Modeling and analysis of MPPT based solar PV system under dynamic weather conditions

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Abstract*— A solar photovoltaic system (PV) generate electricity through photo-electric effect through photo cell. In practice, the output from a solar cell is quite low and so required number of solar cells are arranged properly in series-parallel combination to obtain significant output forming a module. In present analysis performance of a PV system having resistive load was analyzed under dynamic weather condition. A power electronic interface is embedded in the system to achieve maximum power point tracking (MPPT). A controller is incorporated in the system to regulate the duty ratio of the power electronic interface. In present study, two different algorithms were applied in the controller namely: Hill Climbing algorithm and Incremental Conductance. A comparative analysis of the system was carried out with the controller actuated by the above-mentioned logics simultaneously. Although both the method provided satisfactory results, INC method provided better system response.

***Keywords*— Sustainability, Greenhouse gases (GHG), PV array, MPPT controller, P&O method, INC method, DC-DC converter**

I. Introduction

Energy is the main constituent of keeping civilization thriving and alive. Economic growth and advances in science and technology require consumption of energy. Total energy in this universe is a fixed quantity and exists in different forms in nature. Energy resources can be classified into two parts: non-renewable and renewable. It is evident that fossil fuel-based resources are of finite nature and hence will not sustain in distant future [1] whereas renewable is abundant by nature. On the other hand, fossil fuel-based resources pollute environment as they emit greenhouse gases during consumption whereas renewable resources are eco-friendly in nature. However, we cannot sacrifice our economic growth and more and more energy consumption is pertinent in the coming era followed by the technological advancement [2-5]. Keeping in view these two contradictory aspects, an optimized mixture of energy is evident for an efficient system.

In between different forms of renewables, solar is the most promising one due to its steadiness, ease of implementation and cost effectiveness [6]. Solar power has two forms for extraction, namely photovoltaic and solar thermal. PV generates electricity both in islanded mode as well as on grid connected mode with similar performance characteristic [7-8]. Extraction of maximum power from such a system has become a matter of great concern to the researchers since last few decades [9]. This issue can be tackled by several proposed methods like Perturb and Observe (P&O), Incremental Conductance (INC) etc. which helps in optimize a PV system in operation. In present study, a simulation based comparative performance analysis is carried out with different power electronic interfaces at variable insolation level at different temperatures in MATLAB/Simulink environment. The power converter is regulated by a MPPT controller. Two different algorithms (P&O and INC) were adopted in this controller and performance analysis of these two were compared. MPPT algorithm is of significant importance for the tracking of maximum power point and hence necessary to implement an efficient system. The results shows that both the algorithm works efficiently. However, INC provided comparatively better response.

II. Solar Power System

Solar cell is the most crucial part in a PV based system. It is treated as a constant current source providing electricity while on exposure to the sunlight of a particular wavelength range. In present analysis, single diode representation of solar PV cell was considered [10] as shown in fig. 1. MATLAB/Simulink package provide several techniques to implement a solar PV system such as physical block modelling, mathematical block modelling and embedded MATLAB programming. In present study, physical block modelling is used. As mentioned above solar PV is modelled as a constant source of current connected in parallel with the diode as evident in figure 1.

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