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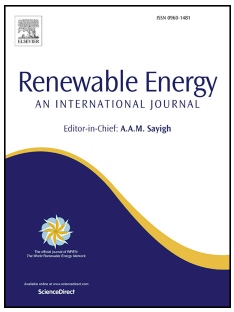

Forseeing energy photovoltaic output determination by a statistical model using real module temperature in the north east of France

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Forseeing energy photovoltaic output determination by a statistical model using real module temperature in the North East of France.

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ABSTRACT

The goal of the work carried out is firstly to achieve a model of parameters influencing the performance of photovoltaic (PV) energy output under real working conditions and secondly implementing the model into a single Field Programmable Gate Array (FPGA) that should be applied to energy management for future smart building design. Only the former aspect is discussed in this paper to guide the undergoing research laboratory theme of the latter as the GREEN platform is equipped with several renewable energy technologies for modeling, managing and optimization of energy consumption. It's well known that PV nominal specifications such as power output or energy yield of recent modules are evaluated by manufacturers under Standard Test Conditions (STC) that are generally not representative of real working conditions of solar modules. In this study, we showed high correlation between the operating cell temperature (T_c) and the measured back surface temperature (T_{back}) of polycrystalline PV modules in real experimental conditions. Methods used in previous study referred mainly to ambient temperature. An accurate relationship is derived for power output between solar irradiance φ (W/m²) and the back surface temperature and the calculated power output is compared to measured power output data with a high correlation coefficient. This power output is introduced in the Weibull probability density function to model the energy yield which is finally compared to real conditions recorded data. Good concordance is shown between the proposed model and measured data of energy yield for the middle year (2013) and last year (2016) of the seven years range experimental data of a semi continental zone. The model is ready to be implemented on FPGA chip to be compared to real working high temperature environment conditions.

Keywords : Photovoltaic, temperature effect, operating temperature,Weibull model, silicon modules, statiscal model, power output.

1.Introduction

Solar photovoltaic (PV) systems can be installed on rooftops, integrated to a buliding's envelope or ground-mounted. Photovolaic applications include residential systems, larger industrial systems and utility-scale power plants, but also consumer goods. Actually photovoltaic nominal specifications such as power output or energy yield of recent modules are evaluated by manufacturers under standard conditions (STC) by a flashing technology and these nominal specifications are hand out to customers. However, manufacturers must refer to the economical solar simulator based on micro-channel solar cell thermal (MCSCT) [1,2] that has been designed and tested in indoor condition. Heat extracted from the bottom of solar modules by the MCSCT system has shown to improve the electrical performance of PV system and hence the energy payback time (EPBT) [3] and energy production factor (EPF). Though, under real conditions and when connected to grid,energy output depends not only on weather conditions but also on the environmental stresses undergoing by modules. These includes extreme temperatures in summer and winter, thermal expansion, mechanical loading due to snow, factors due to connection loss and accumulative dust etc.

Since 2008, University of Lorraine, physics departement in Metz, is equipped with a 200 m^2 designed GREEN platform where several renewable energy technologies are implemented for modeling, managing and optimisation of energy consumption. All technologies are monitored,including real weather conditions data are recorded, processed and should be implemented on FPGA chips for prediction analysis. The GREEN platform scheme is represented in figure 1.