x		x							
	Mono-block windows													x	x	x	x	x	x	x	x	x					
	Reduced insulation, facade			x		x	x		x	x	x	x															
	Reduced insulation, roof			x		x	x		x	x	x	x															
	Reduced insulation, ground floor			x		x	x		x	x	x	x															
	Improved insulation, facade		x																x		x	x					
	Increased ground floor insulation																		x		x	x					
	Improved insulation, roof																		x		x	x					
	2-layer windows								x	x	x	x															
	3-layer windows	x						x																	x	x	x
	4-layer windows				x																						
	Increased airtightness																							x	x	x	x
Ventilation	MVHR	x																	x		x			x	x	x	
	MVHR, moisture controlled									x																	x
	Decentral ventilation + HR					x	x		x																		
	Exhaust ventilation + HP											x															
	Exhaust ventilation without HR							x			x																
	Hybrid mechanical and NV				x																						
	Exhaust air HP -> air									x																	
DHW	Energy efficient taps					x																					
	HR Gray waste water				x				x	x																	
	Electric DHW heating								x	x																	
Generation	District heating and DHW	x	x	x	x	x	x				x													x			
	HP air-water, heating & DHW														x					x	x				x		x
	Exhaust air HP -> heating											x															
	Exhaust air HP -> DHW											x															
	Condensing gas boiler							x				x		x	(x)	x	x	x	x	(x)	(x)	x				x	
	HP air, DHW																									x	
Heating	Heating via ventilation system									x																	
	Electric emitters								x					x	x	x	x	x	x	x	x	x					
Cooling	In any form																										
RES	PV panels on roof						x		x			x				x	(x)					x					x
	Solar heating, DHW			x					-	-	-	-		x	-	x	x			-	-	x					
	Solar heating, heating & DHW							x										x	x								
	Heat pump									x		x			x					x	x				x	x	x

Possible visual outcomes

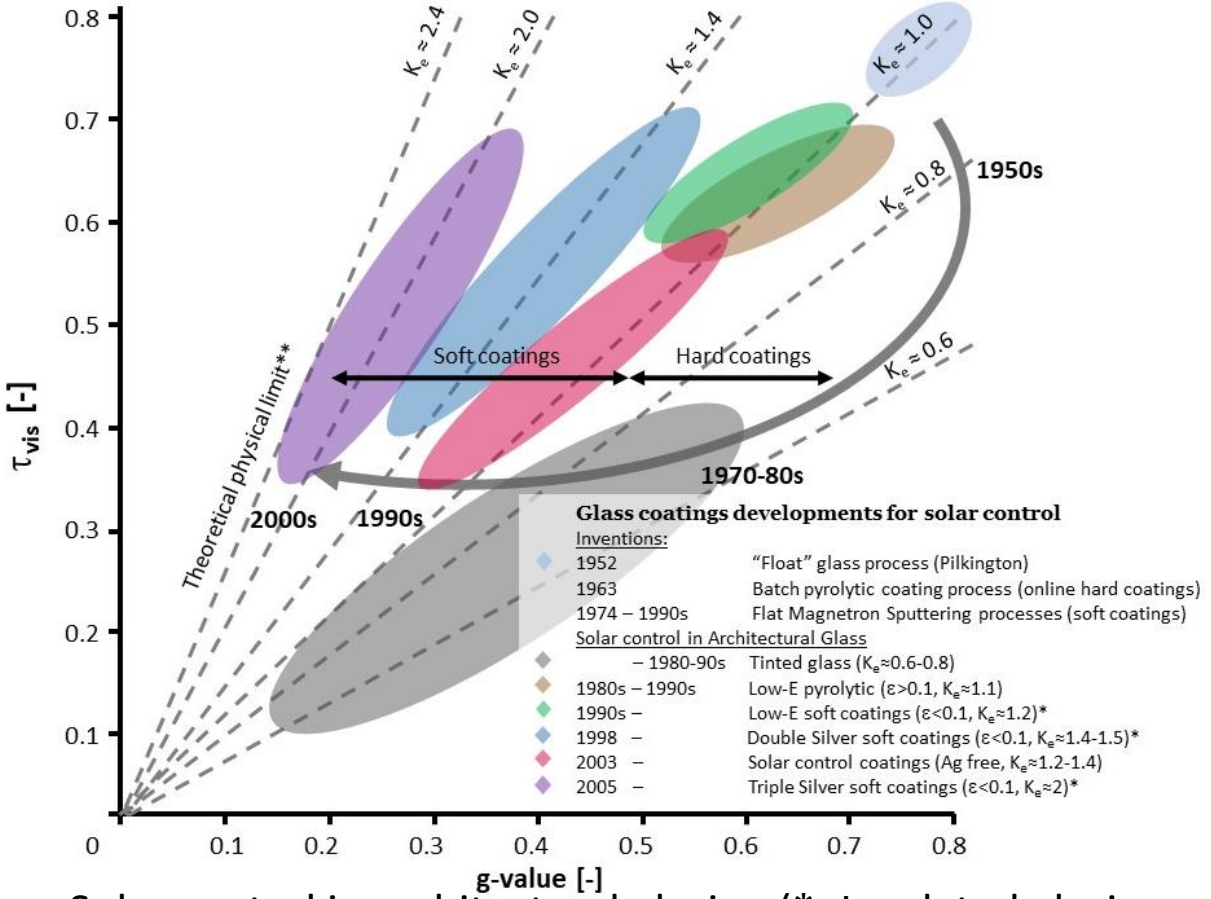
- Qualitative analysis per kind of functionality (e.g. reducing thermal losses, air tightness, air quality, RES energy generation, cost…)



Figure·3.1.·Overview·of·functionalities·and·advanced·fenestration·technologies·described·in·this·Chapter.·(PCM:·phase·change·material,·VIG:·vacuum·insulation·glazing,·DSF:·double-skin·façade,·AIF:·advanced·integrated·façade)¶

Part 2, nZEB: Possible visual outcomes

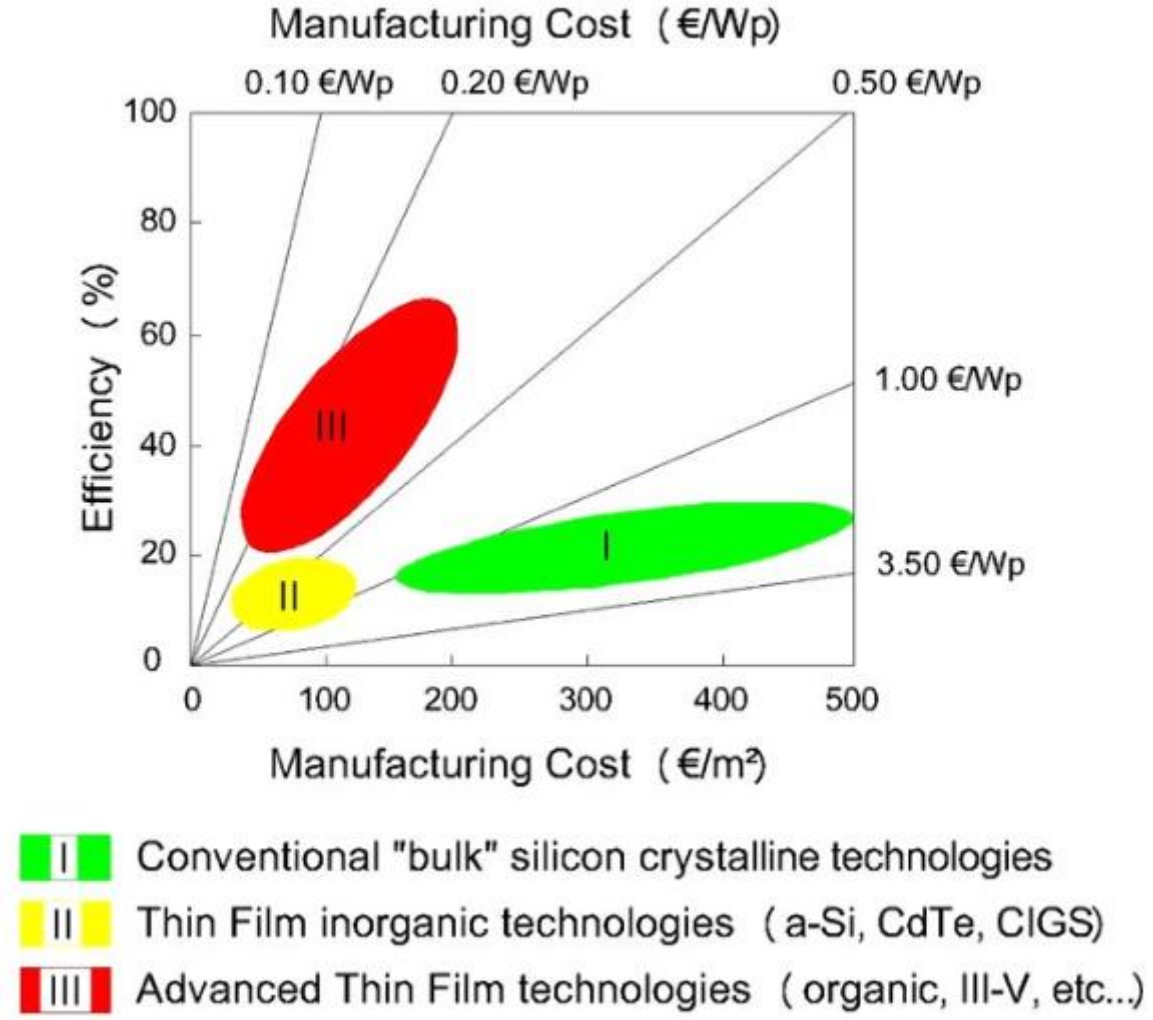
- Performance based (for techs in the same category)
- PRO: Possibility to map techs KPIs
- CONS:
  - Difficult to be directly linked to nZEB



Solar control in architectural glazing (*: Insulated glazing unit integration for durability reasons; **: ratio between energy within the whole solar spectrum and the one only in the visible region of 380-780 nm , based on AM1.5 solar spectrum (Favoino et al., 2015))

Part 2, nZEB: Possible visual outcomes

- Quantitative analysis … costs VS potential % impact in nZEB energy reduction or generation??!



Part 2, nZEB: discussion

Questions to participants:

- **In your project, how do you evaluate your solutions impact in a nZEB vision?**
- **Which KPIs and at which scale?**
- **In your project, have you already evaluated that?**

Part 2, challenges and threats: discussion

Questions to participants:

Which are the biggest challenges and threads for your solutions to effectively contribute to the nZEB target?

Thank you all for the participation!