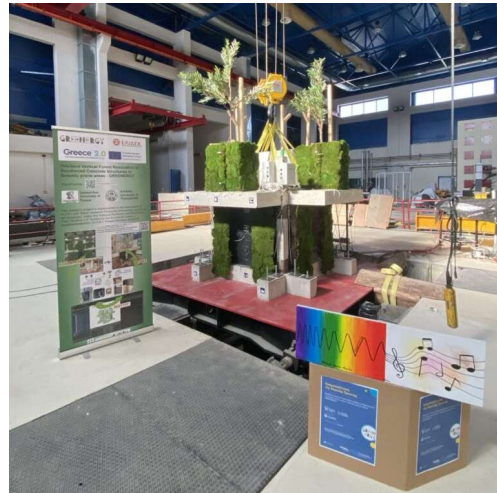




## Resilient Vertical Forest Renovation of Reinforced Concrete Structures in Seismic prone areas



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### Project background

The 2-year project GREENERGY project is carried out within the framework of the National Recovery and Resilience Plan Greece 2.0, funded by the European Union – NextGenerationEU (Implementation body: HFRI)

### Newsletter no 2.

## GREENERGY Hybrid Workshop Presents Final Research Results

The hybrid Workshop of the research project “Resilient Vertical Forest Renovation of Reinforced Concrete Structures in Seismic Prone Areas–GREENERGY” was successfully held on Friday, December 12, 2025, at Amphitheatre 1 of the Department of Civil Engineering of Democritus University of Thrace (DUTH). A highlight of the event was the laboratory demonstration conducted at the Laboratory of Reinforced Concrete and Seismic Design of Structures at DUTH in Kimmeria, Xanthi. Attendees had the opportunity to observe experimental seismic excitation tests performed on a nearly full-scale reinforced concrete structure incorporating vegetation on rooftops, balconies, and vertical surfaces, demonstrating innovative approaches to seismic resilience and sustainable building design.

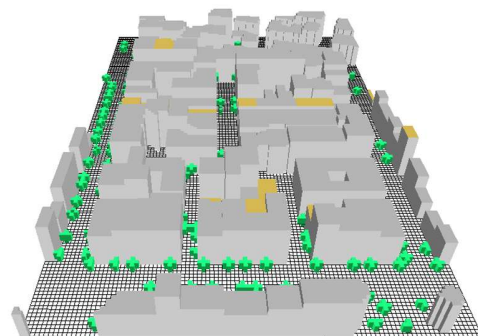
## The GREENERGY team

The Host of Organization for GREENERGY Democritus University of Thrace (DUTH), while a collaborating organization is Aristotle University of Thessaloniki (AUTH).



# GREENERGY Upscale: The Impact of VGS on Urban Built Environments

GREENERGY goes beyond the leading state of the art concepts in the area and provides a thorough assessment regarding the influence of VGS integration on the microclimate and buildings' energy efficiency. At the district scale, facade greening produced small but systematic reductions in pedestrian-level air temperature and vertical greening tends to deliver localized improvements. At the building scale, the coupled ENVI-met/EnergyPlus workflow showed that even limited facade retrofitting can yield a robust reduction in cooling-related energy demand on a peak summer day. The results support the dual role of green walls observed in the literature: district-average air temperature reductions are typically modest, yet facade greening can still translate into measurable building-level cooling-energy savings, especially when it improves envelope thermal performance and reduces facade heat gains.



**Information for Project, Final Research Results and Workshop**

<https://greenergy.civil.duth.gr/workshop/>



# The Structural Health Monitoring (SHM) system

Within the GREENERGY project, an advanced Structural Health Monitoring (SHM) system was applied and tested on the structure during both its initial and renovated phases under incremental seismic loading. The experimental program included increasing levels of peak ground acceleration (PGA), representative of high-intensity seismic events. The SHM system relied on low-cost, autonomous, compact devices and low-energy piezoelectric (PZT) sensors, which operated reliably throughout the tests, demonstrating good performance under realistic seismic conditions. PZT sensors were installed inside the RC members of the initial structure, while additional sensors were attached to the renovated structure to monitor the effectiveness of the strengthening retrofit and the anchorage systems related to the vertical forest concept. In addition to detecting damage in RC elements, the monitoring strategy successfully assessed the structural behaviour of both the initial and renovated GREENERGY structure, as well as the innovative materials introduced for vertical forest implementation. The results demonstrate the robustness and reliability of the SHM approach and highlight the potential of PZT-based monitoring for continuous assessment of existing and strengthened RC structures.



# ReplicaXLite

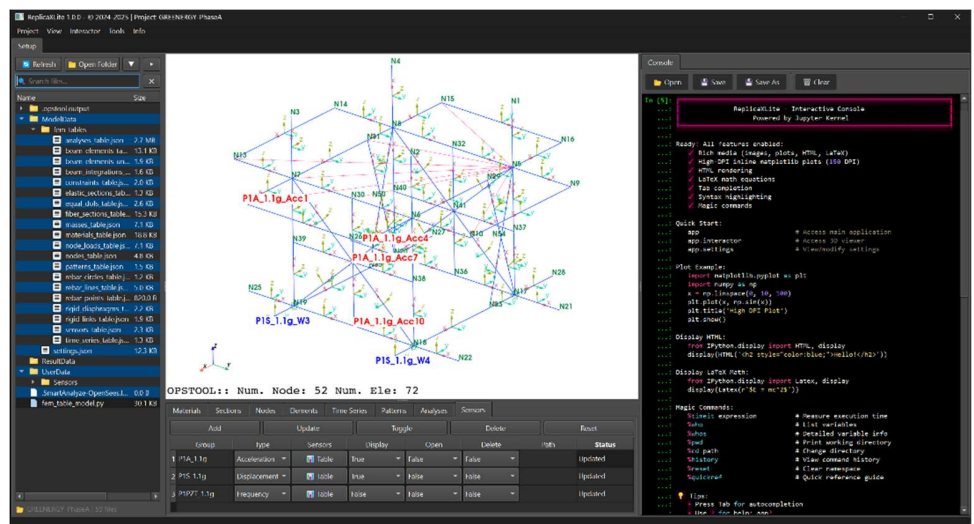
A finite element toolkit for creating, analyzing and monitoring 3D structural models.

## Overview

ReplicaXLite is a comprehensive finite element toolkit built with Python. It provides programmatic and graphical interface for creating, analyzing, and monitoring 3D structural models using OpenSeesPy as the computational backend and opstool as visualization backend.

## Features

- Modular API: Structural, Sensors, Units, DataValidation, Table
- 3D Model Creation: Interactive 3D modeling with the Structural API
- Finite Element Analysis: Built on OpenSeesPy + opstool for robust structural analysis
- Sensor Data Integration: Tools for processing and analyzing sensor data
- Visualization: Advanced 3D rendering with multiple view modes
- Console Interface: Integrated Python console for advanced scripting
- Graphic User Interface: Modern interface built with PySide6
- OpenSees Result Integration: Native support for OpenSees recorder files



<https://github.com/Vachan-Vanian/ReplicaXLite>

## The GREENERGY achievements

We are pleased to announce the publication of our research articles and the presentation of our work on the GREENERGY project.

You can find all the above in the link of the GREENERGY site:

<https://greenery.civil.duth.gr/%cf%83%ce%b5%ce%bb%ce%af%ce%b4%ce%b1-%ce%ac%cf%81%ce%b8%cf%81%cf%89%ce%bd/>

You can find us on our YouTube channel:

<https://www.youtube.com/@GREENERGYDUTHDemocritusUnivers>

