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Energy Audit and Renovation Scenarios for a Historical Building in Rome: A Pilot Case Towards the Zero Emission Building Goal

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Abstract : The aim to achieve a fully decarbonized building stock by 2050 stands as one of the most challenging issues within the spectrum of energy and climate objectives. Numerous strategies are imperative, particularly emphasizing the reduction and optimization of energy demand. Ensuring the high energy performance of buildings emerges as a top priority, with measures aimed at cutting energy consumptions. Concurrently, it is imperative to decrease greenhouse gas emissions by using renewable energy sources for the on-site energy production, thereby striving for an energy balance leading towards zero-emission buildings. Italy's predominant building stock comprises ancient buildings, many of which hold historical significance and are subject to stringent preservation and conservation regulations. Attaining high levels of energy efficiency and reducing CO2 emissions in such buildings poses a considerable challenge, given their unique characteristics and the imperative to adhere to principles of conservation and restoration. Additionally, conducting a meticulous analysis of these buildings' current state is crucial for accurately quantifying their energy performance and predicting the potential impacts of proposed renovation strategies on energy consumption reduction. Within this framework, the paper presents a pilot case in Rome, outlining a methodological approach for the renovation of historic buildings towards achieving Zero Emission Building (ZEB) objective. The building has a mixed function with offices, a conference hall, and an exposition area. The building envelope is made of historical and precious materials used as cladding which must be preserved. A thorough understanding of the building's current condition serves as a prerequisite for analyzing its energy performance. This involves conducting comprehensive archival research, undertaking on-site diagnostic examinations to characterize the building envelope and its systems, and evaluating actual energy usage data derived from energy bills. Energy simulations and audit are the first step in the analysis with the assessment of the energy performance of the actual current state. Subsequently, different renovation scenarios are proposed, encompassing advanced building techniques, to pinpoint the key actions necessary for improving mechanical systems, automation and control systems, and the integration of renewable energy production. These scenarios entail different levels of renovation, ranging from meeting minimum energy performance goals to achieving the highest possible energy efficiency level. The proposed interventions are meticulously analyzed and compared to ascertain the feasibility of attaining the Zero Emission Building objective. In conclusion, the paper provides valuable insights that can be extrapolated to inform a broader approach towards energy-efficient refurbishment of historical buildings that may have limited potential for renovation in their building envelopes. By adopting a methodical and nuanced approach, it is possible to reconcile the imperative of preserving cultural heritage with the pressing need to transition towards a sustainable, low-carbon future.

Keywords : energy conservation and transition, energy efficiency in historical buildings, buildings energy performance, energy retrofitting, zero emission buildings, energy simulation
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