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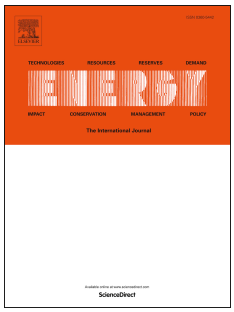

Electric and thermal characteristics of photovoltaic modules under partial shading and with a damaged bypass diode

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Electric and thermal characteristics of photovoltaic modules under partial shading and with a damaged bypass diode

Abstract:

In this paper, characteristics of PV (photovoltaic) modules under partial shading or with a damaged bypass diode in the junction box were evaluated by comparing a theoretical model and empirical data. For the electrical analysis of the current- voltage (I-V) curve of each module, a PV module with one diode cell model was proposed, and the model closely matched the empirical results. The damaged bypass diode was replaced with an element of resistance in the simulation model. The calculation shows that the open circuit voltage of the PV module with a damaged bypass diode was slightly higher than that of a PV module under shading conditions while the PV system was operating. The I-V curve of each module obtained with the solar simulator was similar to the results of the simulation. From the results of field testing each PV module, when the PV system was operating in connection with the power grid, the internal temperature of the junction box connected to the shaded PV module was 5 °C higher than that of the PV module with the damaged bypass diode. Furthermore when the PV system was not operating, the internal temperature of the junction box in the PV module with the damaged bypass diode was extremely high. This condition caused a short-circuit and the surface temperature of the damaged bypass diode reached 219 °C. In this paper, we theoretically and empirically analyzed the characteristics of a shaded PV module and a module with a damaged bypass diode.

Keywords: partial shading, damaged bypass diode, photovoltaic module, open circuit voltage, short circuit current

1. Introduction

A bypass diode is widely used in PV (photovoltaic) modules to prevent fire caused by hot spots as well as to decrease energy losses during shading and mismatching. Bypass diodes,