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Effects of Measurement Equipment on Rating of Photovoltaics Modules of Different Designs

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Abstract

The ratings of PV modules are critical to all the stakeholders in solar industry. Researchers and engineers rely on these data to optimise new designs of photovoltaic modules. Then, manufacturers market and price their products based on these data and installers and developers calculate the yield and financials from these data. Finally, grid operators manage the connections and dispatches of solar systems refering to these data. However, there are still challenges associated with accurately measuring the power performance of photovoltaic modules, even though comprehensive standards have been established.

Among those challenges, one difficulty is to characterise the enhancement of photovoltaic modules with light redirecting ribbon designs. Since some of these designs require scattering or diverting of the incident light, the power performance enhancement varies depending on the angle of incidence. However, there are different types of solar simulators with distinct angular profiles of their irradiance. Consequently, modules with unique angular responses will be rated differently with different solar simulators. As a result, ratings of these solar modules become less accurate and misleading when used in project designs and financial estimations. And it is even worse for module optimisation, because these modules will be optimised according to the best match between their angular response to the angular profiles of the solar simulators.

In this work, optical simulations based on Angular Matrix Framework (AMF) were used to understand the effects of solar simulators with different angular profiles on the rating of solar modules with different ribbon designs. AMF is particularly beneficial to this analysis due to its capability of capturing the full angular response of a module and the compatibility of different angular distribution of irradiance without repeated simulation. The results revealed the different power gains of modules when illuminated with light of different angular distributions. Based on the analysis, a system-oriented modelling methodology is also proposed by optimising the module designs based on yield in realistic conditions.

Supporting Information

Figure 1 shown schematics of tower and table solar simulators, which have different angular profiles due to different designs of light paths [1]. The optical enhancements of modules interconnected with scattering ribbons (patterned with V-grooves), rounded wires (multi-bus bar, MBB) and triangular ribbons were simulated with AMF based on these two angular profiles [2]. The differences were plotted in Figure 2 and demonstrated the significance of considering the angular response of modules and the angular profile of solar simulators in photovoltaic module designs.

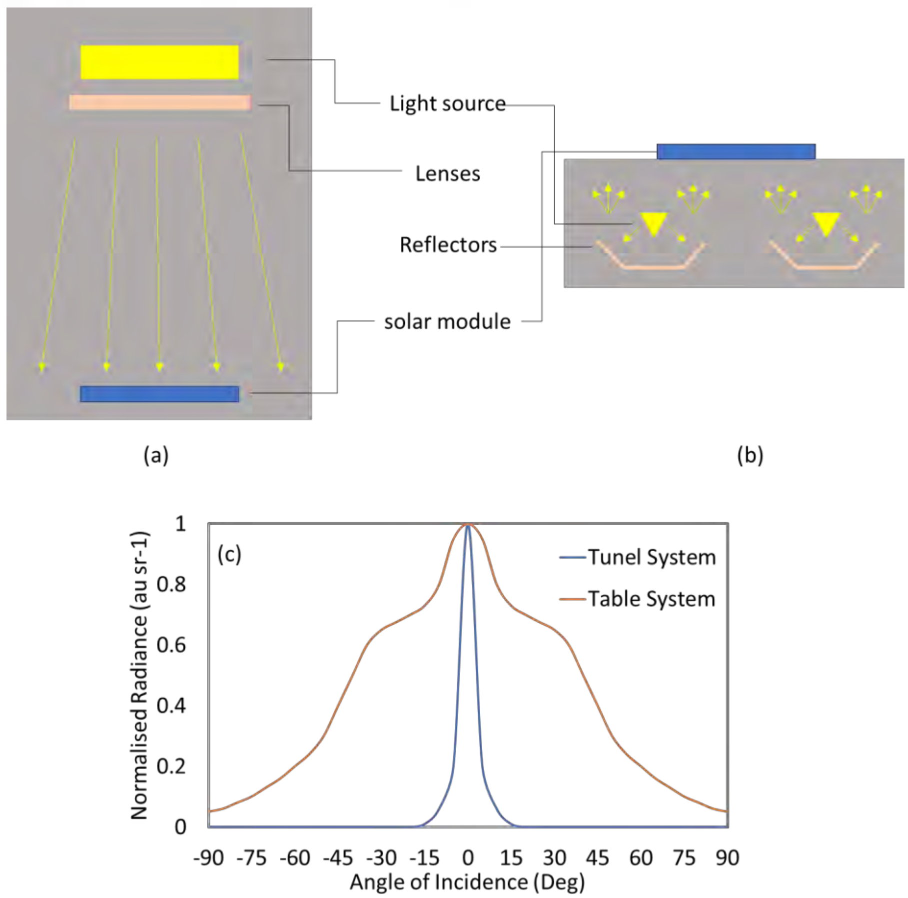

Figure 1. Schematics of two different solar simulator setups: (a) tunnel system, with high direct light component, (b) table system, with high diffuse light component and (c) normalised angular profile of the two setups.

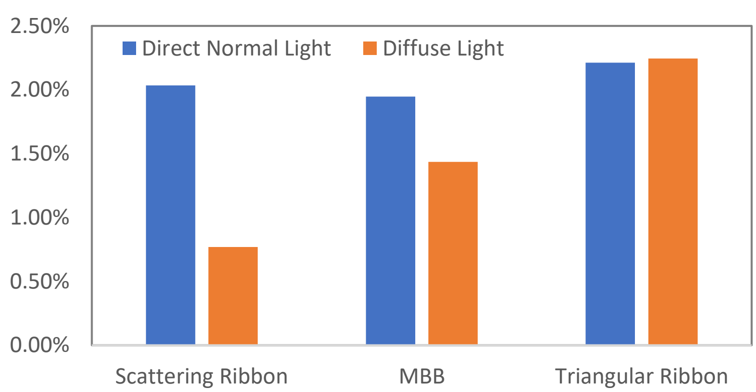

Figure 2. Optical Enhancements of modules with scattering ribbons, MBB and triangular ribbons compared to 5BB flat ribbon simulated with direct normal and diffuse irradiance.

References

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