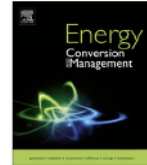




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Characterization of PV panel and global optimization of its model parameters using genetic algorithm

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ABSTRACT

This paper details an improved modeling technique for a photovoltaic (PV) module; utilizing the optimization ability of a genetic algorithm, with different parameters of the PV module being computed via this approach. The accurate modeling of any PV module is incumbent upon the values of these parameters, as it is imperative in the context of any further studies concerning different PV applications. Simulation, optimization and the design of the hybrid systems that include PV are examples of these applications. The global optimization of the parameters and the applicability for the entire range of the solar radiation and a wide range of temperatures are achievable via this approach. The Manufacturer's Data Sheet information is used as a basis for the purpose of parameter optimization, with an average absolute error fitness function formulated; and a numerical iterative method used to solve the voltage-current relation of the PV module. The results of single-diode and two-diode models are evaluated in order to ascertain which of them are more accurate. Other cases are also analyzed in this paper for the purpose of comparison. The Matlab-Simulink environment is used to simulate the operation of the PV module, depending on the extracted parameters. The results of the simulation are compared with the Data Sheet information, which is obtained via experimentation in order to validate the reliability of the approach. Three types of PV modules, using different technologies, are tested for the purpose of this validation, and the results confirm the accuracy and reliability of the approach developed in this study. The effectiveness of the model developed by this approach to predict the performance of the PV system under partial shading conditions was also validated.

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1. Introduction

Photovoltaic systems are one of the most popular renewable energy sources in today's world. There are ubiquitous in numerous settings, be it urban or rural [1–3]. Due to the many factors and benefits, both the public and private sectors are showing a tremendous amount of interest in the potential and capability of energy generation from these devices [4–7]. One of the major advantages of PV technology is its long lifecycle time, with low operation and maintenance costs, due to the fact that it does not rely on a minimal number of moving parts. Furthermore, this technology heralds a clean and environmentally-friendly energy source. Another salient feature of the PV technology is its modularity, where instead of installing a whole new system whenever required; a current system can be upgraded accordingly within a short period of time [8–17]. Its benefits

and flexibility makes it ideal for space and earth applications [16,18], and it is expected to grow in the near future, from small PV stand-alone site applications, to large PV grid connected systems [19–21].

As previously mentioned, a PV power system is one of the more important renewable energy sources. Due to its importance, large PV power systems have been installed in multiple countries. However, due to the high initial capital needed for this technology, the optimal utilization of the solar energy should be insured, and precise studies and simulation of the PV power system shall be performed prior to its installation [22–24]. The modeling of the PV module represents the important task in the whole PV system pre-installation procedure.

Modeling of the PV cell is a mathematical description of the PV output current–voltage (I–V), and power–voltage (P–V) relations. A general equivalent circuit (model) that represents the operation of the PV cell is illustrated in Fig. 1. This model is called a single-diode model. A more detailed model is a two-diode model, which uses two diodes to express the P–N junction effect, and this model is shown in Fig. 2.

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