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A new framework to switch from Zero Energy to Zero Power Buildings

By

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Declaration

I hereby declare that, the contents and organization of this dissertation constitute my own original work and does not compromise in any way the rights of third parties, including those relating to the security of personal data.

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Abstract

The building sector represents a significant portion of the global energy balance, having a crucial role in reducing energy consumption and improving the quality of life. As such, building energy performance is a relevant issue for a vast number of stakeholders, including researchers, policy makers, industry, and final users. While buildings constitute a significant component of the global energy balance, they also offer an essential opportunity to enhance global consumption and improve human well-being. Therefore, high-performance buildings are a win-win solution for everyone involved, providing a more sustainable world for future generations.

Research and development of new technologies have addressed this issue, providing innovative solutions such as the nearly Zero Energy Building (nZEB) concept. However, the design goal of reaching the Zero Energy target is not enough as there is a significant gap between design and operational performance.

This PhD thesis proposes a new framework for the performance assessment of new and existing buildings ready for the challenges of the future, integrating the complexity of current tools and their opportunities. In this perspective, the thesis introduces the Zero Power Building concept, a novel approach which considers buildings as highly dynamic entities, closer to reality. This methods grounds on three main variables of the building energy balance: the physical boundary, the weighting system, and the time frame of the analysis.

The methodological advances presented in the thesis have been applied to different case studies to test their effectiveness and flexibility. Results have been explored in both a reference case scenario as well as in a district scale existing scenario. The results have been compared with state-of-the-art approaches, providing significant contributions to the thesis objectives.

The proposed methodology has significant potential to address unresolved issues related to building performance assessment, including the gap between design and

operational performance. By taking into account the three main variables of the building energy balance, the Zero Power Building concept provides a more accurate and reliable building energy assessment. The proposed approach could contribute to the development of sustainable and energy-efficient building design practices, providing a valuable contribution to the current global climate crisis.