MULTIFUNCTIONAL FAÇADES FOR RENOVATION THROUGH INDUSTRIALIZATION

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Editorial

In the pursuit of a sustainable future, and as the global community strives to reduce carbon emissions and combat climate change, the renovation of existing buildings stands as a pivotal challenge. Industrialized, multifunctional, prefabricated façade components can offer an efficient, effective, and reliable approach able to boost buildings' deep renovation. By off-site manufacturing in controlled environments, we harness efficiency, precision, and sustainability as well as a quality level that onsite is not possible to achieve. Prefabricated façade elements can be carefully designed, and hence directly manufactured, with all needed details on insulation, airtightness, and thermal performance to enhance the energy efficiency of the building. The versatility of prefabricated components also lends itself to innovative design solutions thanks to the extensive use of digital tools, overcoming the old pre-concept of prefabrication as lack of design freedom. Architects and engineers are presented with a canvas of possibilities, enabling the integration of renewable energy systems, advanced insulation materials, and cutting-edge technologies. Thanks to modular and scalable approaches a wide range of alternatives can be provided, still under an industrialized concept. This flexibility allows for tailored solutions that align with the unique characteristics of each building and its surroundings, a key feature to assure high market penetration in the renovation market.

However, research and innovations are still needed for the development of multifunctional envelop solutions coupling passive and active technologies for deep renovation, that are sufficiently flexible and customizable, encompassing advances in ICT, digitalization, automation, and robotics and that can address significant market segments in EU for deep renovation reaching Near Zero-Energy Building (NZEB) standards, while being competitive for a recognized set of added values.

This Special Issue compiles results of EU H2020 funded projects working on the development of multi-functional envelope solutions for deep renovation of buildings. The projects have a common and aligned objective to develop and demonstrate plug & build smart components, including insulation materials, heating and cooling elements, ventilation, smart windows, energy production, solar harvesting, and storage with necessary connecting and controlling parts to be integrated in a prefabricated envelope system. They highlight that plug & build solutions are suitable for mass production by industry for buildings undergoing deep renovation to NZEB standards. They also underline that the development and implementation of digital based technologies can boost the application of such industrialized concepts. The following projects have offered contributions and support in the preparation of the Special Issue (in alphabetical order):

- *DRIVE0 (https://www.drive0.eu/), that aims to enhance a consumer centered circular renovation process.*
- *ENSNARE (https://www.ensnare.eu/), that develops modular adaptable components and a set of digital tools and a digital platform to support and accelerate the renovation process;*
- *INFINITE (https://infinitebuildingrenovation.eu/), that develops five all-in-one industrialized envelope kits coupling industrialization and digitalization for deep renovation of residential buildings;*

- *PLURAL (https://www.plural-renovation.eu/concept), that develops a palette of versatile, adaptable, scalable, off-site prefabricated plug-and-play kits that account for user needs and integrate various renewable energy technologies together with digital tools to support decision making;*
- *StepUP (https://www.stepup-project.eu/) that aims to make decarbonisation of existing buildings a reliable, attractive investment by developing solutions and technologies for the uptake of deep energy renovation processes;*
- *Switch2Save (https://switch2save.eu/), that develops lightweight Insulating Glass Units (IGUs) suitable for large windows and glass façades integrating electrochromic (EC) and thermochromic (TC) windows with optimized maximum energy saving potential.*

The selected articles cover a variety of technology developments and system /kit assessment topics. They address the design of prefabricated opaque and transparent façade systems to incorporate renewable technologies using a range of materials, manufacturing, implementation, and experimental performance assessment towards nZEB. They also present innovative approaches in data collection for representing façades into building models, comparative cost analysis of traditional and industrialized deep retrofit scenarios for a residential building and holistic assessment methods for off-site prefabricated hybrid façade systems.

The presented innovative, affordable, ready-to-go, all-in-one façade systems are intended mostly for deep renovation of residential and office buildings, in some cases without the removal of the existing envelope. They address the energy and comfort needs of building users, creating a high-quality environment opening new horizons for the transformation of renovation practices. For this transformation to reach its full potential, collaboration and knowledge-sharing are imperative. We invite architects, engineers, manufacturers, and policymakers to profit from the new ideas presented in the Special Issue aiming to help them to refine and implement best and innovative practices.

In conclusion, we believe that the results and lessons-learned presented in this Special Issue can act as an inspiration for further industrialization of prefabricated all-in-one façade components, setting a first science-demonstrated basis of robust methods and technologies. The innovative solutions set the stage for a paradigm shift in building renovation practices. Embracing the all-in-one technologies and approaches presented in this Special Issue can not only accelerate our progress towards a sustainable future but also paves the way for a more resilient and prosperous society.

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