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Innovative Model based on the Irradiance-Temperature Fitting of Equivalent Circuit Parameters for Commercial Photovoltaic Modules towards Accurate Power and Energy Prediction

By

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Declaration

I hereby declare that the contents and organization of this dissertation constitute my own original work and does not compromise in any way the rights of third parties, including those relating to the security of personal data.

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Abstract

The knowledge of the equivalent circuit parameters for a PhotoVoltaic (PV) generator permits to deeply study and simulate its performance under any weather condition. Many works in literature present procedures that determine these values starting from experimental data. The best compromise between simplicity and high accuracy is the equivalent circuit including five parameters: however, they are, generally, provided for specific weather conditions. In addition, these parameters are affected by the irradiance and the module temperature, but their dependence on these environmental quantities is studied for a few of these parameters only. Indeed, some works propose trends quantifying the parameters dependence on weather conditions, but they are qualitative, and some coefficients are not provided and, generally, unknown. Therefore, the generated PV energy in any weather condition cannot be predicted using the values of the equivalent circuit parameters. This work proposes an innovative methodology to determine the values of the equivalent circuit parameters using long term experimental campaigns. Moreover, their dependence on weather conditions was investigated, and this information was used to predict the generated energy by PV modules during the experimental campaign. The model was applied to seven commercial PV generators with different technology and rated power. In particular, two experimental campaigns were carried out for the modules under test: one at Politecnico di Torino (Turin, Italy) and one at the Universidad de Jaèn (Jaén, Spain). The effectiveness of the proposed model was investigated by comparing its energy prediction with the experimental energy (set as reference to quantify the deviations), and with the energy estimated by the most common model in literature (the Osterwald model).