Area: Performance and Reliability of PV Modules

LOSS ANALYSIS AND DESIGN OPTIMIZATION OF SHINGLED BIFACIAL PHOTOVOLTAIC MODULES

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High cell packaging density and high efficiency are the two key features of shingled photovoltaic (PV) modules. In shingled PV modules, solar cells are cut into small strips along the busbars. These solar cell strips are then interconnected in shingled pattern by connecting the p-busbar of one cell-strip to n-busbar of other cell-strip. Similar to the monofacial cells, bifacial cells can also be interconnected to form a shingled bifacial PV modules. In this study, we show that bifacial shingled modules show less power loss compared to standard double-glass bifacial PV modules when measured under standard test conditions (STC) and provide more energy in outdoor conditions compared to standard monofacial PV modules. The improved STC performance of shingled bifacial module is due mainly to almost no loss from the cell-gap region as in the case of standard bifacial PV modules with transparent rear side. For the optimal performance of shingled bifacial PV module, a number of parameters should be optimised such as front and rear metallisation grid, cell overlap, number of cell cuts, string connections to form a module, etc. In this study, we investigate design parameters for the shingled bifacial module and their influence on both, front and the bifacial performance of the module. Using our in-house developed grid optimisation simulation tool “Griddler”, we quantify the resistive and optical losses in shingled interconnections of solar cells and compare it with the standard cell interconnections. In “Griddler”, various resistive, optical shadow and recombination parameters for cell and module are taken into account to calculate the losses when bifacial cells are cleaved and interconnected in shingled pattern. Our study shows that the performance of the shingled module is limited by the number of cuts and cell overlap which is a design constrained due to the lay-up and stringing tools. As we introduce more cuts, we reduce resistive losses. At the same time, the optical losses will increase, depending on the cell overlap. We have simulated the bifacial shingled module performance for a number of cell overlap ranging from 0.5 mm to 2.0 mm and with the number of cell cuts ranging 3 to 6. Simulated results in Figure 1 shows that for more than 1.2 mm cell overlap, 6-cut shingling is no longer offering advantage compared to 4 or 5-cut shingling. In shingled bifacial PV modules, the metallization design (busbar width and number of fingers) of front and rear side of the bifacial cell have a significant impact on silver consumption. Hence, we also perform design optimisation based on cost and performance of the module. In addition, this study investigates the bifacial performance of the module considering simultaneous front and rear side illumination.

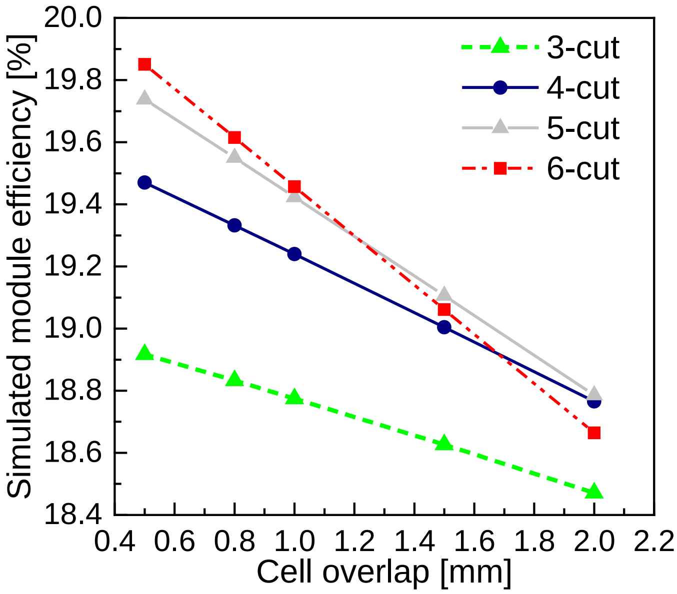

Figure 1: Simulated efficiency of shingled bifacial PV module for varying cell overlap and number of cell cuts.