Chapter 96
Towards Zero Energy Buildings (ZEB):
The Role of Environmental Technologies

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ABSTRACT

In 2009, European Union (EU) member states forged a long-awaited compromise on the recast buildings directive, agreeing that all new buildings would have to comply with high energy-performance standards by the end of 2020. The recast Energy Performance of Buildings Directive, which was finally announced in May 2010, requires the public sector to take the lead by owning buildings with "nearly zero" energy consumption standards by the end of 2018, which is two years in advance of the private sector. The objective of this chapter is to discuss both the range of potential consequences to European cities resulting from widespread implementation of zero energy buildings (ZEBs) and the relevant environmental technologies in accordance with the national goals set by the EU Member States. As EU member states are moving ahead with their targets and strategies for ZEBs, this chapter presents the most possible scenarios for the implementation of the EU recast buildings directive regarding ZEBs by 2020. A detailed review regarding the existing EU member states' definitions and policies on low energy buildings and ZEBs, and the current status of RES technologies for ZEBs is also presented. Finally, some first thoughts are provided regarding the minimisation of energy consumption in the building sector and the green city goal, as energy is considered to be one of the most important chapters when evaluating a green community. The next step for the integration of green buildings would be the adoption of principles resulting from ZEB analyses and descriptions in existing green building models.

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INTRODUCTION

High energy prices and global climate changes force developed societies to reconsider their energy consumption habits. In the building sector, energy consumption continues to increase, primarily because new buildings are constructed faster than old ones are demolished. Because traditional building use consumes almost 40% of the total fossil fuel energy in the US and European Union, energy efficient buildings are becoming more interesting. A zero energy building (ZEB), or net zero energy building, is a general term applied to a building when it has zero net energy consumption and zero carbon emissions annually. This term implies that the ZEB energy demand for heat and electrical power is reduced, and this reduced demand is met on an annual basis from on-site renewable energy technologies. The zero energy building design rationale is a progression from passive sustainable building design. However, the object of a ZEB goes even further; not only should the energy consumption of the building be minimised by means of passive design methods, but the building itself should be able to balance its energy requirements with active techniques and renewable technologies. Zero energy buildings (ZEBs) constitute a growing part of the European building stock because two-thirds of European countries already include them in national roadmaps as a goal for future new buildings. Sustainable building is a rapidly growing practice in new construction development and is constantly gaining importance and popularity.

ZEBs are built with significant energy-saving features. The heating and cooling loads are lowered by using highly efficient equipment, natural ventilation, and other techniques. ZEBs are normally designed to use passive solar heat gain and shading combined with thermal mass to stabilise diurnal temperature variations throughout the day. To reduce the net consumed energy for heating and cooling purposes, these advanced buildings will need significantly higher insulation levels than conventional buildings. ZEBs employ super-insulation to significantly decrease the heat transfer through the walls, roof, floor, and windows. There are countless different insulation products available (many of which are natural) that can be used to provide the required high thermal resistance values (R-Values). The elimination of thermal bridging in ZEBs is taken into consideration not only because of energy loss, but also to avoid condensation that could result in damage to the building fabric. ZEBs also require the use of onsite renewable energy technologies to offset the building's primary energy use.

There are several definitions of what ZEB means, with a particular difference in usage between North America and Europe. According to the interim conclusions of the European concerted action for the building energy performance implementation directive, currently 23 different terms are identified across Europe for defining high performance buildings. The variation exists not only in terms of the absolute level of energy consumption in a low energy building, but also in terms of the deviation from the minimum requirements as stated in the national building regulations (Concerted Action, 2008). Further, the national calculation methods vary from country to country, which makes it rather complicated to compare the absolute values of the energy requirements. For instance, energy performance can be calculated by conditioned floor area, habitable area, or gross floor area based on primary or consumed energy (EN 15217:2007). Additionally, different energy consuming processes are included in the different calculations of the energy performance. These different standards in calculation inputs and assumptions can easily result in important deviations.

The development of modern ZEBs became possible not only through the progress made in new construction technologies and techniques but also by academic research on existing and experimental buildings through the collection of precise energy performance feedback. Today's advanced models can precisely demonstrate the efficacy of