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Innovative pre-fabricated components including different **W**aste construction materials reducing building **E**nergy and minimising **E**nvironmental impacts



InnoWEE project focuses on the development, production and field tests of **new high performance eco-friendly prefabricated geopolymeric panels** including different recycled Construction and Demolition Waste (CDW) for **insulating facades** (ETICS, ventilated façade panels) and for **indoor radiating system** (monolithic panel, assembled panel) with **low environmental impact, low embodied energy, low CO₂ emissions and high thermal performance.**



The EU Framework Programme for Research and Innovation

Installation of the InnoWEE panels in demo sites

The panels developed in the InnoWEE project have been installed for demonstration activities in the following demo buildings:

- **Don Orione residential care center** in Bucharest (Romania) – ETICS-like panels;
- **Pilot House** in Padua (Italy) – ETICS-like panels, ventilated façade panels;
- **Residential Eco-house** in Putte-Mechelen (Belgium) – radiant panels;
- **Old city hall of Voula** in Athens (Greece) – ETICS-like panels, ventilated façade panels, fire resistant indoor wood panels.

Bucharest (Romania)



Putte-Mechelen (Belgium)



Padua (Italy)



All the works are performed according to the **specific rehabilitation design** developed for each demo building, considering **the most performing solutions, requirements of the demo site**, but also architects', engineers' and our Advisors' **experience**.

Athens (Greece)

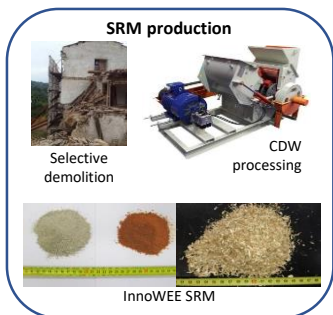


Demo sites and their **thermal parameters are monitored** to assess **performance and efficiency** of the installed panels in **real conditions**.

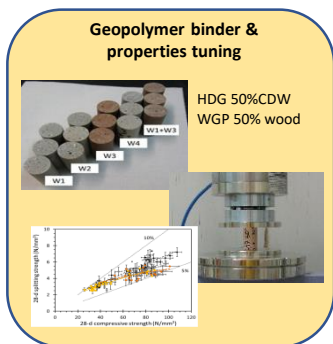
Binder development and prototype panels

Recycling of Construction & Demolition Waste (CDW) to make **new eco-friendly secondary raw materials (SRM)**.

At ECO a **new CDW processing plant** has been set up to achieve a fully characterized **fine fraction SRM** consisting of **concrete** and **fired clay brick aggregates < 2mm in size** for inclusion in geopolymer binders. **Wood chips** were obtained by shredding wood from construction waste.



Use of the SRM with **geopolymeric technology** to **produce new insulating and radiating panels** with **high content of CDW** for **higher performance of buildings**.

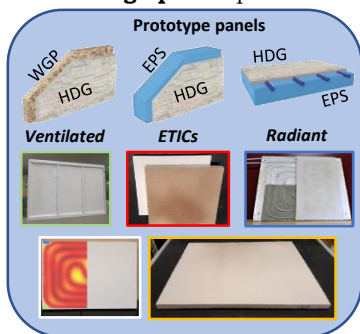


At CNR-ICMATE a large set of **binder formulations** was tested including **up to 50% weight of inorganic CDW** and **50% of wood waste**.

Mechanical, physical and chemical properties as well as **workability** and **open time** were assessed to achieve the best **binder formulation for upscaled panel production**.

Manufacturing and assessment of **prototype panels** in laboratory to obtain a **basis for scaling-up** the production process.

Designed respecting **wind** and **seismic safety** guidelines and allowing **installation with commercial anchoring** solutions. A set of **real scale prototype panels** were produced to **verify the feasibility of the fabrication process** and to **assess their properties**.



Energy performance simulation and thermal design of InnoWEE products

Simulation models are being developed by TECNALIA and RED to evaluate the **energy performance of InnoWEE solutions** under different parameters. Thus, optimized solutions are suggested based on **economic feasibility studies**. Calibrated simulation models allow:

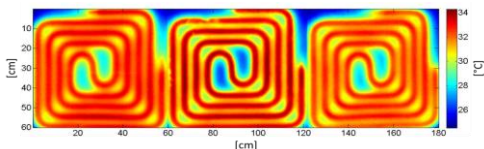
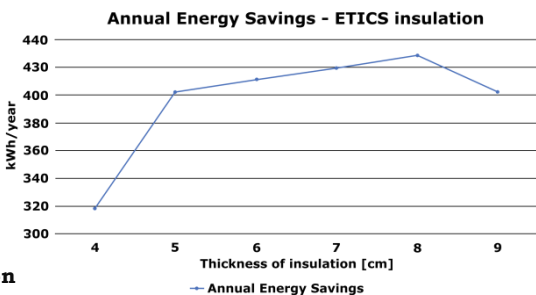
- to **evaluate the performance and quantify the savings** according to the International Performance Measurement and Verification Protocol (IPMVP);
- to **select and optimize the best technical solutions** and project designs based on a **cost-effective analysis**;
- thermo-hygrometric, energy and economic assessment of the solutions;
- to analyse the **replication potential** under different climates.

The results indicate that the solutions proposed by InnoWEE consortium **perform as competitive applications in construction sector**.

Moreover, they would be **suitable to achieve the EU goals** in terms of **energy efficiency** and **integration of renewable energy in buildings**.

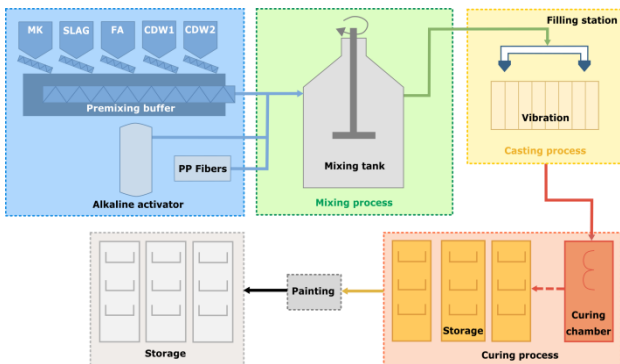
CNR-ITC performed the **thermal design of InnoWEE radiant panels** to obtain the **best thermal performance** while respecting the constraints on **material thickness** and **piping geometry**. The design process was divided in three steps:

1. Thermal characterization of materials – the **thermal conductivity** as the key parameter;
2. Numerical simulations of the alternative solutions – **More than 60 design alternatives have been investigated** to define the **best configuration of geopolymeric thickness, mixture, and piping geometry**;
3. Thermal testing on specimen in laboratory – Thermal testing in a climatic chamber, both in steady state and in transient regime.



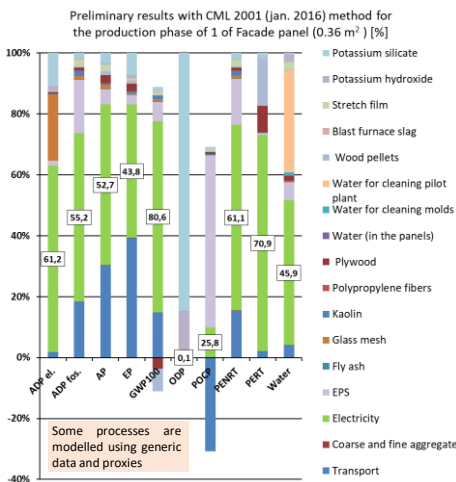
Pilot production of InnoWEE panels and LCA

Following the most strict and advanced **industrial standards**, under a **fully automated monitoring processes**, the **“Technology Upscaling Pilot Plant” (TUPP)** has been designed by AMS in such technical flexibility that is **capable to upscale a wide range of technologies**. The **TUPP** was modified to meet all the **specific requirements of the High Density Geopolymer (HDG) panels**. The modified pilot line involves many steps like 1) preparation of raw materials, 2) pre-mixing, 3) mixing, 4) casting, 5) post curing, 6) curing, 7) painting and 8) logistics.



Scheme of the „Technology Upscaling Pilot Plant”

Life cycle assessment (LCA) is the study of the **environmental impacts** related to different life cycle stages of the product. In the InnoWEE project ZAG performs **life cycle inventory** and **impact assessment** for four types of panels where **secondary raw materials (SRM)** are used. The processing and the preparation of SRM must be taken into account when calculating the **environmental footprints**. Due to the substitution of virgin materials with SRM considered “waste”, the **environmental footprints tend to be lower** as when using virgin materials.





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EeB-04-2016 New technologies and strategies for the development of pre-fabricated elements through the reuse and recycling of construction materials and structures

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