

A review of smart solar shading systems and their applications in cold climate zones

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ABSTRACT

The green building movement has emphasized the importance of environmentally sustainable building systems design practices and their impact on reducing building-related carbon emissions. A significant portion of a building's overall energy consumption is used towards meeting indoor heating, cooling, and lighting requirements. As a result, it is pertinent that energy losses through the building envelope be minimized to improve building energy performance. Within the building envelope, a significant portion of heat is gained and lost through the fenestration area; the effects are most prominent in buildings with high window-to-wall ratios and glazing units with low thermal resistance. Though effective for improving building energy performance, glazing unit upgrades tend to be costly and disruptive to occupants within the indoor space. The implementation of fenestration-related energy-saving technology within new constructions or as an energy retrofit in existing buildings serves as an effective alternative to glazing unit replacements to improve building energy performance. Technologies such as automated blinds and solar shading systems, smart glazing, window films, and insulative features have shown effective at reducing building cooling and heating load and optimizing daylighting within the indoor space within cooling-dominant climate zones. In comparison, their application and energy performance within buildings in cold climate zones has not been thoroughly investigated. This review provides an overview of recent developments in fenestration-related energy-saving technologies along with their energy performance in various climate zones. The various factors that affect the energy performance of these technologies are discussed to justify their feasibility within cold climate zones. The review provides a summary of measurement and verification processes for the quantification of energy performance – including both simulation and experimental-based approaches. Finally, the review explores the future directions of fenestration-related technologies within the commercial and residential sector, including an overview of available government funding and incentives for the development and use of fenestration-related energy-saving technologies. The review provides the foundation for further research and technological development to improve urban resiliency to climate change, occupant comfort within indoor spaces, and building energy performance in the coming years.

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