Maximum Power Point Tracking (MPPT) of Partially Shaded Photovoltaic Cells: A Technical Review

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The world's energy supply has been under a tremendous pressure due to the rapid depletion of fossil resources, energy security and reliability, environmental sustainability and the ever-increasing modern living sophistication. The issue of persistent hikes in oil prices, climate threats and soaring energy demand has diverted the global interest to exploiting and investing in renewable types of energy (RE), solar energy in particular. A photovoltaic (PV) system is easy to install, has no moving parts, is almost free of maintenance, has maximum reliability, reduced vulnerability to power loss and is expandable. Regardless of these advantages, PV energy costs considerably higher than fossil fuels. This is due to its lower efficiency and higher costs. An expansive study has been carried out for PV fabrication, but it is equally important to extract the maximum power by enhancing the maximum power point tracking (MPPT) capability. The review covers the detailed partial shading condition (PSC) modelling and the various MPPT techniques and algorithms employed. It describes how to extract the maximum output power under continuous varying irradiation conditions in large PV arrays to make the technology commercially viable.

Keywords: renewable energy; photovoltaic; maximum power point; efficiency

1. Introduction

The world's energy supply has been under a tremendous pressure due to the rapid depletion of fossil resources, energy security and reliability, environmental sustainability and the ever-increasing modern living sophistication. The World Energy Forum (2011) anticipated that the fossil fuel reserves would be drained out in less than 100 years. It accounts for over 79% of the primary energy consumed in the world. The fossil energy demand will expand almost 60% from 2002 to 2030 with an average rise of 1.7% per annum [1]. The electricity generation of the world is approximately 85% on fossil resource dependency; in contrast to renewable energy (RE) which remains at 4% [2-3]. Thus, the issue of persistent hikes in oil prices, climate threats and soaring energy demand has diverted the global interest for exploiting and investing in RE. Solar PV energy is a sustainable and abundant source progressively being envisioned as a significant RE source of the future.

The uses of non-renewable fuels have various challanging effects that cause pollution, acid rain and global warming. These fossil resources are depleting at a very fast rate causing increasing fuel prices which has led the engineers and economists to use alternative resources. As more countries have ratified the Kyoto accord intended for greenhouse gas emission reduction, traditional power generation from burning fossil resources are no longer bearable for adding into the system generation capacity [4].

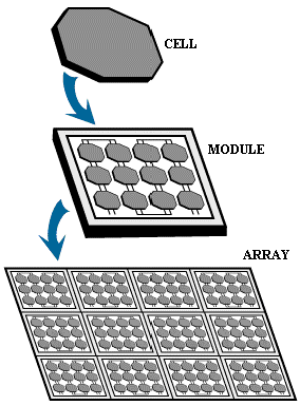

Fig. 1 PV cells hierarchical arrangement of modules and arrays

Solar power transforms sunlight into electricity either, directly, by using photovoltaic (PV) technology or indirectly, by transformation using concentrated solar power (CSP) [5]. PV technology is easy to install, has no moving parts,