Abstract

Among the emerging renewable energy technologies, solar photovoltaic (PV) power generation is growing steadily in the mainstream energy supply mix contributing about 2.58% of the global total power generation by 2018 from 2.1% in 2017. The negative high PV module temperature effects continue to pose significant hurdles though being addressed through active and passive cooling methods. Thermoelectric generator (TEG) technology, given its modularity, augments well in cooling PV modules' and generating additional electricity. However, thermal coupling of the two technologies has remained an impediment to their good performance due to the microscopic roughness of the PV and TEG surfaces. Non-uniform temperature distribution from the PV cells hinders efficient heat transfer thus affecting the performance the two technologies. In this study, PV cell temperature distribution have been evaluated analytically and experimentally under outdoor setup environments. Further, cell temperatures distribution is investigated using three thermal interface materials (TIM) under air- and water-cooled environments with aluminium honeycomb cooling panels as the cooling contact medium. Results show that the three TIMs substantially reduced the temperature mismatch effects with the heat spreader (HS) presenting lower temperature and voltage mismatch compared with the other two TIMs under both air- and water-cooled test conditions exhibiting preference. Based on the best observed conditions, PV module power output increased by 1.8% and 2.5% under the two test conditions while the TEG generated an additional 19.7% and 24.85% of power, respectively. This translated to an improvement of 11.3% and 50.6%, respectively, compared to the bare cell TEG power generation. The use of TIMs hence has the potential to mitigate thermal coupling challenges associated with PV–TEG systems improving their overall power output.