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Achieving informed decision-making for net zero energy buildings design using building performance simulation tools

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Abstract

Building performance simulation (BPS) is the basis for informed decision-making of Net Zero Energy Buildings (NZEBs) design. This paper aims to investigate the use of building performance simulation tools as a method of informing the design decision of NZEBs. The aim of this study is to evaluate the effect of a simulation-based decision aid, ZEBO, on informed decision-making using sensitivity analysis. The objective is to assess the effect of ZEBO and other building performance simulation tools on three specific outcomes: (i) knowledge and satisfaction when using simulation for NZEB design; (ii) users' decision-making attitudes and patterns, and (iii) performance robustness based on an energy analysis. The paper utilizes three design case studies comprising a framework to test the use of BPS tools. The paper provides results that shed light on the effectiveness of sensitivity analysis as an approach for informing the design decisions of NZEBs.

Keywords

decision support,
early stage,
net zero,
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Article History

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1 Introduction

1.1 Background

The design of Net Zero Energy Buildings (NZEBs) is a challenging problem of increasing importance. The NZEB objective has raised the bar of building performance and will change the way buildings are designed and constructed. During the coming years, the building design community at large will be galvanized by mandatory codes and standards that aim to reach neutral or zero energy built environments (ASHRAE 2008; EU 2009; IEA 2008). At the same time, lessons from practice show that designing a robust NZEB is a complex, costly, and tedious task (Renard et al. 2008; Achten et al. 2009; Kurnitski et al. 2011; Marszal et al. 2011; Zeiler 2011; Attia 2012a; Georges et al. 2012; Pless et al. 2012). The uncertainty of decision-making for NZEBs is high (Athienitis et al. 2010; Kolokotsa et al. 2011; Marszal and Heiselberg 2011). Designers have been faced with a pool of various choices to arrive to the NZEB performance objective. Combining passive and active systems early on is a challenge, as is, more importantly, guiding designers towards the NZEB objective that requires high energy and indoor comfort performance criteria. An international effort to define the main building design aspects for NZEBs is ongoing in the International Energy Agency (IEA) joint Solar Heating and Cooling (SHC) Task 40 and Energy Conservation in Buildings and Community systems (ECBCS) Annex52 titled "Towards Net Zero Energy Solar Buildings" (Sartori et al. 2012). Table 1 shows a simplified model for six main building design aspects that designers should address early on during the conceptual stage. In fact, the integration of such design aspects during the early design phases is extremely complex and time consuming and requires a high level of expertise as well as software packages that are currently not available. At this stage, the architects

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