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Getting to Zero
Beyond energy transitions towards carbon-neutral Mediterranean cities

Green Responsive System (GRS): A Paradigm Shift in Urban Decarbonization in the Mediterranean Context

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CONFERENCE SESSION

3. Eco-technologies and materials

ABSTRACT

The proposed contribution reports on the applied research experience conducted at ABITAlab, focusing on the energy transition for high carbon intensity technological systems in the Mediterranean basin through the realization of the Green Responsive System (GRS) demonstrator. Within the research context, the design and prototyping of the GRS are based on digitized production of building elements, employing advanced technologies and sustainable materials to develop modular wall devices for positive buildings. These contribute to urban decarbonization, enhancing the resilience processes of circular and adaptive clusters. The methodology adopted during the Pre-Design and In-Manufacturing phases aims to evaluate the efficiency of the GRS in energy and environmental performance, with a focus on employing parametric and dynamic digital technologies, eco-friendly materials, and cloud-based sensors for monitoring. Urban context analysis and Mediterranean climatic characteristics guide the selection of biobased (for insulation), biogenic (for green walls and new material panels), and upcycling materials (for hybridizing recycled materials from various sectors), integrated with energy production technologies. Material selection is based on experimental assessments of adaptability to local conditions, proposing original workflows. Environmental analysis also informs the selection of plant species to maximize environmental benefits and reduce Co_2 and PM_{10} concentrations. Device design and integration incorporate digital technologies to enhance precision and efficiency, followed by continuous monitoring to assess environmental and socio-technical impacts. Results highlight the effectiveness of the GRS in reducing carbon emissions, acting as a significant carbon sink in Mediterranean urban environments, demonstrating its potential as a scalable solution for urban decarbonization. Through the Regenerative Digital Design approach, addressing the crossover point identified in 2037 as the challenge of surpassing anthropogenic mass compared to living biomass, a hybrid device integrating biomass and anthropogenic mass is designed and implemented, capable of producing alternative technological and environmental systems, with adaptive envelopes for buildings in different contexts. The implementation of the GRS represents a significant advancement in researching solutions for existing and new zero carbon emission (NZeb) or positive buildings in the Mediterranean context across different latitudes and locations, promoting socially sustainable green transition through the application of enabling technologies (digital prototyping and manufacturing) and emerging technologies (upcycling, IoT) to demonstrator systems. The widespread application of the GRS can contribute to revolutionizing urban architecture in Europe, mitigating climate change, and promoting the transition to zero carbon emission energy systems, aiming to achieve an increase in the energy mix for renewable energy sources by 2030 and net-zero emissions for climate and carbon neutrality by 2050.

KEYWORDS

Advanced parametric tools; Demonstrators; Emerging Technologies; Net-zero emission goals; Urban decarbonization.