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Editorial

# Zero Energy Buildings: A Reached Target or a Starting Point?

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The debate about zero energy buildings (ZEBs) has been one of the main new drivers of innovation in the construction industry around the world in the past decade. What may have been seen ten years ago as a theoretical objective has become a current construction standard. Most of the new buildings in various countries, at least the European ones, are now highly-performing buildings (in Europe they are called nearly zero energy buildings), and achieving the high-performance targets became compulsory.

Despite the differences that arise when looking at how ZEBs (or nearly-ZEBs) are defined in standards and legislative requirements around the world, the primary features of a residential ZEB can be clearly identified: superinsulation, mechanical ventilation with heat recovery, system efficiency, exploitation of renewable energy sources. However, the “recipe” of a ZEB is far from being as trivial as may appear at first sight, since the design of a ZEB requires a holistic approach and its target can be reached with the best combination of envelope, systems, energy sources, under technical and financial constraints that change in space and time. A ZEB design that best suits at a certain location will not be the optimal one for another location. The current design of a ZEB will not necessarily be resilient in the future nor be able to adapt to climate change. This is why, even though a considerable amount of research has been performed on ZEB, this topic is still of great interest for academic researchers and also for the construction industry.

In fact, the ZEB target has been the driver for a large amount of research activities over the last six years in the field of building energy performance. There are reasons to say it has been the leading topic, especially in some EU countries, in this specific building physics field. This is certainly due to the studies that were carried out by EU member countries to implement the nearly-ZEB requirements (article 9 of EPBD), but, at the same time, legislative requirements, far from being merely an obligation, have led toward a new generation of research studies on the global energy performance of a building, encompassing various technologies and approaches (both numerical and experimental). Various new research centers on ZEBs have been created from Norway to Australia and are now well established in the field. So, everything has been said on that topic? Not at all, and up-to-date research on all aspects related to the design of a zero-energy building is still being developed, as the articles reported [1–11] in this special issue testify.

In fact, the reader will find in the following papers, some works at the level of the component—such as the one of Memon et al. [2] that studies the performance of a triple vacuum glazing, the one of Viljanen and Lu [6] on the moisture performance of highly insulated walls, the one of Dong et al. [5] on the energy savings potential of cross-laminated timber constructions, and the study of passive solar systems by Cui et al. [11]—and the others at the level of the building. Two works (Ruiz et al. [3] and Ferrara et al. [8]) treat the problem of the integration of renewable sources within a ZEB. In particular, the second one, provides an holistic framework (EDeSSOpt) for the simultaneous optimization of the energy demand (envelope) and supply (systems, energy sources) sides options to reach the ZEB target in case of a single-family house. Wang et al. [4] treats through dynamic simulation the capability of a highly-performing building case study to reach the zero-energy target. But ZEB is not only limited

to new buildings. The works by Firlag and Piasecki [1] and Sanchez Ramos et al. [9] are devoted to study the renovation of existing or historic buildings toward the ZEB target; finally, two interesting side studies. Zanon et al. [7] present an innovative approach to assess the visual quality of homes and Iyer-Raniga [10] discusses the peculiarity of the holistic approach toward the zero energy objective in the built environment.

In conclusion, I would like to point out two major key-words characterizing the studies on ZEBs and also the anthology of the present Special Issue. These are *optimization* and *holistic approach*. Many studies on ZEB are based on optimization; from manual and trial and errors approaches to very refined computational models and algorithms, since there is always the need to find a final solution that is able to perform well in a scenario of conflicting requirements. Optimization functions are frequently multi-objective and the complexity of the relations between inputs and outputs of a building model makes the task of optimizing a building into a ZEB a quite complicated task that is still of interest for researchers. This optimization approach should not be merely seen in relation with whole-building numerical studies, because also when designing new construction materials or energy systems, there is the need to find out an optimized design that best suits with the objective of the ZEB.

The second key word is holistic. The building is a very complex system, both as a real system to be analyzed and as a numerical model that represents the building behavior. Every ZEB study has to be intrinsically holistic to capture the complexity of the building behavior.

Finally, far from being a reached final objective, the ZEB target can be considered as the starting point of future challenging and up-to-date research activities that will have the capabilities to really improve the energy and environmental performance of buildings as complex systems that interacts with humans and the outdoor environment.

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