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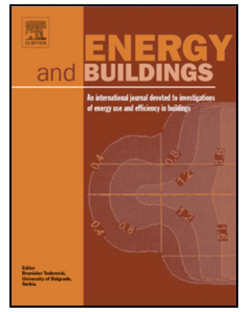

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Energy Performance Analysis of An Office Building in Three Climate Zones

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Highlights

- This study presents dynamic simulations of a full scale office building with 160 zones
- Fifteen energy performance cases for three climate zones of Helsinki, London and Bucharest were simulated
- Alternative heating and cooling solution using radiant floor panel and radiant ceiling panel were explored
- It is easier to minimize the space heating demand of a building then electricity
- Near optimal solutions for achieving nearly zero energy building based on this study are presented

Abstract

As we proceed towards 2020, the EU directives and country specific guidelines are becoming more stringent to reduce energy consumed by buildings. To guide the architectural, engineering and construction industry towards the application of nearly zero energy buildings (nZEBs), this study shows diversified near optimal solutions to improve the energy performance of multi-story buildings, applicable in many climate zones. Most of the studies encompassing dynamic simulations of multi-storey buildings account only for a few selected zones, to simplify, decrease simulation run-time and to reduce the complexity of the 'to be simulated' model. This conventional method neglects the opportunity to see the interaction between different zones as it relates to whole building performance. This paper presents fifteen individual cases of dynamic simulations of a six-storey office building with 160 zones. The energy performance analysis was conducted for three climate zones including Helsinki in Finland, London in the United Kingdom and Bucharest in Romania. For each location, the following three cases were simulated: (i) building as usual simulated according to valid national building codes; (ii) Energy-efficient (EE) case with selected necessary parameters enhanced to reduce total delivered energy demand; and (iii) nZEB case representing partial enhancement of the EE case based on the parametric analysis. The results of nZEB indicate that for Helsinki, it is possible to reduce the space-heating load by 86%, electricity consumed by lighting, appliance, and HVAC by 32%. For London, the heating load is reduced by 95%, cooling load is slightly increased, and electricity demand is decreased by 33%. For Bucharest, 92% of energy in heating can be saved, cooling energy demand was reduced by 60% and electricity consumption by 34%. Based on the nZEB cases for each location, alternative heating and cooling choices of a radiant floor panel system and radiant ceiling panel system were explored. There are small differences in absolute consumption demand for heating, cooling, and electricity for three cases in each location. The specific energy/m^2 for heating remained nearly the same in all systems for all three cases in each location. Marginal difference in heating energy required for space heating can be seen for London nZEB IHC and London nZEB RCP of 0.8 kWh/m^2/year and for Bucharest nZEB IHC and Bucharest nZEB RCP case of 1.3 kWh/m^2/year. RFP has the availability of large surface area for heat exchange and can provide heating at a low temperature and cooling at high temperature, but requires supporting air based cooling during the humid season. For RCP, the limited temperature exchange surface may increase the airflow rate, but supplies it at a lower temperature for the same load.