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Editorial

Hybrid Solar Technology for Power Polygeneration and Energy Saving

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Global climate change and fuel supply security have led to the fast development in renewable energy applications. In the building sector, the limited space available for solar panels has driven a demand on the use of hybrid solar technology for polygeneration of active power and/or passive solar devices. The importance is growing with the worldwide trend of constructing low-energy and zero-carbon buildings. This special issue is for the collection of contemporary research and review papers in addressing the state-of-the-art.

The progression on flat-plate collector technology so far has dominated the combined photovoltaic/thermal (PVT) research. While the forced airflow type is a simple low-cost design, the water flow type receives more attention because of the better heat transfer capability and the flexibility in applications. The effectiveness of different absorber designs for forced or natural flow, free-stand or building integration has been widely investigated. The two papers presented by J.-H. Kim and J.-T. Kim discussed and compared the energy performance of the glazed and unglazed water-flow thermosyphon PVT collector systems, and further for the unglazed option, the performances of the sheet-and-tube and the rectangular-box-channel thermal absorber designs were compared. The performance of the building-integrated water flow option (BiPVT/w) was discussed in T. Matuska’s paper, where two types of fin configurations were compared with the corresponding BiPV installation using polycrystalline silicon cells. In his study, two different European climates, namely, Athens and Prague, and both roof and façade applications were evaluated. The paper of T.-T. Chow and J. Ji introduced the life cycle assessment of a rectangular-box-channel PVT/w collector system in terms of economic, energy, and greenhouse-gas payback time; both free-stand and building-integrated performances were addressed, confirming the merits of the hybrid solar design over the plain PV option.

For the production of hot water at high temperature, either heat pump integration or concentrator PVT (c-PVT) design can be adopted. Y. Bai et al. presented a case study of using PVT/w collectors as the water preheating device of a solar assisted heat pump system. The energy and economic performances of the same system in cities of different climates, including Hong Kong and three other cities in France, were compared. The paper of X. Ji et al. presented the development of simulation model of an experimental trough c-PVT system; the quality of the numerical work was demonstrated by experimental validation. With this, they found that the trough c-PVT system performance can be optimized by improving the mirror reflectivity and the thermal solar radiation absorptivity of the lighting plate, and by pursuing a suitable focal line with uniform light intensity distribution. The L. Zhang et al. paper gave a general review of c-PVT technology and then proposed a PV system with integrated compound parabolic collector plate that adopts a low precision solar tracking method; the performance was shown better than the fixed installation or the case with periodic adjustment in months.

While silicon-based PV technology has many physical barriers, it is expected that the future PVT developments will be closely linked to the breakthroughs in solar cell technology. The next-generation solar cells such as polymer,
nanocrystalline, and dye-sensitized solar cells will be less expensive, flexible, compact, lightweight, and efficient. The paper of L.-T. Yan et al. addressed the use of hybrid ZnO/TiO\textsubscript{2} photoanodes for utilizing the high electron transport rate of ZnO and the high electron injection efficiency as well as the stability of TiO\textsubscript{2} materials. Developments in the balance of system are also important. The paper of C.-L. Shen and J.-C. Su covered the improvements in power quality and power factor in PV inverter design. On the other hand, the improvements in power supply stability with power conditioner and better integration of renewable energy sources onto utility grid have been other key research areas, as discussed in the paper of D. Amorndechaphon et al. Finally, the review paper given by us included a broad overview of the published works. It comes to us, despite the sharp increase in academic activities in the last decade, that the developments of commercial PVT products and their real system applications are still very limited. More efforts must be on the identification of robust product designs, suitable product materials, manufacturing techniques, testing and training requirements, operation and maintenance needs, potential customers, market strength, and so on.

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