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Efficiency of Power Conditioning Devices in a Basic Off-Grid Photovoltaic Panel System in a Pollution Intensive Area

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Abstract

The current resurgence of interest in the use of renewable energy is driven by the need to reduce the high environmental impact of fossil-based energy. As people are much concerned with the fossil fuel exhaustion and the environmental problems caused by the conventional power generation, renewable energy sources and among them photovoltaic panels (PV) and wind-generators are now widely used. PV sources are used today in many applications such as battery charging, water pumping, home power supply, swimming-pool heating systems etc. They have the advantage of being maintained and pollution free but their installation cost is high and, in most applications, they require a power conditioner (DC/DC or DC/AC converter) for load interface.

PV conversion still have relatively low conversion efficiency due to the fact that solar radiation and effect of cloud movement are undeterministic. However, the overall system efficiency can be improved upon and cost can be reduced using high efficiency power conditioners which, in addition, are designed to extract the maximum possible power from the PV module maximum power point (MPP). The power conditioning devices taken into consideration in the paper are DC-DC converters.

The basic aim of this paper is to evaluate the effect of the transient response on the duty cycle in DC-DC converters which is likely attributed to effect of atmospheric conditions. This in turn provides the need for a possible photovoltaic panel switching technique. This will help to reduce the effect of cloud movements as well as improve the overall efficiency of the system.

Preliminary results which include availability of power as well correlation of the PV voltage to daily solar irradiation for a specific latitude in South Africa. Simulation using MATLAB/SIMULINK software is also presented and this would be used to draw the final conclusion. A 220-W polycrystalline prototype system is designed and built to obtain reasonable data. The effectiveness of the proposed system is presented with some simulation and experimental results.

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Keywords: Buck and Boost DC-DC converters, maximum power point tracking, Matlab/Simulink, tilt and orientation angles, PV panels, direct solar radiation