ACTIVE VERTICAL GARDEN SYSTEM FOR WATER TREATMENT AND ENERGY EFFICIENCY

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RESUM

The **Structural Testing, Simulation and Modelling Research Group (GRESMES)** at the University of Alicante, in collaboration with the UNESCO Chair in Sustainability at the Polytechnic University of Catalonia, has developed an innovative **green façade** composed of hydroponic cartridges designed to integrate vegetation into urban environments, providing multiple benefits.

Thanks to a hybrid flow system (vertical and horizontal), these cartridges replicate the behaviour of a constructed wetland, enabling the **treatment and reuse of urban or grey wastewater**. Additionally, the system improves building energy efficiency, reduces thermal loads, contributes to improving air quality, and enhances both the aesthetic and environmental value of façades. Its modular design facilitates installation and maintenance, adapting to different architectural typologies.

This technology targets sectors such as sustainable construction, urban water management, landscaping, and energy efficiency. The research team is seeking companies interested in validating and commercially exploiting the solution.

AVANTATGES I ASPECTES INNOVADORS

MAIN ADVANTAGES

The main advantages of installing this green façade are:

- **Efficient treatment of urban wastewater**, enabled by hybrid flow that mimics natural wetlands.
- **Reduced thermal load on buildings**, improving energy efficiency and lowering cooling demands.
- **Improved environmental quality**, through air purification and green surface creation.
- **Modular and scalable design**, ensuring simple installation, easy maintenance, and adaptability to different architectural typologies.
- **Enhanced aesthetic and functional value of façades**, adding vertical green spaces and increasing property value.
- **Multifunctional green infrastructure**, aligned with sustainability policies, circular economy, and urban regeneration.
- **Industrial scalability**, with strong market potential in vertical gardening, energy efficiency, and water management, especially in dense urban settings or green renovation projects.

INNOVATIVE ASPECTS

The main innovative aspect of this technology lies in the combination of two nature-based solutions: **constructed wetlands and green facades**.

More specifically, the key innovation lies in the **design of the hydroponic cartridge**, which reproduces a **'hybrid flow' of water**. This flow, which alternates between vertical and horizontal movements through the plants and their substrate, mimics the functioning of a wetland ecosystem to

treat and purify urban wastewater, such as greywater generated in buildings.

This flow configuration ensures optimal contact between the water and the plant roots, maximising treatment efficiency. It also guarantees different redox conditions, which improves the removal of organic matter and the nitrification and denitrification processes.

Currently, **there are no commercial solutions** that integrate a modular hydroponic system with real wastewater treatment capacity using biological processes similar to those of a functional wetland within an architectural envelope.

The technology developed is also **scalable and replicable**, allowing it to be integrated into different types of buildings and facilitating its transfer to the market through industrial manufacturing and installation processes.

APLICACIONS DE L'OFERTA

This invention lies at the intersection of **building technology** and **water treatment**. The hydroponic cartridge functions both as a modular living wall (LW) and a constructed wetland (CW) for **urban wastewater treatment**.

Potential **application** sectors include:

- *Architecture & Construction*: integration into new or retrofitted building façades, enhancing sustainability and efficiency.
- *Greywater treatment & reuse*: decentralised purification systems for homes, public buildings, or urban infrastructure.
- *Energy efficiency*: reducing building thermal loads via shading and passive cooling.
- *Urban landscaping & green infrastructure*: creating vertical green spaces with functional value beyond aesthetics.

Potential stakeholders:

- Manufacturers of construction materials and façade systems.
- Producers or distributors of hydroponic systems and vertical gardens.
- Engineering and construction firms.
- Water treatment and resource management companies.
- Urban landscaping and green infrastructure firms.
- Energy efficiency and smart building solution providers.

COL·LABORACIÓ BUSCADA

The University of Alicante seeks partners interested in **validating, applying, or commercially exploiting** this multifunctional green façade solution.

Collaboration options include:

- **Patent licensing** for industrial development and commercialisation.
- **Joint demonstration** or adaptation projects in real urban buildings and infrastructures.
- **Participation in public funding programmes** on sustainability, energy efficiency, or nature-based solutions.

The research team offers scientific and technical support and can adapt the solution to different sectors or contexts.

Preferred collaborators include:

- Companies in sustainable construction, energy efficiency, and urban green solutions.
- Manufacturers of vertical gardens or modular systems seeking to expand their portfolio.
- Firms specialised in greywater treatment and urban water reuse.
- Environmental consultancies, engineering firms, or landscape designers.
- Public entities responsible for urban planning, housing, or environmental management.