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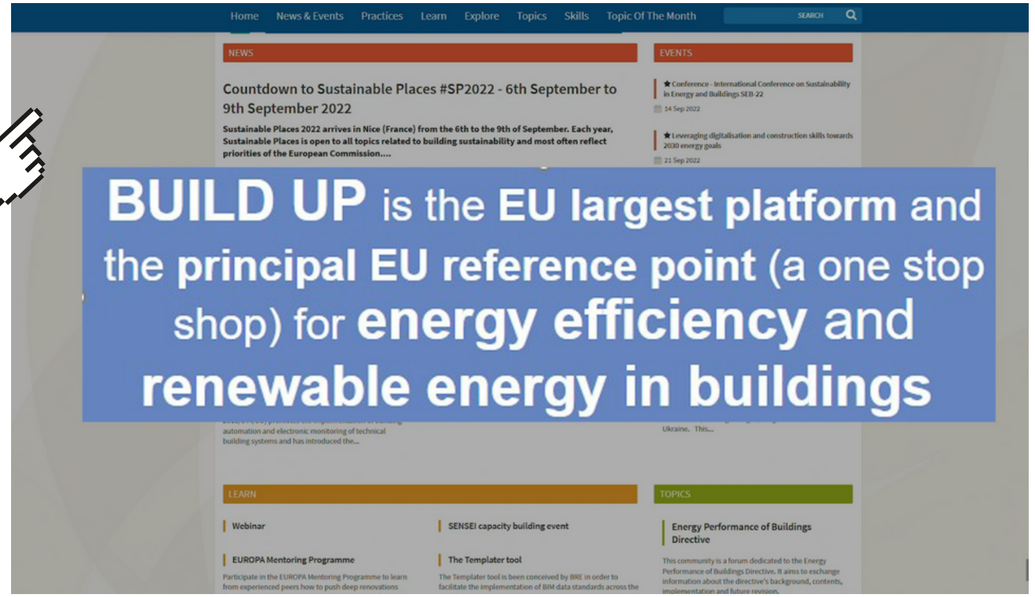
BUILD UP

The European Portal For
Energy Efficiency In Buildings

W E B I N A R

BUILD UP
presentation



WEBINAR

Hosted by
BUILD UP

The Plug-N-Harvest solution enabling smart energetic renovations for different building cases

15th December 2022 - 12.00H

AGENDA

12:05H - 12:15H	PLUG-N-play passive and active multi-modal energy HARVESTing systems, circular economy by design, with high replicability for Self-sufficient Districts Near-Zero Buildings **Iakovos Michailidis (CERTH/ITI), Technical Manager of Plug-N-Harvest**
12:15H - 12:25H	Circular Economy aspects of the design **Toni Herena, AIGUASOL**
12:25H - 12:35H	Pilot Case 3: AHC - Sant Quirze Residential Building, CAT, ES **Nil Juvanteny, AHC**
12:35H - 12:45H	Pilot Case 4: RWM Grevena, Tertiary, GR **Nikolaos Margaritis, CERTH/CPERI**
12:45H - 12:55H	Q&A session Moderated by **Zuzana Prochazkova, PiAg**

PLUG-N-play passive and active multi-modal energy HARVESTing systems, circular economy by design, with high replicability for Self-sufficient Districts Near-Zero Buildings

Iakovos Michailidis
PhD Electrical Engineer
Technical Manager of Plug-N-Harvest
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General overview

- Call: H2020-EEB-2017
- Topic: EEB-07-2017 - Integration of energy harvesting at building and district level
- 63 months: September 2017 – November 2022
- 14 European partners / 4 countries
- 4 demonstration sites + 2 real pre-pilot cases + 1 lab testbed

List of Participants	
1	Centre for Research and Technology Hellas - CERTH
2	Rheinisch-Westfaelische Technische Hochschule Aachen - RWTH
3	Cardiff University – CU
4	Aloumyl, Biomichania Alouminioy Anonimi Etairia - ALUMIL
5	Sistemes Avancats De Energia Solar Termica Sccl - AIGUASOL
6	Odin Solutions s.l. - ODINS
7	SIEMENS SRL - SIE
8	Etra Investigacion Y Desarrollo Sa - ETRA
9	Energy Transitions Limited - ET
10	Eco Intelligent Growth, SL - EIG
11	Agencia De L'habitatge De Catalunya - AHC
12	Perifieria Dytikhs Makedonias - RWM
13	County Council Of The City And County Of Cardiff – CCC
14	Pich Aguilera Architects - PiAg

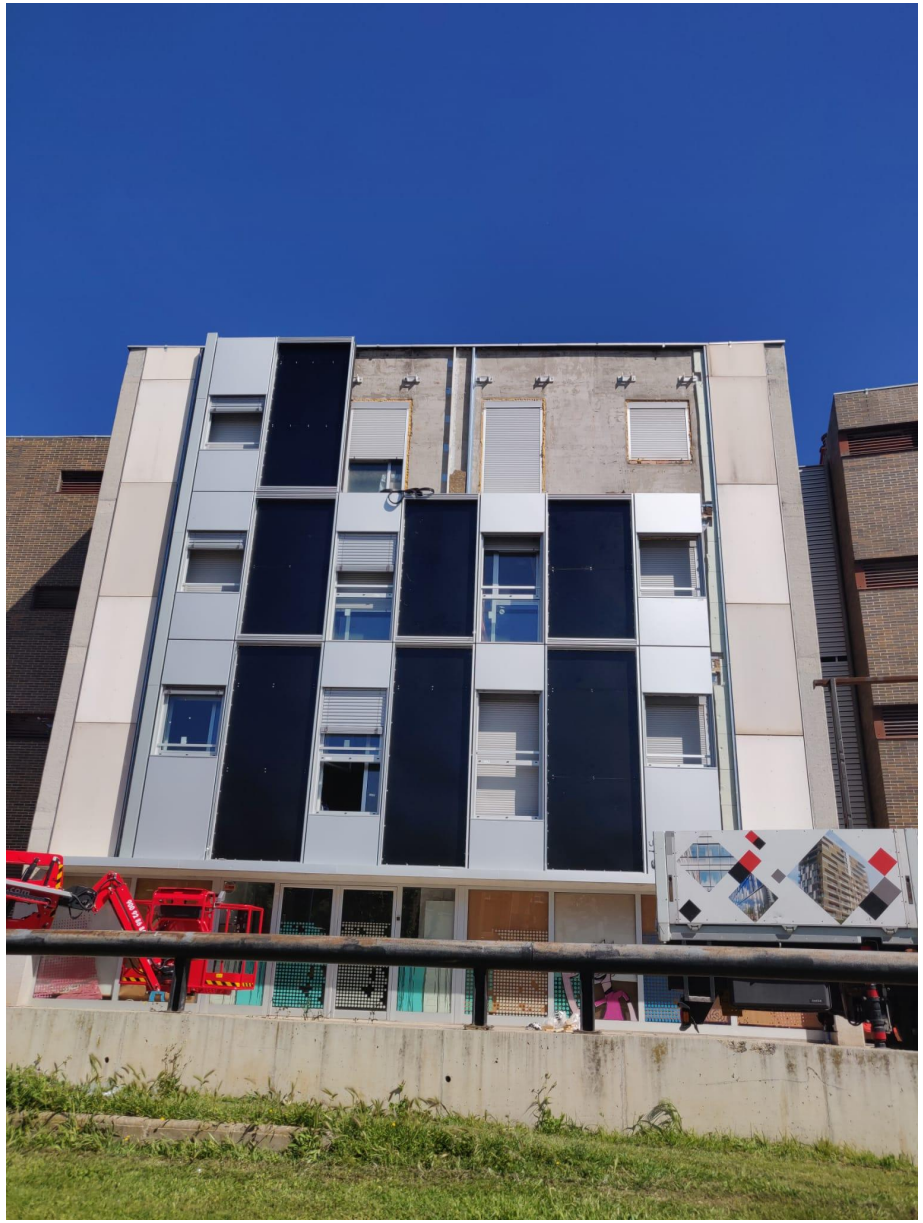
Communication and Follow-Up

- Follow our developments and results:
  - Website: https://www.plug-n-harvest.eu/
  - Social Media:
    - @Plug.N.Harvest
    - @PlugHarvest
    - @plug-n-harvest-h2020
    - @plugnharvest1148

The idea behind

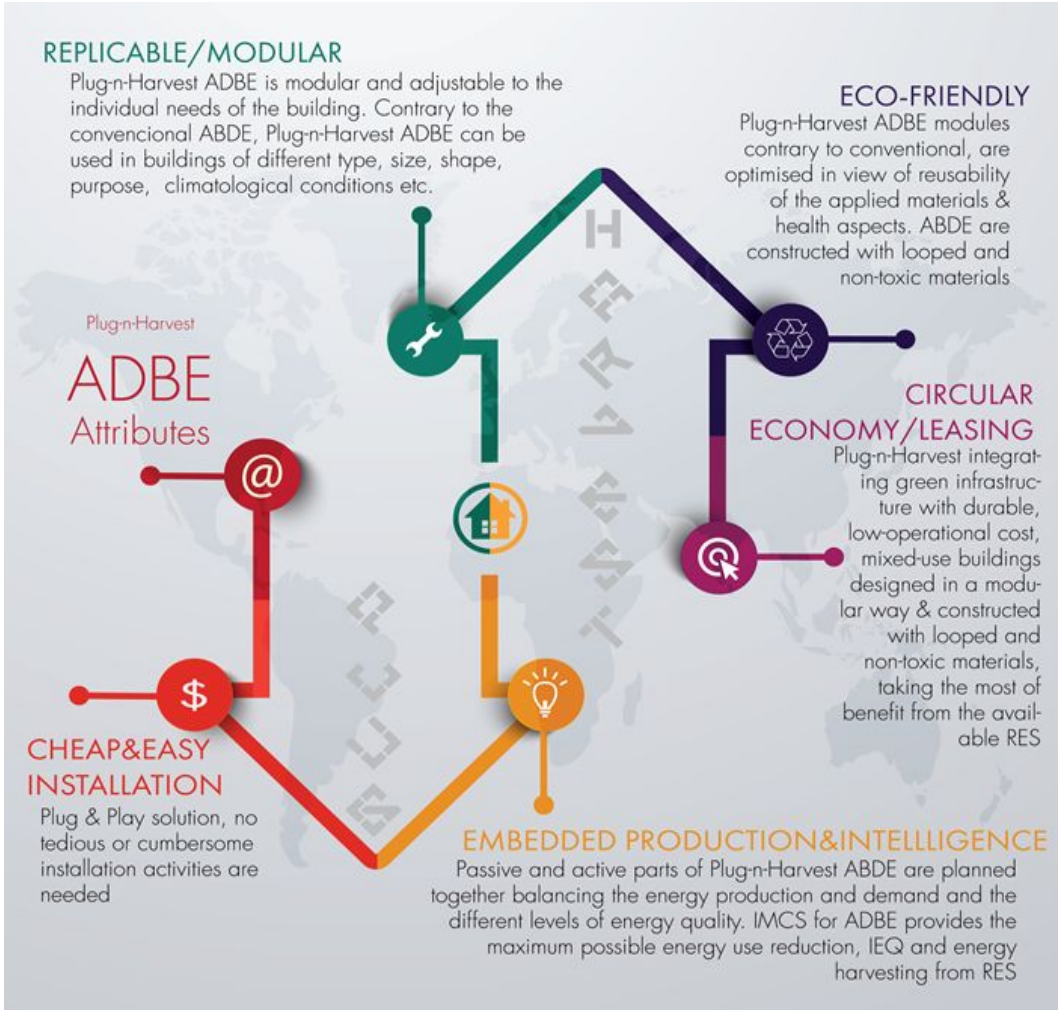
Exploit vertical building facades:

- Enhance the energy harvesting capacity of high-rise buildings by exploiting vertically deployed PV panels instead of focusing on rooftops only.
- Leverage from the vertical deployment strategy to enhance thermal insulation for different apartments (owners) at the same time.
- Aesthetically revamp older and worn-out facades with modern metallic components.



Objectives

- Develop a new modular, plug-n-play solution for smarter **Adaptable Dynamic Building Envelopes (ADBE)**:
  - Enables **high energy harvesting** from integrated RES
  - **Low installation costs** based on pre-manufactured panels
  - **Resilient to structurally withstand heavier loads (e.g., HVACs, PV, etc.)** based on innovative aluminum profiles
  - **Reusable/circular and recyclable** elements
  - Able to be **digitally integrated within the building micro-grid**
  - **AI-based control at building and district level**
- As **generic** as being able to scale production as **specific** as being able to meet local particularities.



Goals and KPIs

- **Installation costs:** less than 20% of the building costs.
- **Operational costs:** almost-zero.
- **Energy bill reduction:** 30% depending on the building/climate zone characteristics.
- **Energy Harvesting:** 30% primary energy reduction.
- **User Satisfaction/Safety:** 90% of the users in the Pilots are satisfied.

Solution

Plug-N-Harvest solution is comprised by two main technological pillars:

- Adaptable Dynamic Building Envelope (**ADBE**)
- Digitalised Micro-Grid Energy Management System (**EMS**)

ADBE Modular Elements Toolbox (Capacity)

Components: demand reduction

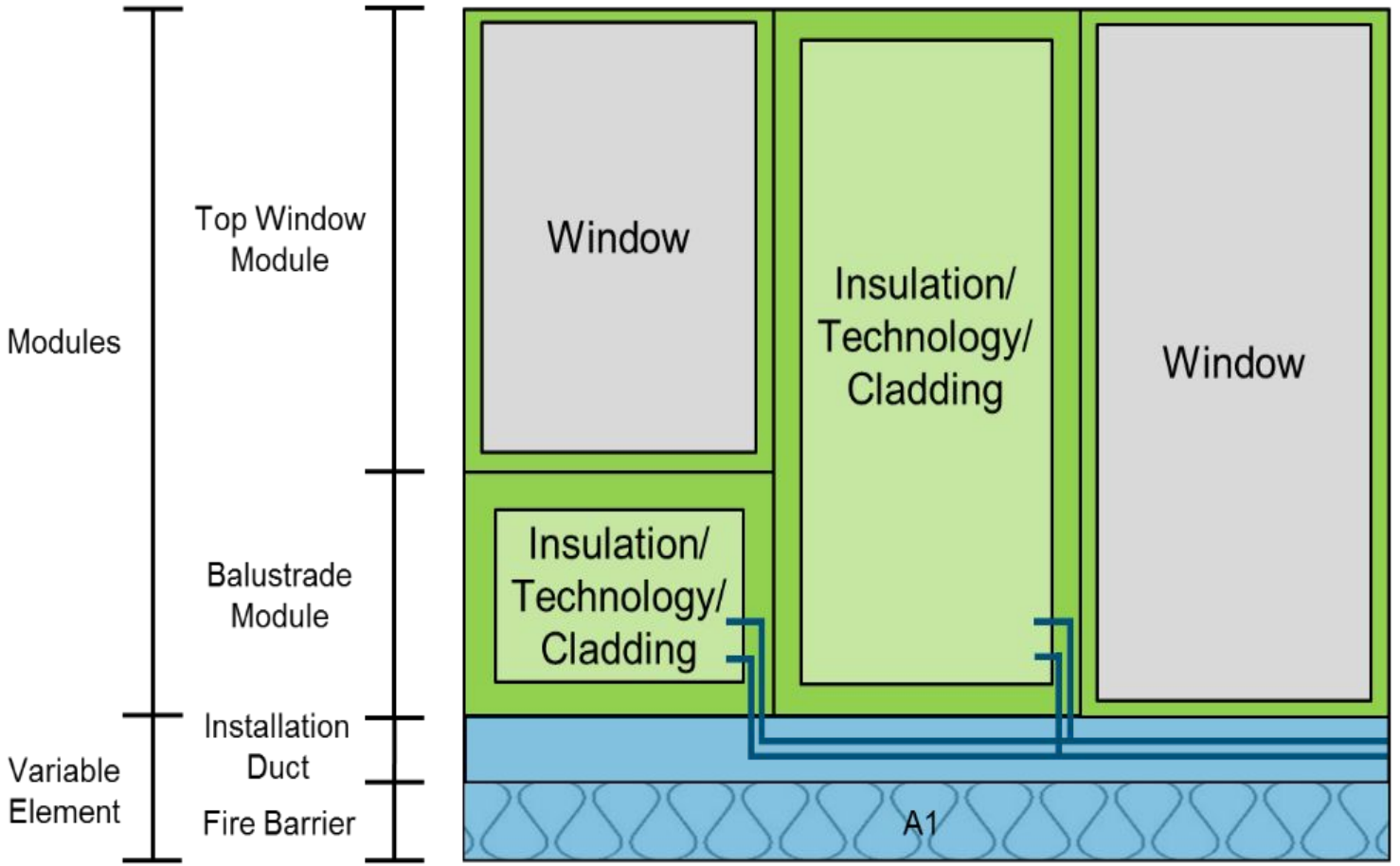
- Insulation
- Sun Shading

Components: energy harvesting

- Photovoltaics
- Storage

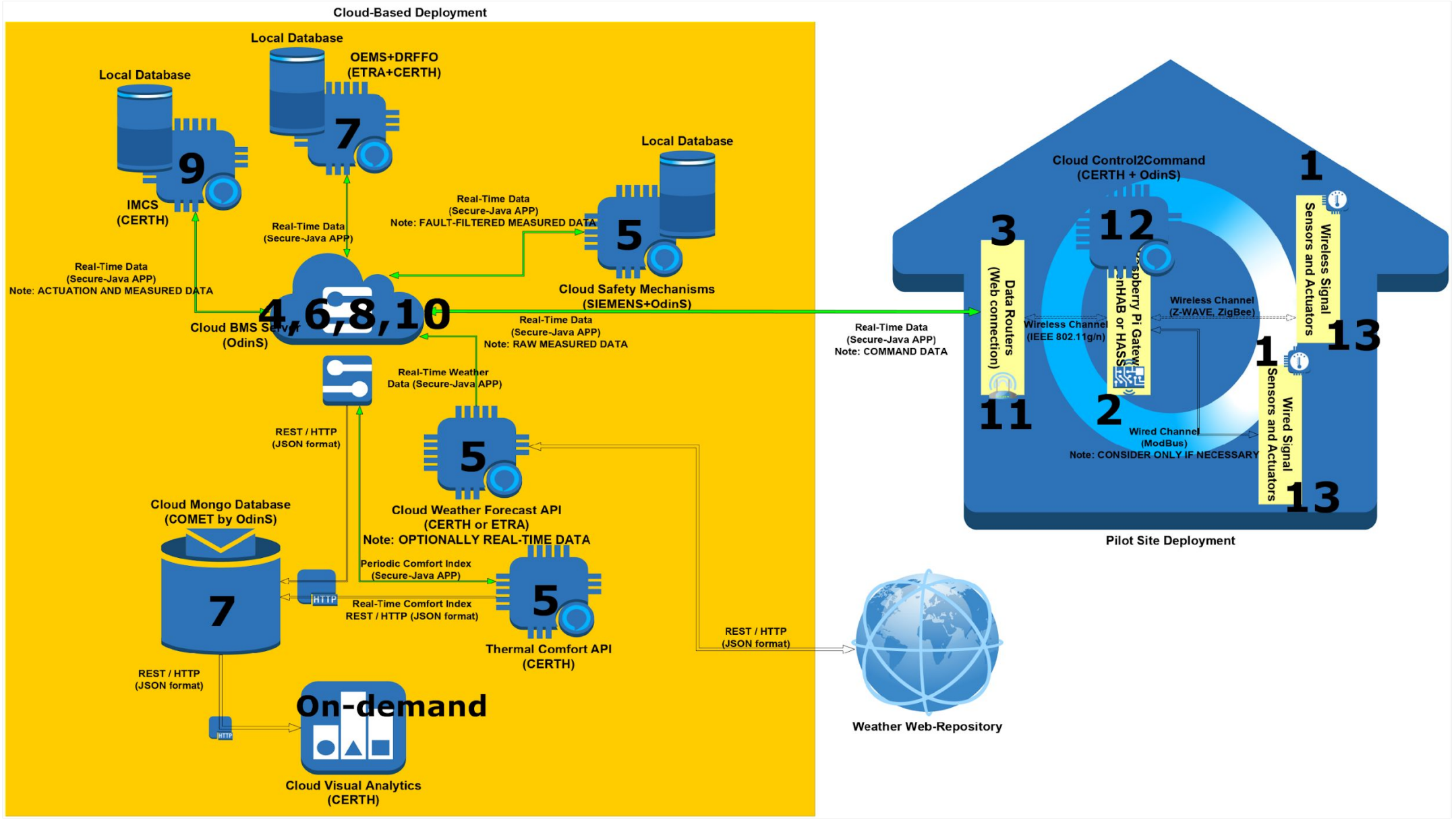
Components: heating/ cooling

- Ventilation with Heat recovery



Digitalised Micro-Grid Energy Management System (EMS)

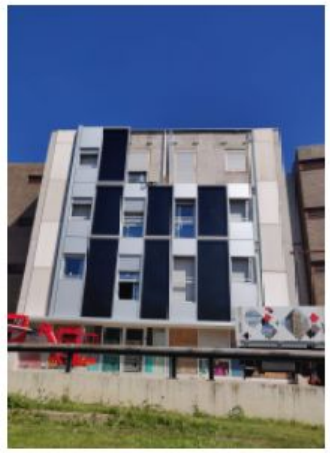
- EMS is comprised by an **ecosystem of ICT tools:**
  - Secure Communication and Routing Mechanisms
  - Data Treatment ensuring Safety
  - Flexibility Forecasting System
  - Intelligent Management and Control System


Cloud-Based Deployment
Local Database
OEMS+DRFFO
(ETRA+CERTH)
7
Local Database
9
IMCS
(CERTH)
Local Database
5
Cloud Safety Mechanisms
(SIEMENS+OdinS)
Real-Time Data
(Secure-Java APP)
Note: FAULT-FILTERED MEASURED DATA
Real-Time Data
(Secure-Java APP)
Real-Time Data
(Secure-Java APP)
Note: ACTUATION AND MEASURED DATA
4,6,8,10
Cloud BMS Server
(OdinS)
Real-Time Data
(Secure-Java APP)
Note: RAW MEASURED DATA
Real-Time Weather
Data (Secure-Java APP)
REST / HTTP
(JSON format)
5
Cloud Weather Forecast API
(CERTH or ETRA)
Note: OPTIONALLY REAL-TIME DATA
Cloud Mongo Database
(COMET by OdinS)
7
Periodic Comfort Index
(Secure-Java APP)
Real-Time Comfort Index
REST / HTTP (JSON format)
5
Thermal Comfort API
(CERTH)
REST / HTTP
(JSON format)
REST / HTTP
(JSON format)
On-demand
Cloud Visual Analytics
(CERTH)
Real-Time Data
(Secure-Java APP)
Note: COMMAND DATA
Cloud Control2Command
(CERTH + OdinS)
12
1
Wireless Signal
Sensors and Actuators
13
3
Data Routers
(Web connection)
11
Wireless Channel
(IEEE 802.11g/n)
Raspberry Pi Gateway
openHAB or HASS
2
Wireless Channel
(Z-WAVE, ZigBee)
1
Wired Signal
Sensors and Actuators
13
Wired Channel
(ModBus)
Note: CONSIDER ONLY IF NECESSARY
Pilot Site Deployment
Weather Web-Repository

Results – ADBE and EMS Deployment

A. Pilot Case 1: RWTH Aachen, Tertiary, DE

B. Pilot Case 2: CCC Cardiff, Residential UK



C. Pilot Case 3: AHC Saint-Quirze, Residential, ES

D. Pilot Case 4: RWM Grevena. Tertiary, GR

Circular Economy aspects of the design

Toni Herena
Business and Energy Analyst
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Circular economy and PLUG-N-HARVEST

PLUG-N-HARVEST pretends to develop and implement products and business models based on the Circular Economy

- allowing the massive replicability of the solutions developed according to the market conditions
- ensuring paybacks periods less than 10 years by considering the complete solutions as physical and financial asset

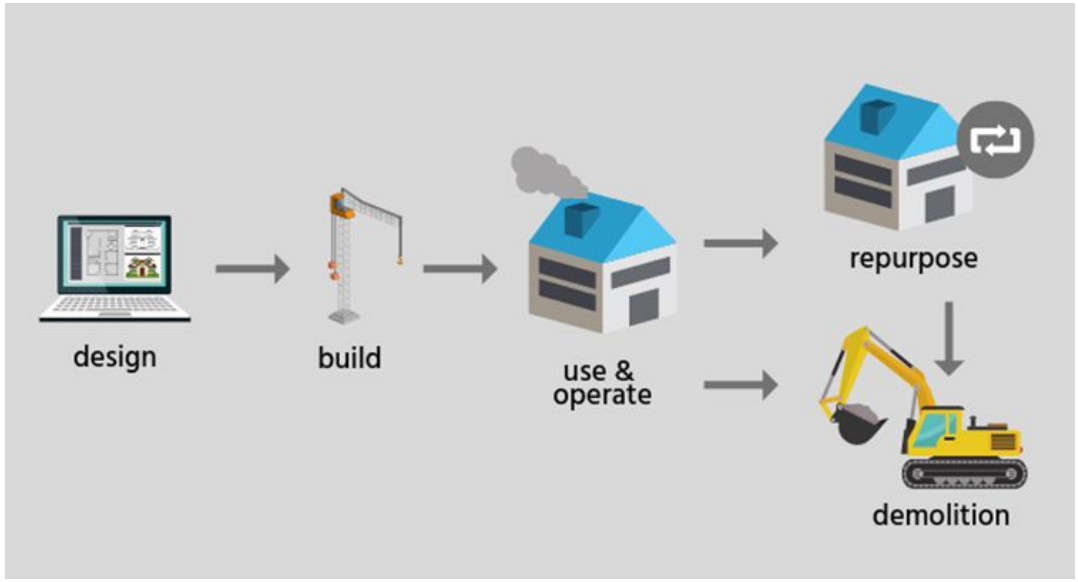
Circular economy and PLUG-N-HARVEST

Design a modular ADBE solution (product & system) consistent with the concepts of circular economy: for instance, the use of reusable non-toxic and recyclable materials or the guarantee of maximum energy reductions and maximum energy harvesting

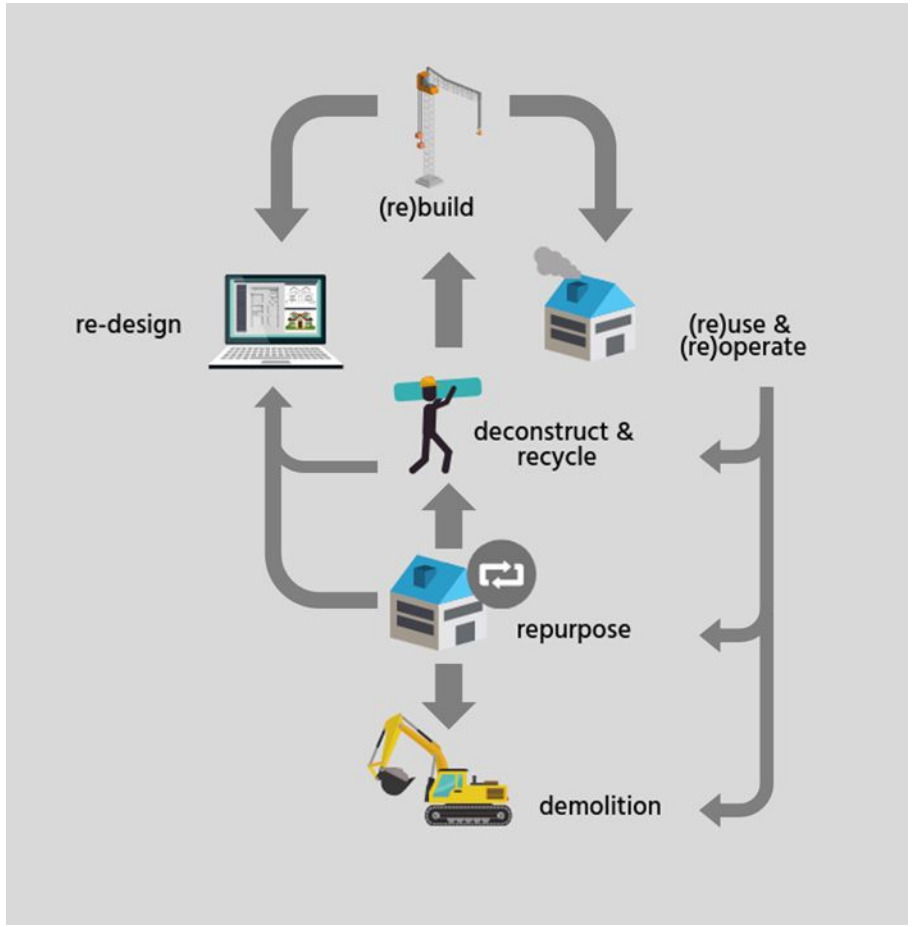
Evaluation methodology and impact assessment of circular economy solutions

Develop business models for each one of the demo cases, adjusting to their singularities, technical and financial boundary conditions and national regulations to obtain viable models based on renting and leasing options

Modular and circular ADBE solution



Building phases in a linear model.
Adapted from BAMB



Building phases in a circular model.
Adapted from BAMB

CDR – Circular Economy Design Requirements

- CDR 1: Use safe materials
- CDR 2: Think in System circularity
  - CDR 2.1: Define the right cycle
  - CDR 2.2: Make it easy to disassemble
  - CDR 2.3: Enhance materials productivity
  - CDR 2.4: Choose the inner cycle
- CDR 3: Preserve transparency and traceability
- CDR 4: Keep track of valuable materials

CDR 5: Rethink business model / New Partnership models / implement business models that support a circular transition

CDR – Circular Economy Design Requirements

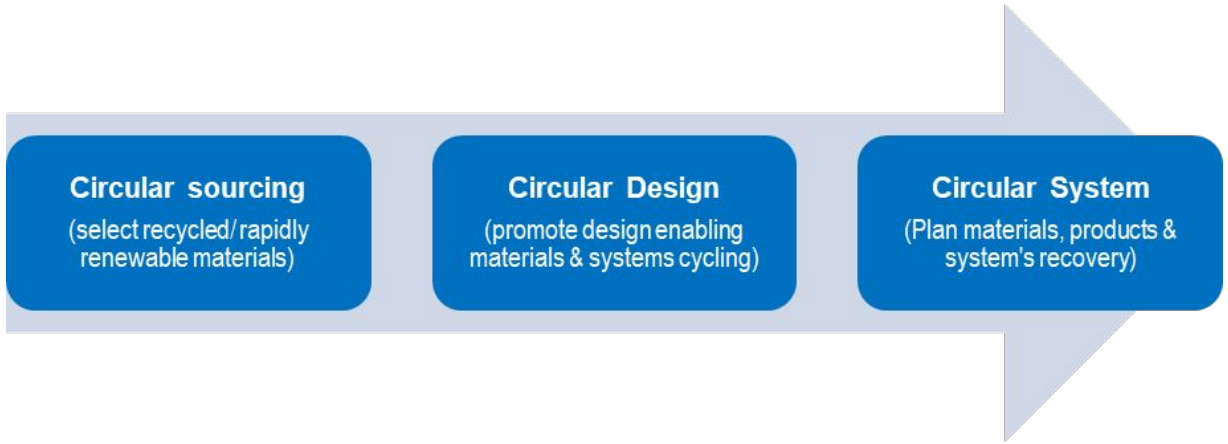
- **CDR 1: Use safe materials**
  - Use of non-toxic materials
    - Extraction and manufacturing
    - Use phase
    - During cycling phase such as reuse, remanufacturing, recycling, etc.
    - Unintentional but probably end-uses such as landfilling, incineration, etc

✔ **The methodology used to select safe materials for the PLUG-N-HARVEST system is the Material Health quality category of the Cradle to Cradle CertifiedTM Products Standard (C2CPII, 2015a).**

✔ **Creation of a Material Data Base**

CDR – Circular Economy Design Requirements

- **CDR 2: Think in Systems Circularity**
  - CDR 2.1: Define the right cycle
  - CDR 2.2: Design for Disassembly
  - CDR 2.3: Enhance materials productivity
  - CDR 2.4: Promote the inner cycle



Circular Sourcing	Circular Design	Circular Systems
% Cycled or Rapidly Renewable Content	% Cyclable Content	Circularity Inventory
% Material Conservation	Designed for Technical or Biological Nutrient Cycling	Active Cycling
	Designed for Disassembly	
	Circular Design Opportunities	

Dimensions of material reutilization aligned with Cradle to Cradle Certified™ Products Standard Draft for v4. Source: (C2CPII, 2018)

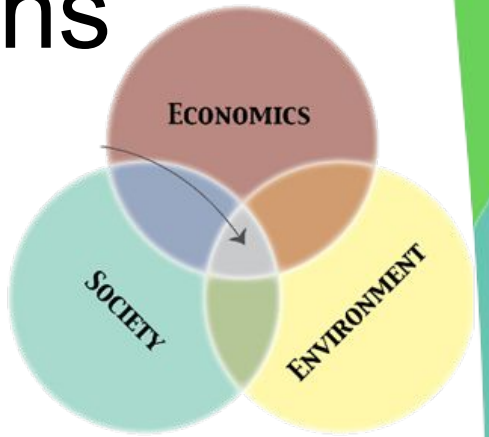
CDR – Circular Economy Design Requirements

- **CDR 3: Preserve transparency and traceability**
  - PLUG-N-HARVEST system is decomposed into all its homogenous materials
  - Work with materials' suppliers as partners. Track the materials up to their sources, analysing the whole supply chain, to gather information not only about chemicals present but also social and manufacturing practices
  - Store all relevant information collected into a PLUG-N-HARVEST Material Database
  - Define different levels to disclose relevant information to different partners or stakeholders, according their need.

CDR – Circular Economy Design Requirements

- **CDR 4: Keep track of Critical materials**
  - Request to materials suppliers to describe the presence of scarce materials in all the devices, products and materials included in the ADBE Modular kit
  - Circular Material database will highlight materials that contains CMRs.
- **CDR 5: Rethink business model**
  - Façade as a Service

Evaluation methodology and impact assessment of circular economy solutions



Circularity is addressed from the perspective of 4 main vectors:

- Energy use
- Materials use
- Water use
- Social impact

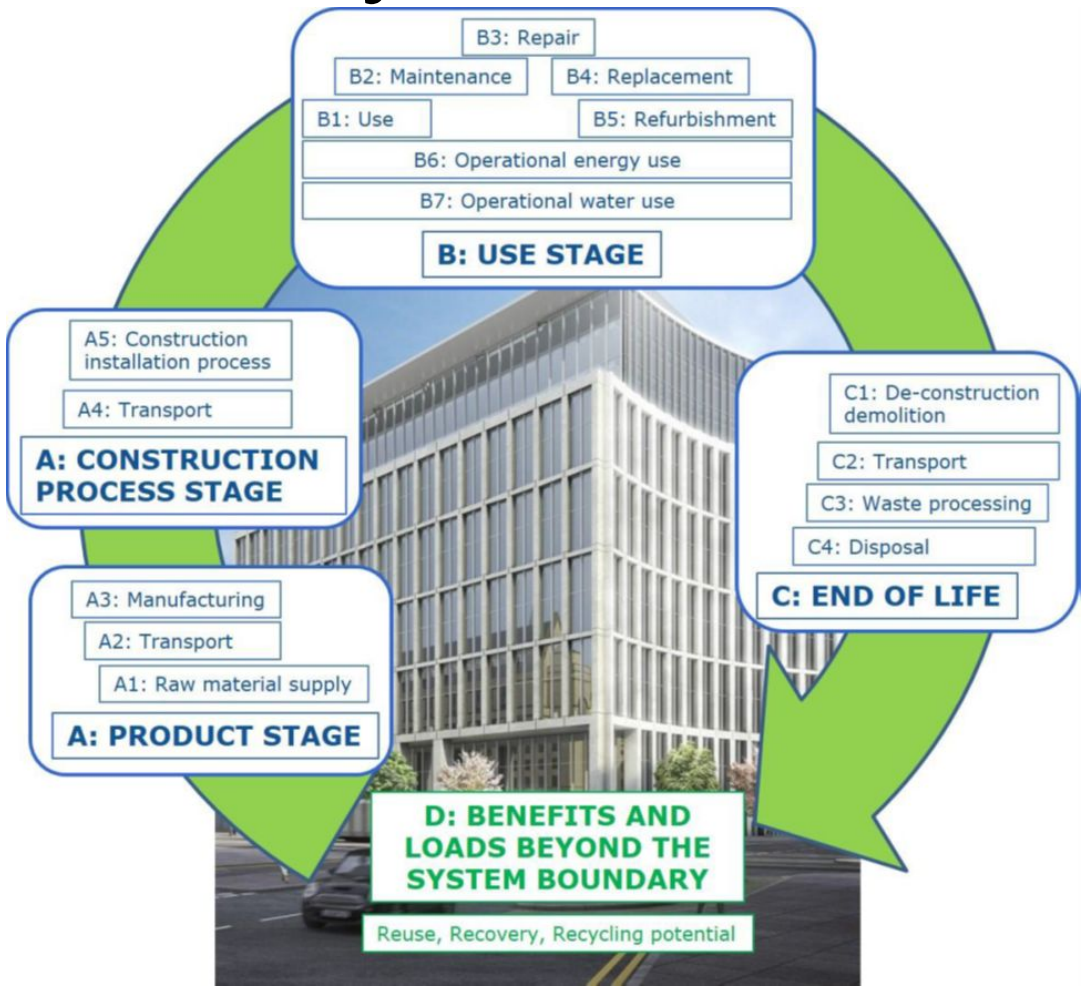
- The methodology include the economic evaluation of the activity addressed (new building construction or major renovation)

cradle to cradle

KPMG TRUE VALUE

Evaluation methodology and impact assessment of circular economy solutions

- Circularity addressed in four life cycle stages (according with EN 15978 Sustainability of construction works – Assessment of environmental performance of buildings)
  - Product stage
  - Construction stage
  - Use stage
  - End of life



Evaluation methodology and impact assessment of circular economy solutions

$$ECI[\%] = \frac{CE_{A1-3} + CE_{A4-5} + CE_B + CE_C}{(E_{th} + E_e)_{A1-3} + (E_{th} + E_e)_{A4-5} + (E_{th} + E_e)_B + (E_{th} + E_e)_C}$$

$$MCI[\%] = \frac{MICS_{A1-3} + MICS_{A4-5} + MICS_B + MOCP_{A5} + MOCP_B + MOCP_C [kg]}{TMI_{A1-3} + TMI_{A4-5} + TMI_B + TMO_{A5} + TMO_B + TMO_C [kg]}$$

$$WCI[\%] = \frac{CW_{A1-3} + CW_{A4-5} + CW_B + CW_C \ [m^3]}{W_{A1-3} + W_{A4-5} + W_B + W_C \ [m^3]}$$

$$SCI[\%] = \frac{SI_{A1-3} + SI_{A4-5} + SI_{B1} + SI_{B2-B5} + SI_C}{N_{A1-3} + N_{A4-5} + N_{B1} + N_{B2-B5} + N_C}$$

$$EV[EUR, USD] = -C_{inv} - C_{energy} - C_{water} - C_{mgmt} - C_{maint} + R_{env} + R_{social} + R_{econ}$$

Methodology to assess the circularity in building construction and refurbishment activities

Evaluation methodology and impact assessment of circular economy solutions

Composing layers of the ETICS system evaluated.

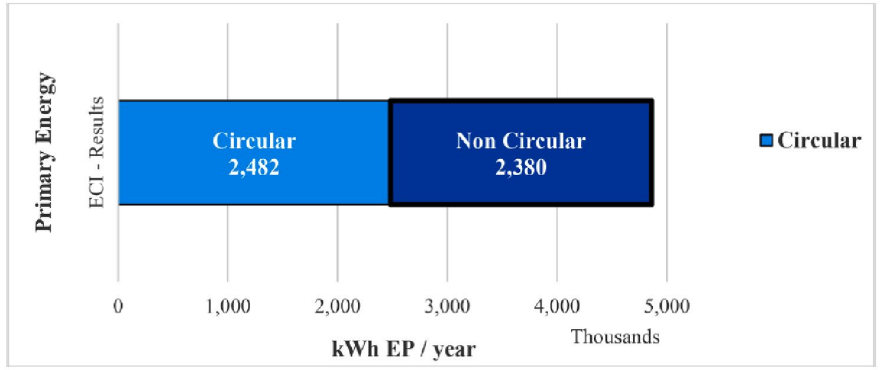
Main Façade Material Layer	Thickness [m]	Conductivity [W/mK]
Cement Board Organic Fibres	0.008	1.000
Ventilation Cavity	0.050	0.000
XPS	0.040	0.045
Cement Plaster	0.003	1.000
Clay Masonry	0.140	0.870
Plaster	0.010	0.250

Bill of Materials of the ETICS system and sizing of the PV system.

ETICS System Layer	Material	Weight of system layer in ETICS [kg/m^2]
Adhesive	Adhesive mortar	4,00
Insulation	Rock wool	6,00
Anchors	Polyethylene, HDPE, granulate	0,05
Anchors	Steel, low-alloyed	0,04
Base Coal	Adhesive mortar	6,00
Reinforcement	Glass fibre reinforced plastic, polyester resin	0,18
Primer	Alkyd paint, white, 60% in H2O	0,04
Finishing Layer	Limestone, milled, packed	4,00
PV system		
System Layer	**Material**	**PV modules rated power**
PV panel	Photovoltaic cell, multi-Si	12,09

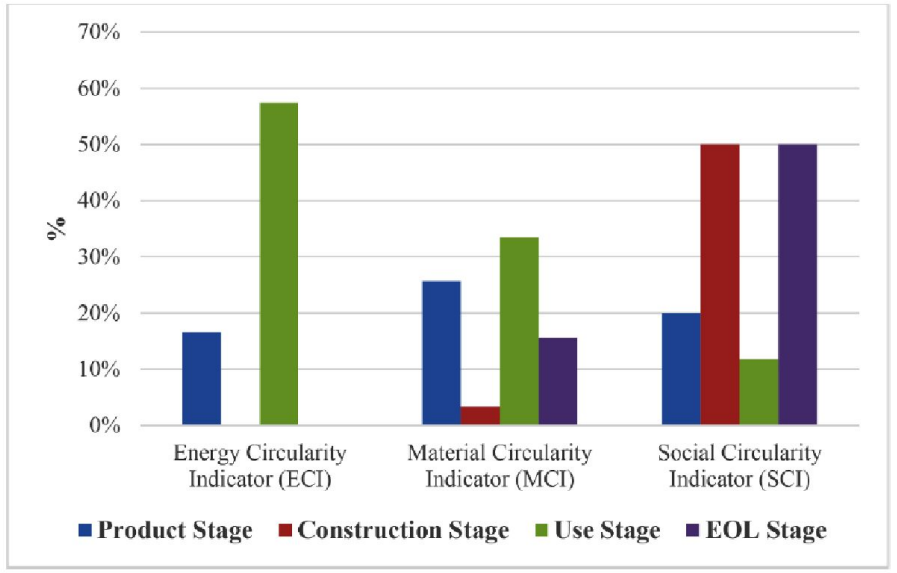
Methodology to assess the circularity in building construction and refurbishment activities

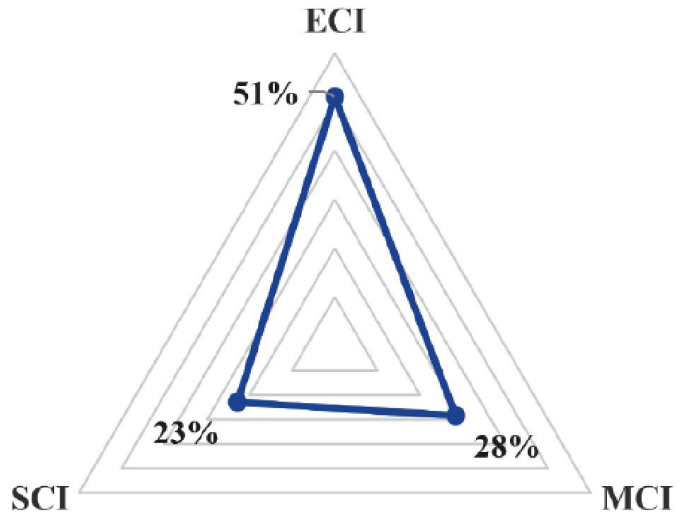
Evaluation methodology and impact assessment of circular economy solutions



Detailed results of the ECI calculation.

	PE Total	Circular PE	ECI
Stage	kWh	kWh	%
Product (A1 – A3)	148,570	24 642	**16.59**
Transportation (A4)	399,777	0	**0**
Construction (A5)	134	15	**11.19**
Operation (B)	4,278,726	2,456,875	**57.42**
EOL (C)	33,911	25	**0.07**
Life Cycle	**4,861,118**	**2,481,557**	**51.05**





Pilot Case 3: AHC - Sant Quirze Residential Building, CAT, ES

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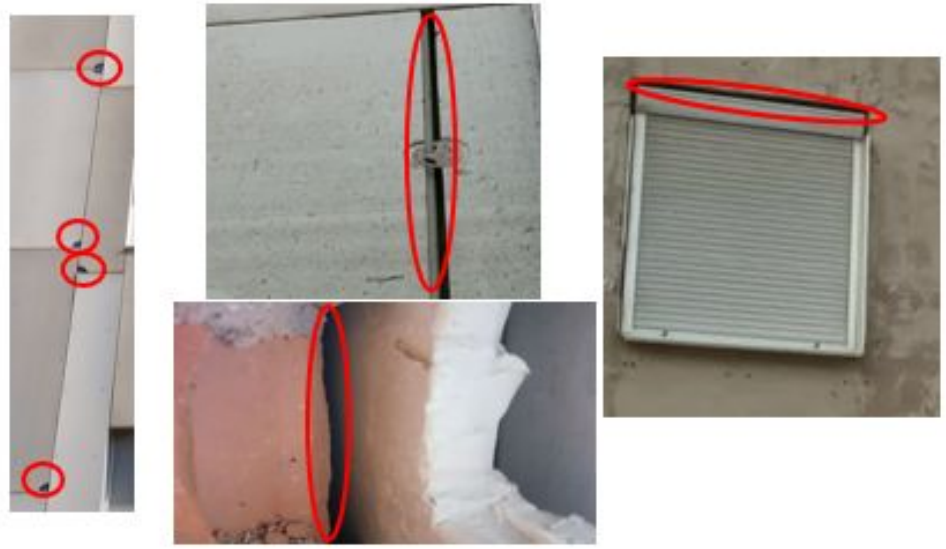
Agència de l'Habitatge de Catalunya

DESCRIPTION OF THE PILOT BUILDING – INITIAL STATE

BUILDING GENERAL DESCRIPTION:

- Location → Sant Quirze del Vallès, Barcelona, Catalonia, Spain
- Residential building from year 2003 dedicated to social housing
- 3 blocks (A, B1 and B2) organized in a U-shape.
  - Only block A is affected by the PnH renovation.
- Principal axis of block A is south-north oriented, and has 4 levels:
  - 1 premises in the ground floor.
  - 6 dwellings in the 1st to 3rd floors (2 dwellings/floor).
- The **PnH renovation is focused on the south façade of block A**.
  - 101 sqm
- The south façade was a “Natuvex” ventilated façade, with low isolation and fiber-cement boards as cladding.

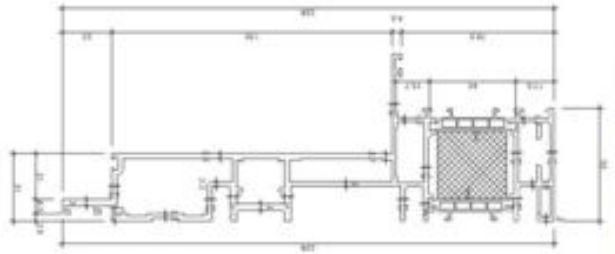
- There were a lot of **pathologies in the south façade** initial state:
  - Fiber-cement boards were broken and falling, especially in the corners.
  - Isolation plates were separated with no mortar or joining in between.
  - Isolation was also separated from the main concrete wall.
  - Big thermal bridges in between the carpentry and the opaque enclosure.

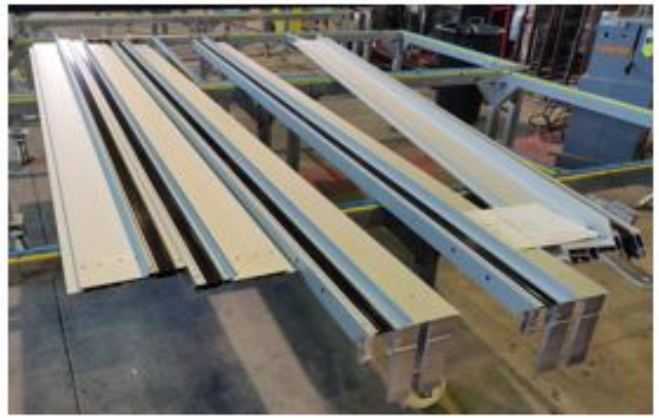


ADBE FAÇADE PANELS – THE PnH SOLUTION

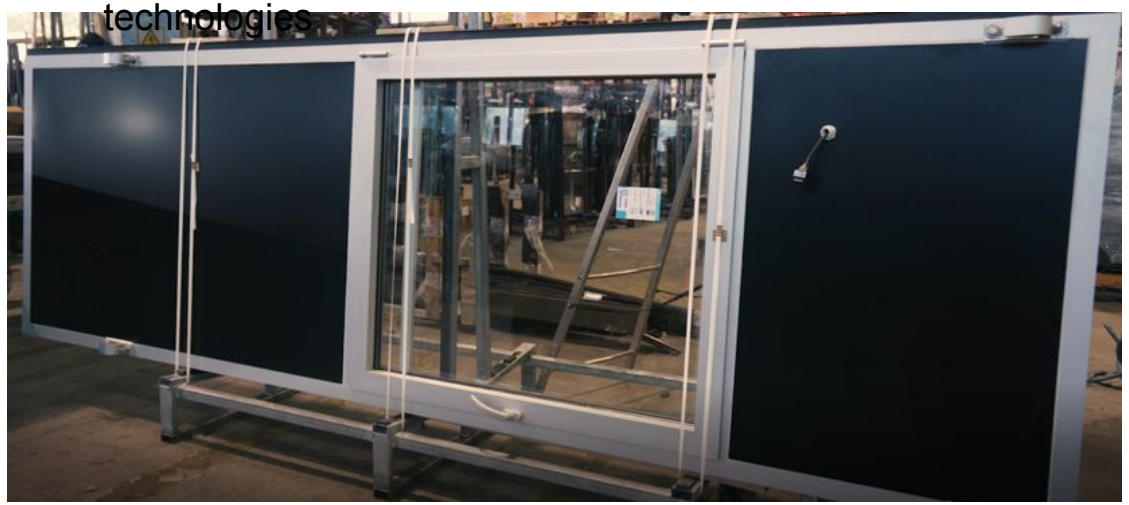
Adaptable Dynamic Building Envelop [ADBE]
FAÇADE PANELS

- Based on an innovative aluminium profile.
- Frame / structure of the façade panels





- Addition of active and passive technologies



ADBE FAÇADE PANELS – SANT QUIRZE CASE

PASSIVE AND ACTIVE TECHNOLOGIES SELECTED:

- ***Thermal insulation***, 100 mm of mineral wool → λ = 0,034 W/m·K

- ***Windows***:
  - Aluminium frame with thermal bridge breakage.
  - Double glazed:
    - Thickness 44.1–16–6 mm,
    - 90% Argon gas gap
    - Low emissivity glass U=1,1 W/m^2·K.
    - Solar factor g=0,59
  - Automatic shutters of anodized aluminium.

- ***BIPV*** - Tailored building integrated ***photovoltaic panels*** – monocrystalline type

- ***Aluminium cladding***

ADBE FAÇADE PANELS – MANUFACTURING AND VALIDATION (TEST)

- **MANUFACTURING** → The manufacture of the ADBE façade panels was carried out by the company Garcia Faura, with the supervision of .

GARCIA FAURA
ARQUITECTURA
EN ALUMINI, INOX
FERRO I VIDRE

Entivema

- **TESTING** → An official test in a certified laboratory was carried c Applus
  - 2 ADBE façade panels were tested.
  - UNE-EN 13830:2016 – Minimum product standards for light façades
  - Ensure a minimum Technology Readiness Level [TRL] – 7
  - Meet the project requirements

- **TESTS REQUESTED AND VALIDATED:**
  - Air permeability test
  - Water thingness test
  - Wind load resistance test
  - Impact resistance test

- All the results obtained were positive → ADBE façade panels vali

ADBE FAÇADE PANELS INSTALLED

A TOTAL AMOUNT OF **21 ADBE FAÇADE PANELS** WERE MANUFACTURED AND INSTALLED**:**

- Divided in 3 rows and 7 columns.
- 3 different type of panels have been manufactured

SINGLE ADBE PANEL [PV]

- 9 units
- All the panel has PV as cladding.

DOUBLE ADBE PANEL

- 6 units
- The lower part is window and the upper aluminium cladding.

TRIPLE ADBE PANEL

- 6 units
- The lower and upper part are aluminium cladding. The windows is in the middle.

RENOVATION - WORKS DONE

RENOVATION TIMES –> FROM MARCH TO MAY 2022 [< 2 MONTHS]

STEP 1: DISMANTLING OF THE EXITING FAÇADE –> 7 WORKING DAYS

RENOVATION - WORKS DONE

RENOVATION TIMES –> FROM MARCH TO MAY 2022 [< 2 MONTHS]

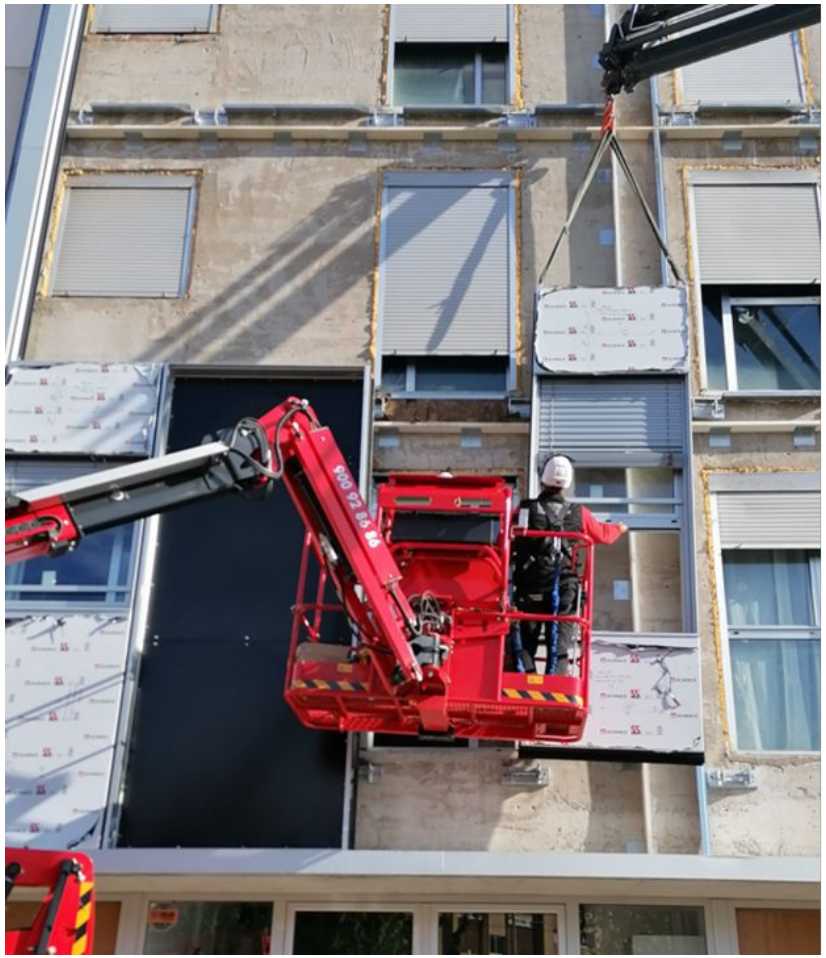
STEP 2: PREPARATION WORKS FOR THE INSTALLATION OF THE ADBE FAÇADE PANELS –> 12 WORKING DAYS

- Anchoring system
- Fire protection elements
- Acoustic isolation band
- Drilling the main wall to pass the wires of the automatic shutters.
- Etc.

RENOVATION - WORKS DONE

RENOVATION TIMES –> FROM MARCH TO MAY 2022 [< 2 MONTHS]

STEP 3: INSTALLATION OF THE ADBE FAÇADE PANELS –> 6 WORKING DAYS

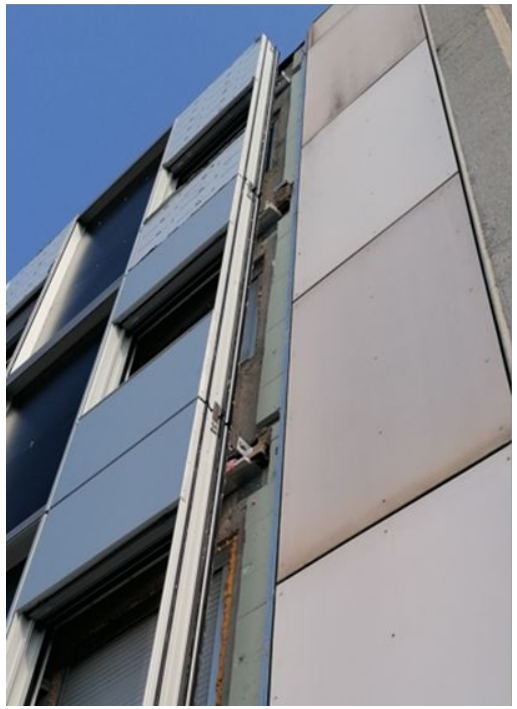


RENOVATION - WORKS DONE

RENOVATION TIMES –> FROM MARCH TO MAY 2022 [< 2 MONTHS]

STEP 4: DISMANTLING OF EXISTING WINDOWS FROM THE INTERIOR AND FINISHES –> 7 WORKING DAYS

- Internal frame of the windows
- Sealing of internal joints
- Completion of electrical circuit for the automatic shutters.
- Lateral and crowning of the façade from the exterior.
- Etc.




STOP
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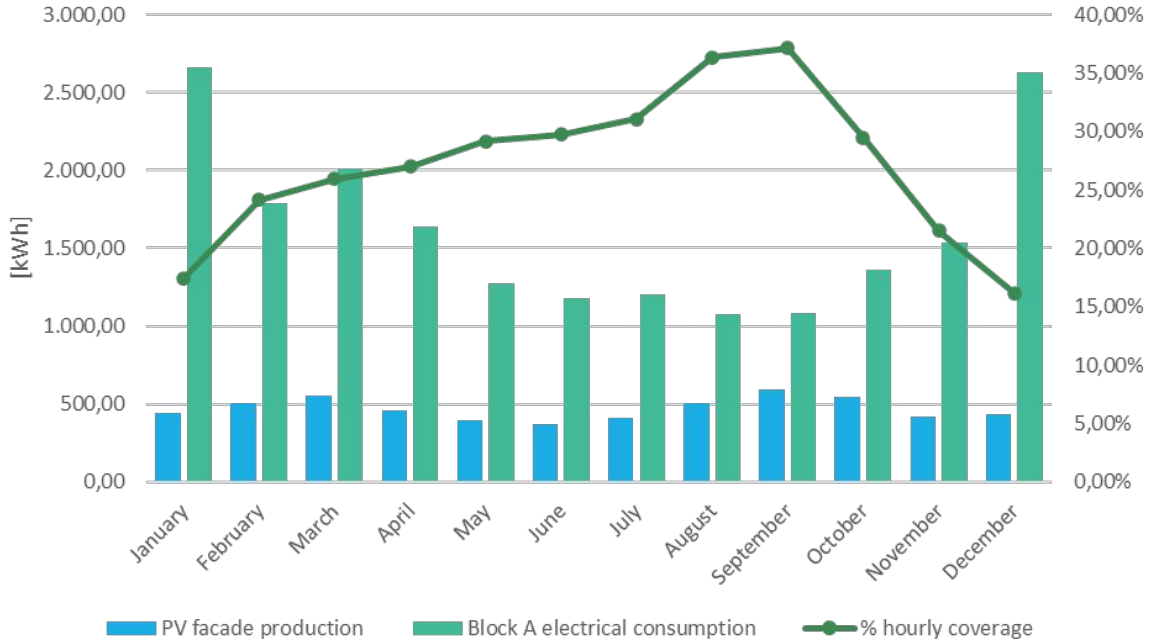
PV SYSTEM

A total amount of 33 PV GLASSES have been installed within the 9 ADBE SINGLE FAÇADE PANELS which incorporate PV

- The total peak power installed is 5,38 kWp
- A SOLIS inverter has been installed with a nominal power of 6 kWn
- The PV system has been started up and legalized in December 2022
- The PV production is shared equally among all the dwellings of the building
- The surplus of PV production is injected to the grid and compensated economically through the electricity bills of the tenants
- It is expected to reach:
  - Self-consumption ratio between 60-80% of PV the production
  - Surplus injected to the grid 20-40% of the PV production
  - Average hourly coverage of 30%



CONCLUSIONS - PRELIMINARY RESULTS

BENEFITS:

- Improvement of the opaque and translucent enclosures -

	Before PLUG-ND-HARVEST	After PLUG-ND-HARVEST
U value of the façade [W/m²·K]	0,78	0,25
U value of the window frame [W/m²·K]	5,70	1,55
U value of the glasses [W/m²·K]	3,30	1,10

- Thermal bridges in façade and windows resolved.
- Expected reduction of the heating & cooling demand around 10-15%.
- PV incorporation → Expected results:
  - 30% of reduction from the electricity consumption of the grid.
  - 30% of reduction of non renewable primary energy.
  - Extra economic savings from surplus compensation through electricity bills.
- Shortening refurbishment times (< than 2 months).
- Benefits of the circular economy.
- Level of user satisfaction very high. All respondents were very satisfied with the renovation.

MORE INFORMATION

- **PnH Project Social Media:**
  - Webpage –> https://www.plug-n-harvest.eu/
  - YouTube channel –> https://www.youtube.com/@plugnharvest1148
  - LinkedIn –> https://www.linkedin.com/company/plug-n-harvest-h2020/

- **AHC official webpage –>** AHC Webpage

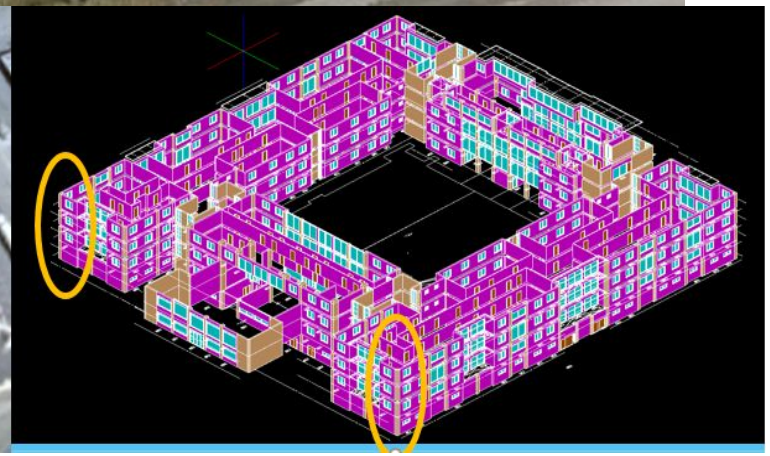
- **BUILD UP portal:**
  - Study case publication → BUILD UP study case

Thank you!

Pilot Case 4: RWM Grevena, Tertiary, GR

Nikolaos Margaritis
Dr. Mechanical engineer
Project Manager at CERTH/CPERI
n.margaritis@certh.gr

Pilot building description



- Floors to be retrofitted: **1st & 2nd (SE and SW)**
- 4 offices in total (2 in each floor)
- Symmetrical building architecture

Implementation of GREEK Pilot in Grevena_PnH project

before PnH

Implementation of GREEK Pilot in Grevena_PnH project

after PnH

Pilot building description

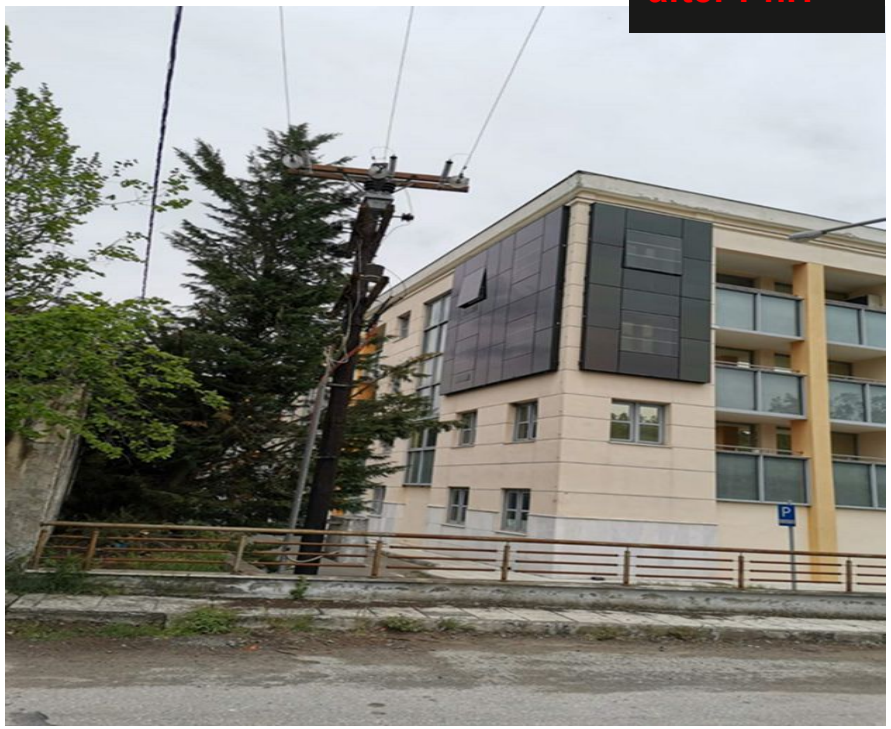
before PnH

after PnH

Pilot building description

before PnH

after PnH



Final Technical specifications

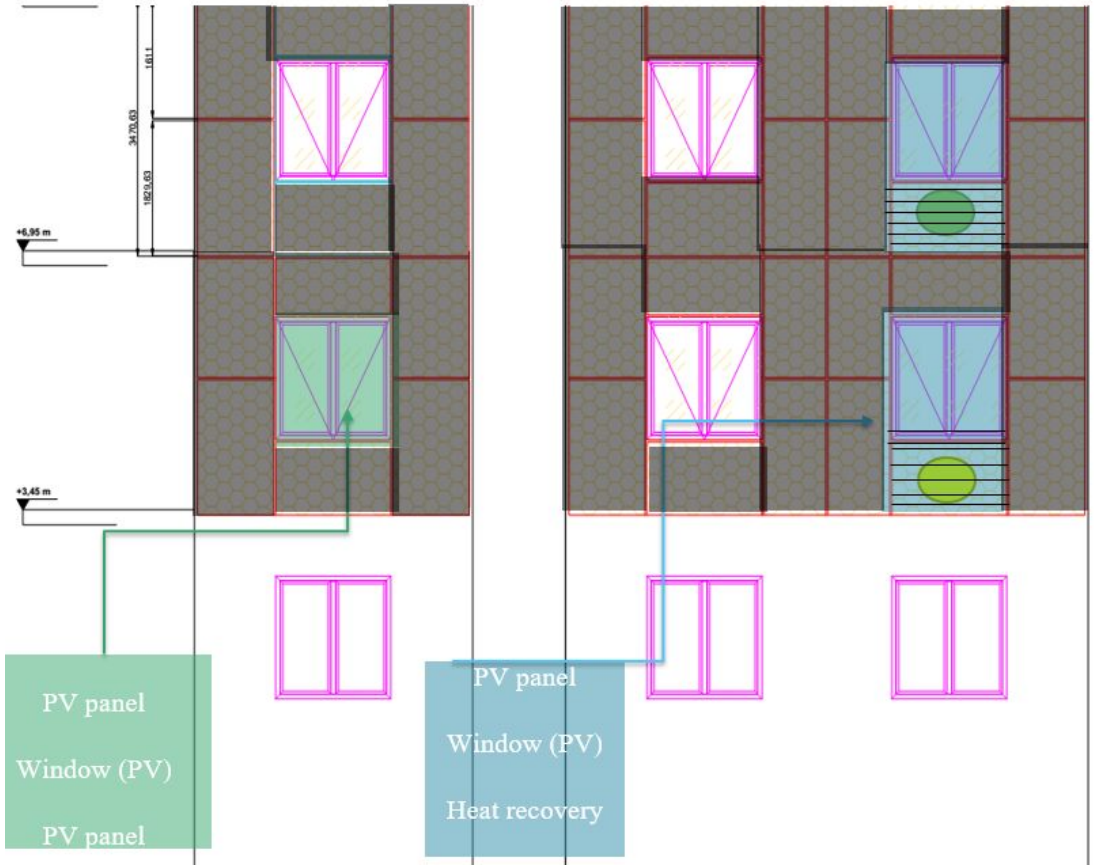
- **Aluminum profile**
  Designed from ALUMIL
  2 modules finally selected
  925mmx3470mm and **1690mmx3470mm**

- **BIPV ~147.4 m2 (autonomous system)**
  - a-Si (amorphous silicon) –Thin film
  - PV glass with a power of ~ **8 kW** (Onyx)
  - 4 inverters and 4 charge controllers

- **Storage unit**
  24 Batteries (OPzV ,682 Ah) for 1 day autonomy,
  2V 6 OPzV 600, Sunlight

- **Insulation**
  ~3 cm stonewool insulation, FIBRAN geo B051,$\lambda_D \leq 0{,}036$ W/mK

- **Ventilation/heat recovery device**
  Below window/one per office (Respiro series)



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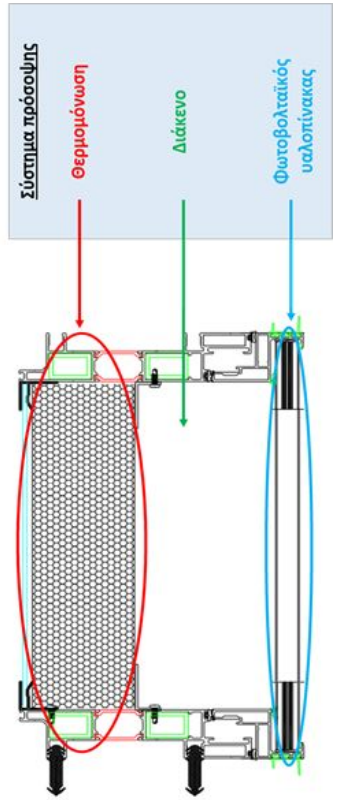
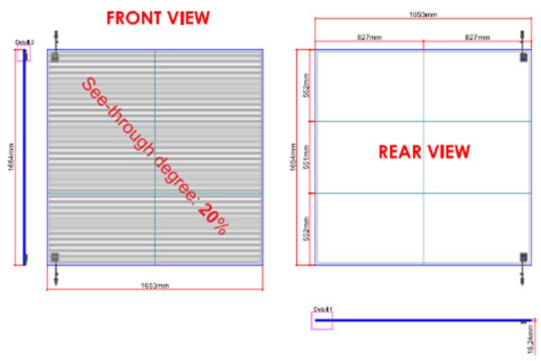
Solar Charge Controller
MPPT 150/35

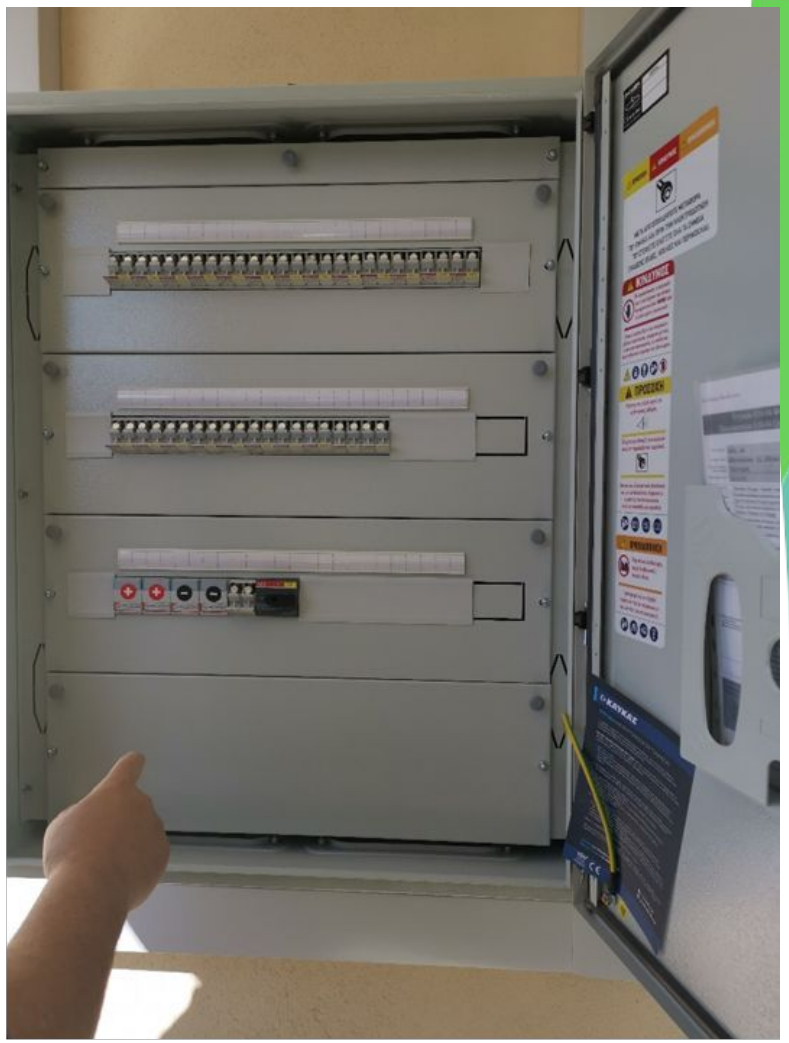


PV insulated glass



Installation of ADBE

1. RENEL IKE through different suppliers installed the components of ADBE in Grevena **within 1 month**, checking that all systems are working properly (**end of April 2022**)
2. due to the delay faced in the delivery of Onyx, the PV panels were installed over the ADBE modules, enabling RENEL IKE to finish within the allowed deadline
3. No big problems were emerged during renovation process. Most important aspect was the good communication between PV panel supplier and the integrator of the whole system on site in order to achieve the optimum result.
4. The selection of materials has been done attending to circular economy considerations
5. The users of the offices were happy about the renovation underway in their workplace and things went smoothly during installation of the ADBE modules and monitoring phase.



Inverters (4 items)

Victron Energy Multi Plus

Lithium ion battery compatible

Charge controllers (4 items)

Blue Solar charge controller MPPT 150/35

No transparency PV panels

(Dark 0%)

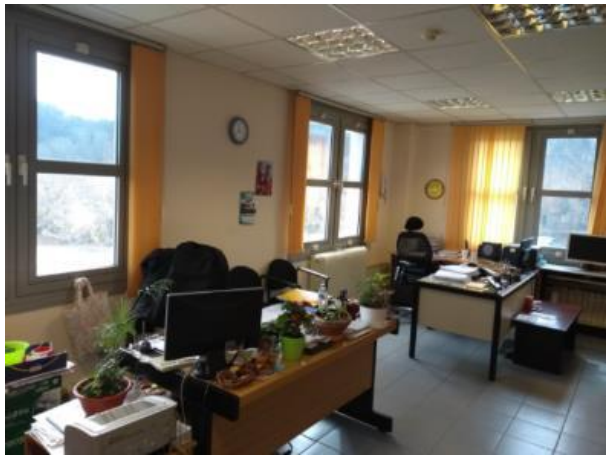
- **Max. power > 57.6 W_p/m^2**
- Visible Light Transmittance 0.2%
- U – Value 5.7 W/m^2K
- UV Transmittance: 0.0%
- Exterior reflectance 7.6%
- Solar Heat Gain Coefficient (SHGC) 22%
- IP65 Protection

Medium transparency PV panels

(L VISION 30%)

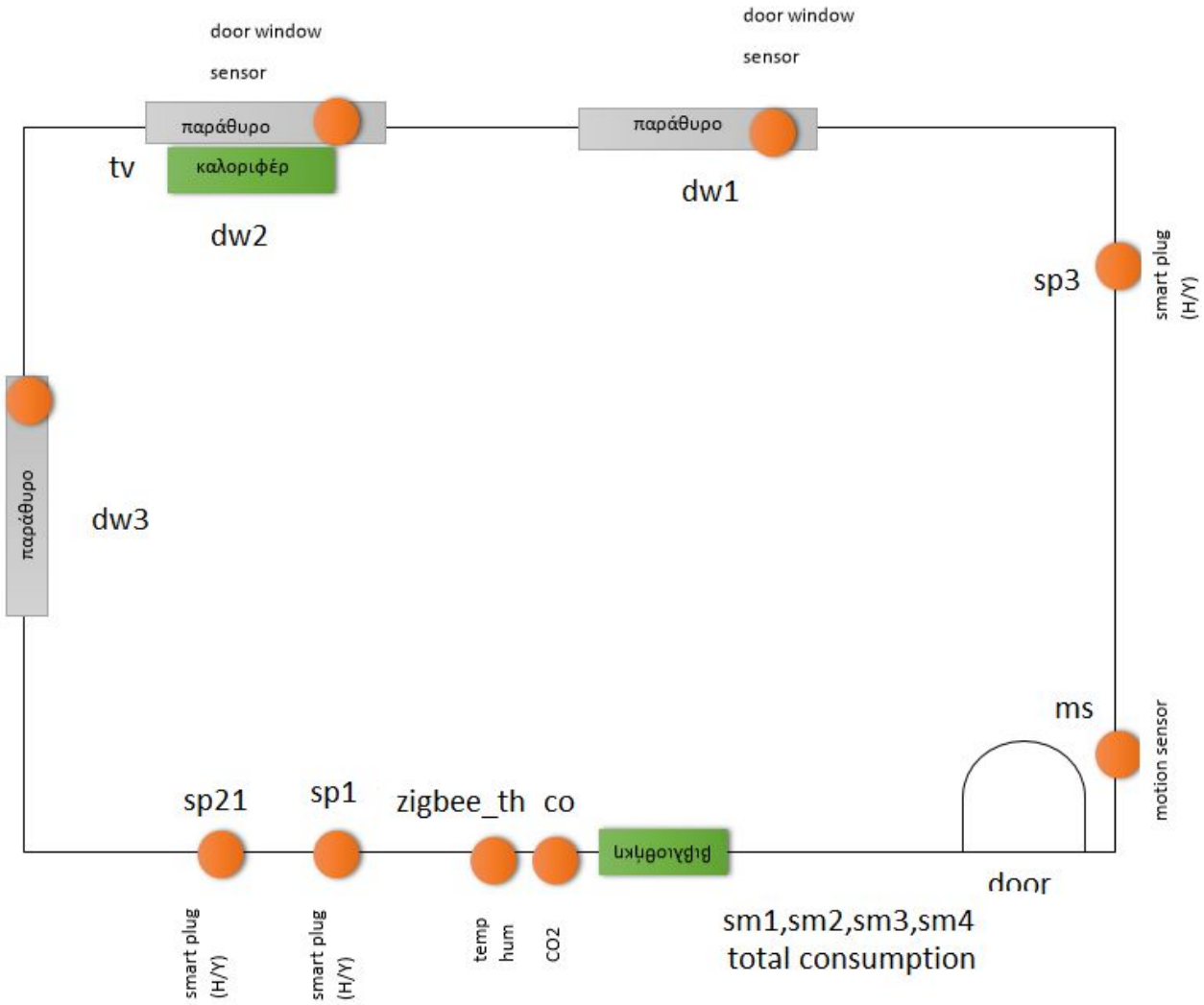
- **Max. power > 34 W_p/m^2**
- Visible Light Transmittance 17.3%
- U – Value 5.7 W/m^2K
- UV Transmittance: 1.5%
- Exterior reflectance 7.6%
- Solar Heat Gain Coefficient (SHGC) 34%
- IP65 Protection

Monitoring phase



The following items have been installed at 4 offices:

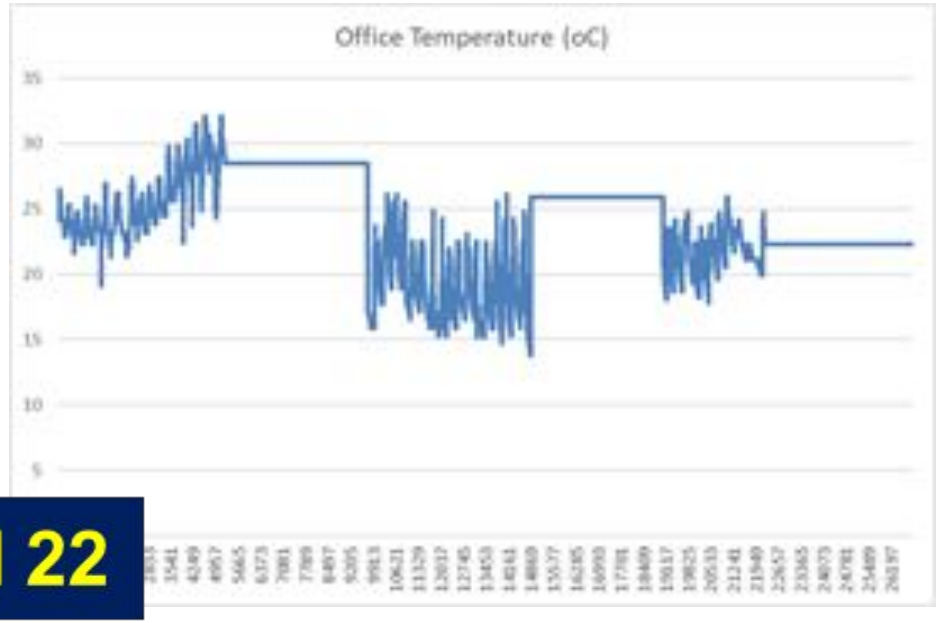
- Temperature and humidity sensors (4 items)
- Temperature, motion, light sensors (4 items)
- Door-window sensors (12 items)
- Energy meters for sockets/lights (14 items)
- Smart sockets for energy consumption of connected devices (12 items)
- Calorimeters for energy consumption of thermal radiators (4 items)
- Thermostatic valves (4 items)
- CO2 sensors (4 items)
- Weather station (1 item)
- Wifi repeaters (4 items)
- LED dimmable lights (96 items)



Node	Sensor	BMS
2	door window	dw1
3	door window	dw2
4	door window	dw3
5	smart plug	sp1
6	smart plug	sp 2
7	smart plug	sp3
8	motions sensor	ms
9	thermostatic valve	tv
10	CO2	co
-	smart meter	sm1
-	smart meter	sm2
-	smart meter	sm3
-	smart meter	sm4

Pre Monitoring_results

Office_SW_362
1st floor



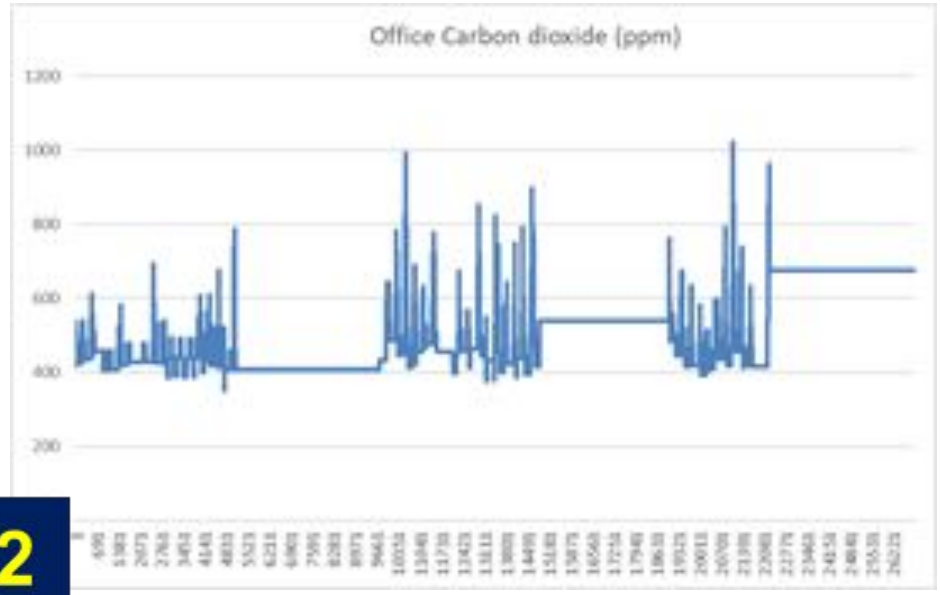
June 21 – April 22

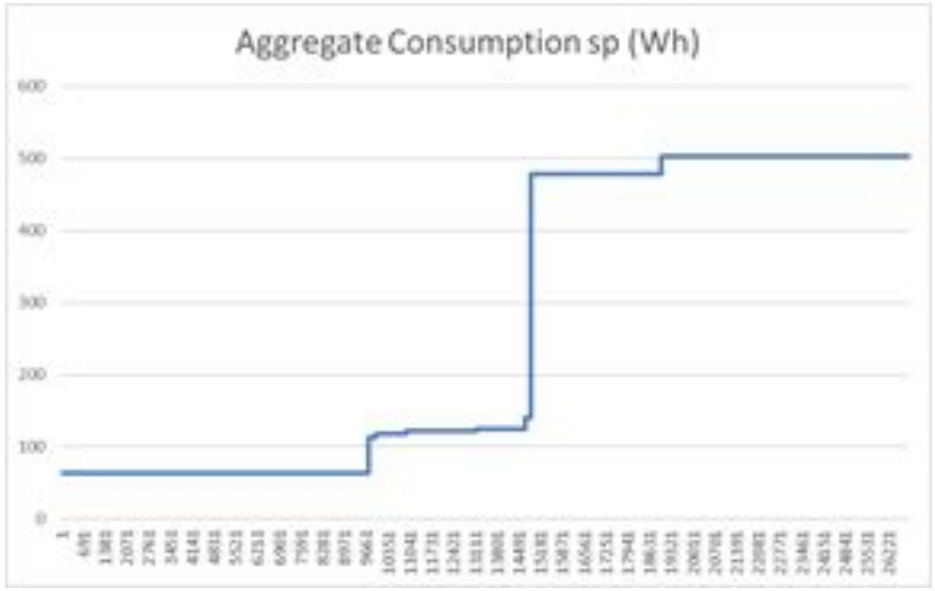
BUILD UP: *Building envelope and facade technologies for efficient buildings*

Pre Monitoring_results

Office_SW_362
1st floor

June 21 – April 22



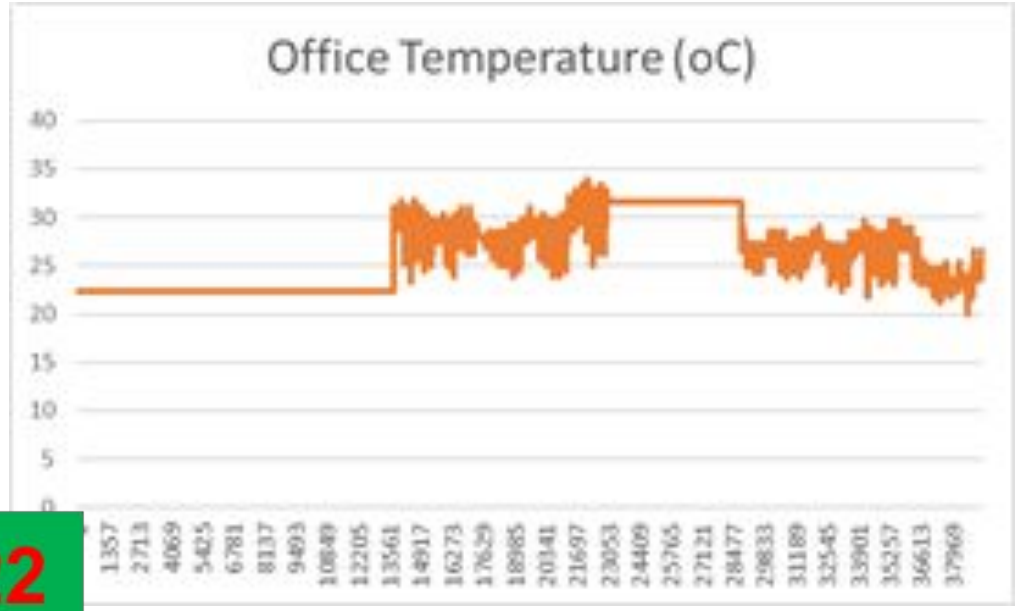


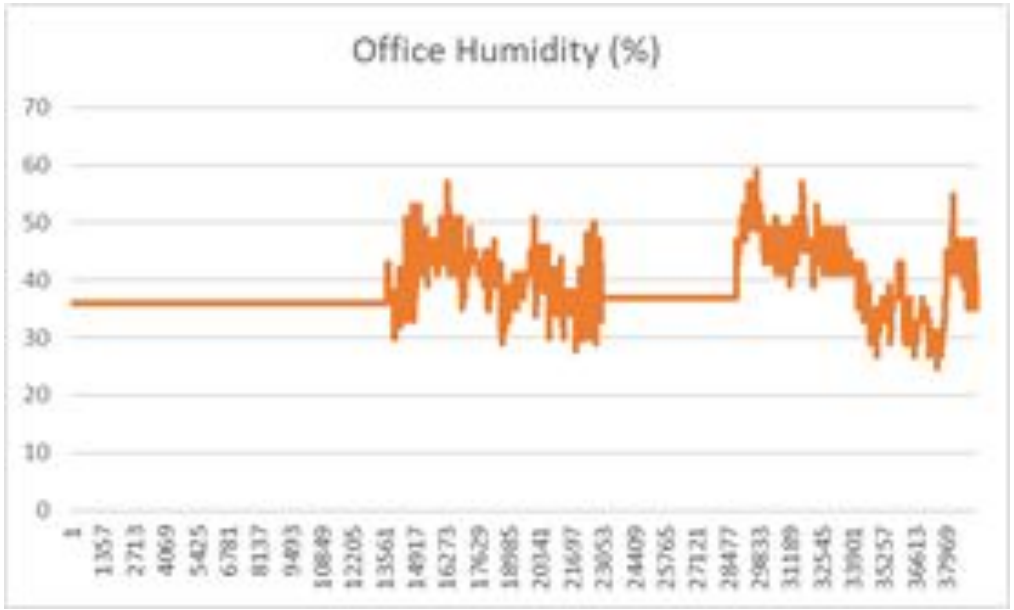
BUILD UP: *Building envelope and facade technologies for efficient buildings*

Post Monitoring_results

Office_SW_362
1st floor

May 22 – Oct 22



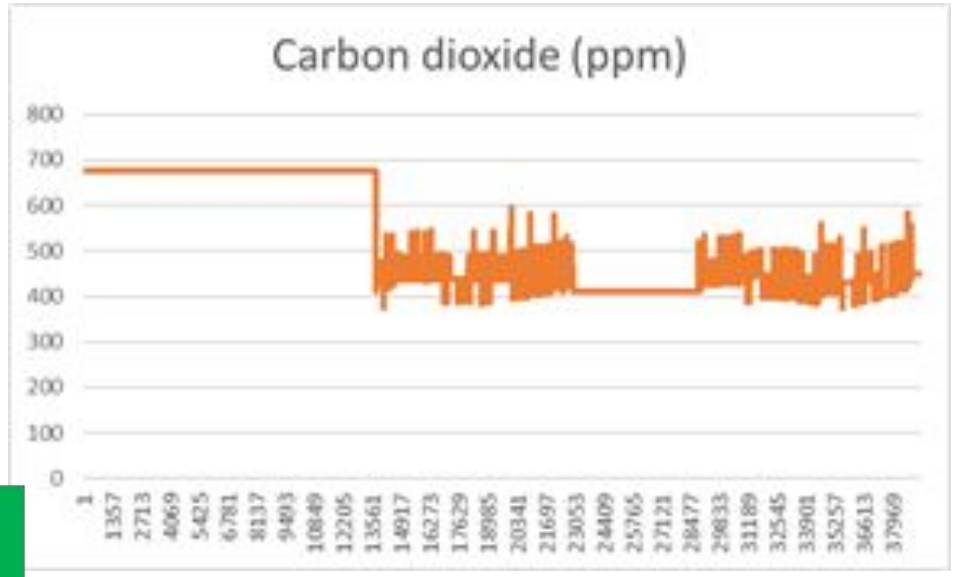


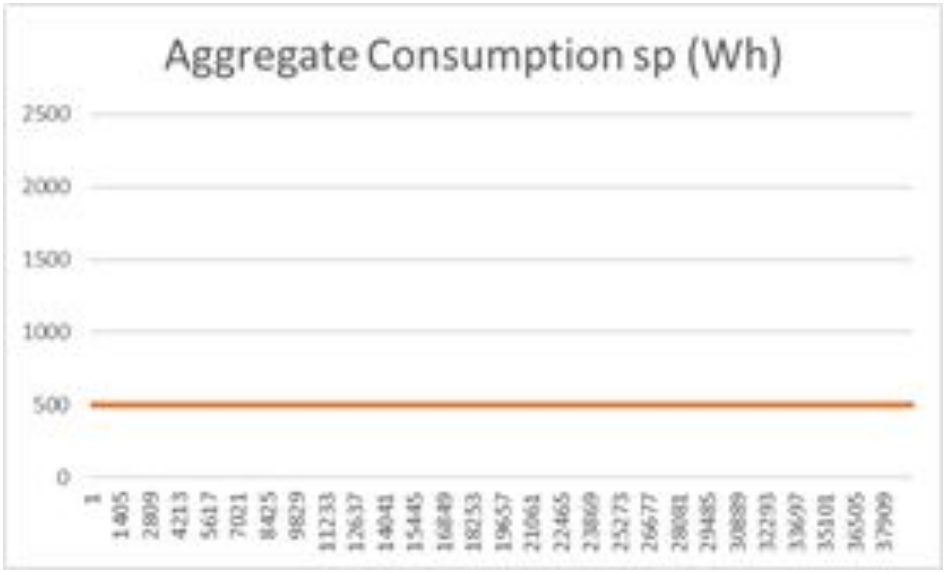
BUILD UP: *Building envelope and facade technologies for efficient buildings*

Post Monitoring_results

Office_SW_362
1st floor

May 22 – Oct 22





Q&A

Zuzana Prochazkova
Innovation Architect
Pich Architects/ Pich Innovation
z.prochazkova@picharchitects.com

Open Discussion and Q&A

Any questions?

- about the Plug-N-Harvest project?
- about its circular aspects?
- in regard to the ADBE implementation in Spain?
- or in Greece?