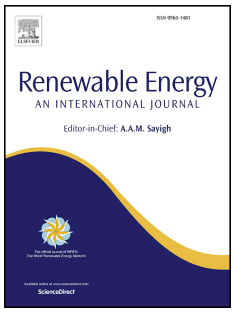
Accepted Manuscript



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PII: S0960-1481(17)30911-4

DOI: 10.1016/j.renene.2017.09.048

Reference: RENE 9246

To appear in: *Renewable Energy*

Received Date: 21 March 2017

Revised Date: 29 August 2017

Accepted Date: 14 September 2017

Please cite this article as: Harrou F, Sun Y, Taghezouit B, Saidi A, Hamlati M-E, Reliable fault detection and diagnosis of photovoltaic systems based on statistical monitoring approaches, *Renewable Energy* (2017), doi: 10.1016/j.renene.2017.09.048.

Reliable fault detection and diagnosis of photovoltaic systems based on statistical monitoring approaches

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Abstract

This study reports the development of an innovative fault detection and diagnosis scheme to monitor the direct current (DC) side of photovoltaic (PV) systems. Towards this end, we propose a statistical approach that exploits the advantages of one-diode model and those of the univariate and multivariate exponentially weighted moving average (EWMA) charts to better detect faults. Specifically, we generate array's residuals of current, voltage and power using measured temperature and irradiance. These residuals capture the difference between the measurements and the predictions MPP for the current, voltage and power from the one-diode model, and use them as fault indicators. Then, we apply the multivariate EWMA (MEWMA) monitoring chart to the residuals to detect faults. However, a MEWMA scheme cannot identify the type of fault. Once a fault is detected in MEWMA chart, the univariate EWMA chart based on current and voltage indicators is used to identify the type of fault (e.g., short-circuit, open-circuit and shading faults). We applied this strategy to real data from the grid-connected PV system installed at the Renewable Energy Development Center, Algeria. Results show the capacity of the proposed strategy to monitors the DC side of PV systems and detects partial shading.

Keywords: Fault detection, Partial shading, Photovoltaic systems, One-diode model, statistical monitoring charts.

1. Introduction

Renewable energy is a key challenging problem increasingly gaining attention in worldwide. Renewable energy sources, such as solar and wind, are promising alternatives to conventional fossil fuels because they are clean, sustainable, safe, and environment-friendly with zero CO_2 emissions. For instance, [1] showed that 100 gigawatts of photovoltaic (PV)-generated power in Europe in 2012 kept more than 53 million tons