A Probabilistic Approach for the Analysis of Partial Shading of PV Arrays

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Abstract

This paper studies partial shading of photovoltaic (PV) arrays from a probabilistic perspective. Partial shading often happens in a PV array because of unexpected reasons such as moving clouds, falling tree lives, over growing tree branches, bird dung, loose plastic bags caught on PV panels, etc. Partial shading may bring detrimental damages to PV panels through the hot spot effect. It can also reduce the energy conversion efficiency of the system. Since partial shading exhibits some degree of uncertainty, evaluation of its effects is somewhat difficult. In this paper, the authors employ the Monte Carlo method to simulate the performance of a PV array undergoing different patterns of shading. The simulation was carried out in the time domain using a circuit simulation program, EMTP/ATP, which is widely used by many universities worldwide for simulation of power system transients. Four array wiring configurations have been considered: series-parallel (SP), total-cross-tied (TCT), bridge-link (BL), and honeycomb (HC). The probability distributions of the maximum power outputs of the PV arrays connected in different configurations are obtained and compared.