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Editorial: Advanced solar utilization and control technologies in buildings

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Editorial on the Research Topic
Advanced solar utilization and control technologies in buildings

To ensure a vibrant, healthy and environmentally friendly future, the world needs another industrial revolution that harnesses affordable, accessible and sustainable energy to drive development, and thus accomplishing a renewable energy strategy in cities must be enforced. As the implementation cost of solar technology decreases, the on-site solar energy development and utilization can help achieve zero-emission buildings and develop energyefficient, low-carbon eco-cities. The building is the best carrier of solar energy utilization in the city, under the dual pressure of energy crisis and environmental pollution. In order to adapt to the sustainable development of human settlements, solar building integration is undoubtedly a positive solution and development direction to achieve sustainable development goal (SDG).

We invite researchers and scientists to submit high-quality original research articles that report fundamental research activities, field and laboratory experiments, innovative operational strategies, integrated modelling, and assessment studies on advanced solar utilization and control technologies in buildings. This Research Topic aims to provide a platform for scientists, engineers, project developers, industry representatives, decisionmakers, the public, and end-users to share the most recent development and innovations in advanced solar utilization and control technologies as well as other related sectors promoting interdisciplinarity. The Research Topic consists of four highly diverse contributions, which we briefly summarize below.

Abojela et al. extensively discussed dual-sided photovoltaic (PV) technology (both monocrystalline and polycrystalline double-sided modules), building-integrated photovoltaic (BIPV) installation, opaque facade walls, flat roof surfaces, types of skylight shading, simulation and optimization software (including simulation software and future trends), zero-energy BIPV technology, and optimization techniques for BIPV systems. They conducted in-depth research and evaluation on the integration feasibility of solar photovoltaics with building envelope structures, annual electricity generation, and energy optimization techniques at the residential building level. The research findings indicate that a thorough investigation into the radiative potential of various building surfaces is necessary to determine the most effective PV layout. Yan et al. proposed a novel method that combines the Variable Increment Conductance (VINC) method with the Grey

Wolf Optimization (GWO) algorithm and conducted simulations and experimental comparisons. The tracking efficiencies for static shadow, simulated dynamic shadow, and experimental static and dynamic shadow tracking were 99.80%, 98.82%, 99.43%, and 98. 51% respectively. The tracking times for simulations and experiments were 46.49% and 89.34% faster compared to the GWO and VINC techniques. The research findings indicate that this method, as compared to the GWO and VINC methods, has fewer algorithm parameters, a simpler computational process, lower complexity, reduced hardware requirements, and better practical implementation performance, significantly improving tracking speed and efficiency. In regions of China characterized by hot summers and cold winters, many buildings do not utilize centralized heating but rely on electrical equipment such as air conditioners, which have high energy consumption and low efficiency. To explore the relationship between building energy consumption, the Energy Efficiency Ratio (EER) of air conditioners, and the area of rooftop photovoltaic (PV) panels, Xie et al. first used energy analysis software to examine the impact of different Air Conditioner Energy Efficiency Ratios (EER) and photovoltaic area on building energy consumption. Subsequently, they proposed a comprehensive building energy consumption evaluation method that takes into account carbon taxes, optimizing both environmental and economic performance. Finally, they proposed the optimal combination of renewable energy sources and parameters for efficient equipment setup. Zhang et al. proposed an improved dynamic thermal design model for estimating the building environment and energy consumption of passive buildings in high-altitude regions. Test validations indicate that the accuracy level of on-site measurements is acceptable for engineering applications with a relative coefficient of variation below 30%. Factors such as window-to-wall ratio, building orientation, and insulation coefficient significantly influence the solar heat gain in high-altitude buildings. This study provides important guidance for energy-efficient building design in high-altitude plateau areas.

The application of advanced solar utilization and control technologies in buildings provides crucial support for sustainable development. By harnessing solar photovoltaic systems and thermal systems, buildings can reduce reliance on traditional energy sources, decrease energy consumption, and mitigate greenhouse gas emissions. Furthermore, advanced control technologies such as smart lighting systems, intelligent windows, and smart temperature control systems can optimize energy usage, enhance building comfort, and lower operational costs. The implementation of these technologies also facilitates buildings to achieve net-zero energy or positive energy balance, thereby driving the construction industry towards a more sustainable trajectory. However, to achieve optimal results, it is essential to consider factors such as architectural design, material selection, and system integration, while continuously innovating and improving technologies to meet evolving needs and challenges. In the future, building infrastructure must encompass electricity, heating, and cooling supply, necessitating exploration of innovative solar utilization and control technologies to meet diverse energy requirements within buildings. Additionally, there remain various constraints hindering the integrated development of solar architecture, warranting further exploration of its impact on architectural aesthetics, structural safety, and indoor thermal environment.

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Conflict of interest

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