BUILD SIMUL (2019) 12: 1
https://doi.org/10.1007/s12273-019-0517-5



# Simulation studies on advanced window technologies

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Windows account for a considerable proportion of the air conditioning load in buildings, especially in modern high-rise buildings with large window-to-wall ratios (WWRs). It was estimated by the Department of Energy (DOE) of the United States that about 30% of the energy used to heat and cool buildings is lost through inefficient windows. Therefore, developing advanced windows to retrofit existing inefficient window systems has a huge energy saving potential.

In recent years, many high-performance window technologies have been developed and utilized. For example, researchers have developed low-e glass, electrochromic glass, vacuum glass, spectrum selective glass, and so on. These materials are used to passively reflect or prevent superfluous heat gain and daylight illuminance to reduce window-related energy use as much as possible. In addition, building-integrated photovoltaic windows (BIPV windows), which are manufactured by replacing the outside glazing layer with semi-transparent PV laminates, are attracting more and more attention because, in addition to reducing the air conditioning cooling load, they actively convert superfluous solar radiation into electricity.

Although there are a few advanced window products on the market, their penetration is strangely low. There are many possible explanations to account for their low popularity. One important technical factor is the lack of systematic simulation studies on the performance of various products for various climates and building types. Thus, to further spread advanced window technologies and accelerate their large-scale utilization in buildings, a topical issue, entitled "Simulation Studies on Advanced Window Technologies," was proposed and implemented. This topical issue covers original simulation studies related to advanced window technologies and explores the topics of thermal performance, daylight performance, power generation performance, energy performance modeling, and overall energy saving potential.

After a careful peer review process, 11 outstanding papers were accepted for publication in *Building Simulation* journal. The authors and co-authors of these papers are from places around the world, including Norway, the UK, the US, the Netherlands, Australia, R.O. Korea, and China, which implies that the related studies were conducted with consideration of different climates, locations, and building types. These papers also focus on many emerging advanced window technologies, such as building-integrated photovoltaics (BIPV), vacuum glazing, gasochromic smart windows, thin-glass triple-pane glazing, and so on. BIPV windows are a hot topic in this issue due to their remarkable performance and their ability to generate electricity in situ, reduce air conditioning energy use, and mitigate daylight glare. In addition, two papers are related to triple-pane glazing that achieves incredible thermal performance. As reported in the collected papers, the energy savings potential of the thin triple glazing in place of typical low-e windows in residential buildings is 16% in heating dominated climates, such as Minneapolis, MN; 12% in mixed climates, such as Washington DC; and 7% in cooling dominated climates, such as Houston, TX. Mg-Y coated gasochromic windows, which are different from electrochromic and thermochromic windows, are another type of smart window. They provide a degree of flexibility to reflect undesirable incident solar radiation rather than absorb the solar heat that might eventually enter the indoor space. They also show a 27% energy saving potential in comparison with standard double glazing.

Overall, the papers in this topical issue show that windows are responsible for a considerable amount of building energy use and many advanced technologies have been developed recently to reduce window-related energy use as much as possible. This topical issue is just a start; much work is still needed to make these advanced technologies more mature, reliable, and affordable so that their large-scale application can be realized.

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