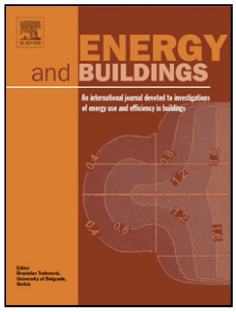

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Facade design principles for nearly zero energy buildings in a cold climate

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Abstract

Cost optimal and as energy efficient as possible façade solutions, including window properties, external wall insulation, window-to-wall ratio and external shading were determined with energy and daylight simulations in the cold climate of Estonia. Heating dominated in the energy balance and therefore windows with higher number of panes and low emissivity coatings improved energy performance. The window sizes resulting in best energy performance for double and triple glazing were as small as daylight requirements allow, 22-24% respectively. For quadruple and hypothetical quintuple glazing the optimal window-to-wall ratios were larger, about 40% and 60% respectively, because of daylight utilization and good solar factor naturally provided by so many panes. The cost optimal façade solution was highly transparent triple low emissivity glazing with window-to-wall ratios of about 25% and external wall insulation thickness of 200 mm (U=0.16). Dynamic external shading gave positive effect on energy performance only in case of large window sizes whereas due to high investment cost it was not financially feasible. Limited number of simulations with Central European climate showed that triple glazing with double low emissivity coating and window-to-wall ratio of about 40%, i.e. slightly larger and with external shading compared to Estonian cost optimal one, clearly outperformed conventional design.

Keywords: Façade design, windows, fenestration, daylight, nearly zero energy buildings, cost optimality, energy simulations

1. Introduction

In order to achieve nearly zero energy building (nZEB) requirements by 2021 in a cold climate energy efficient façades are one important factor in the design of such buildings. Facade performance including windows, opaque elements and shadings has strong impact on heating, cooling and electric lighting energy needs as well as on daylight.