Steady-State and Dynamic Study of Photovoltaic (PV) System in University of New Haven: Towards to a Green and Secure Campus

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INTRODUCTION

In this study, several kinds of PV modeling methods have been discussed in order to find a best way to simulate the solar power array in University of New Haven. The Maximum power point tracking (MPPT) is studied and employed to maximize the output power of the photovoltaic system. Simulation based on Matlab/Simulink is carried out to verify the model and MPPT method.

METHOD & MATERIALS

The basic equations that mathematically describe the I-V characteristic of the ideal PV cell.

$$I_{PV} = I_{PV,cell} - I_{O,cell}\left[\exp\left(\frac{qV}{\alpha kT}\right) - 1\right]$$

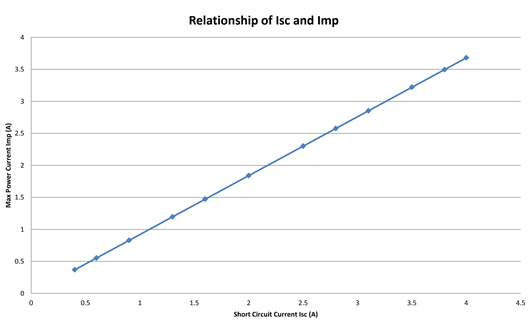
$$I = I_{PV} - I_0\left[\exp\left(\frac{V + R_S I}{(V_t \alpha - 1)}\right)\right] - \frac{V + R_S I}{R_P}$$

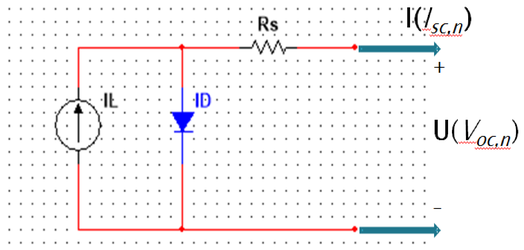
where α is the thermal voltage timing completion factor.

The main idea of the MPPT technique is

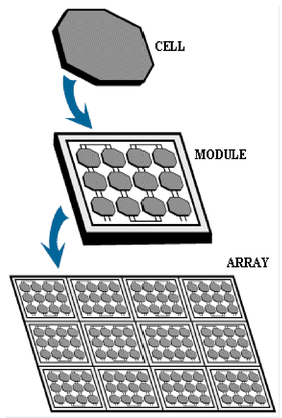
$$I_{MP} = K_{CMPPT} * I_{SC}$$

where K_{CMPPT} is the current factor CMPPT control, and I_{SC} can be measured or calculated from a valid model.

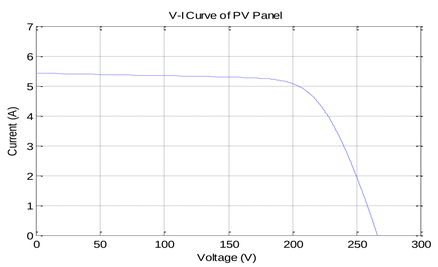


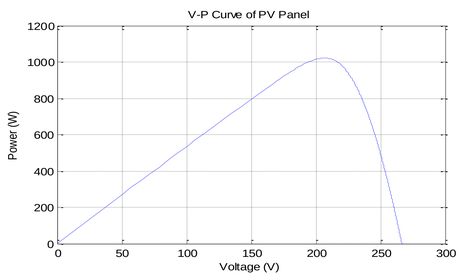


One-diode Equivalent Model



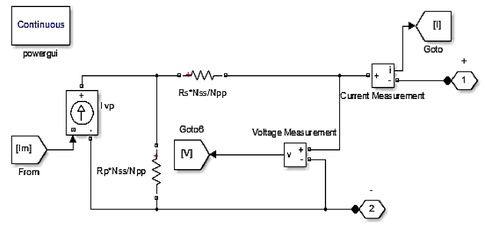
Basic structure of A PV system



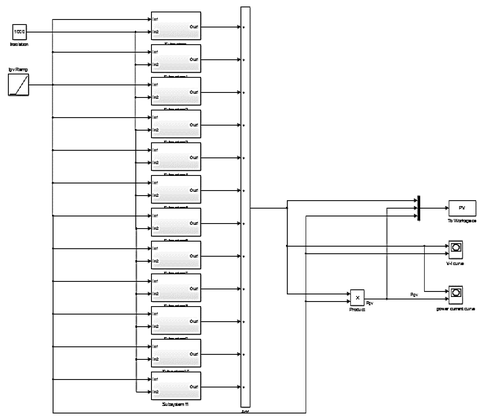


V-I Curve and V-P Curve of the PV system

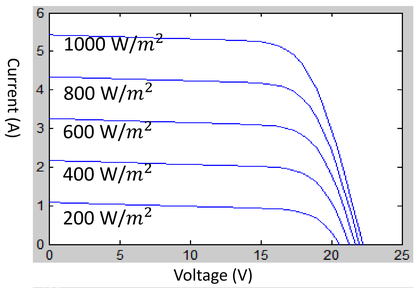
RESULTS

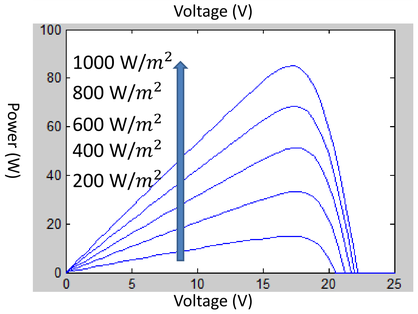


Basic SIMULINK Model of Equivalent PV Module



Overall Model of A PV Array





V-I Curve and V-P Curve of the PV system Deployed Irradiation difference

Discussion

Maximizing the PV array power also maximizes the output power at the load of the converter. In this situation, the converter is considered a lossless converter. Most loads can be simplified as a combination of a set of voltage source current source and resistance or one of them. For different type of loads, a different value should be maximized to obtain a maximum power output. For instance, the load current should be maximized if the loads are a voltage source type. For loads belong to current source and resistance types, both output current and output voltage can be maximized to get a maximum power. This is true for any loads types only if there are no negative impedance characteristics. Normally, it is adequate to maximize load voltage or load current in order to get a maximum power output. As a result, in most of PV systems, only one sensor in each system is enough. For most PV systems, battery is the most common voltage source type loads in a system and it plays a role of backup at the same time to make sure the system works in a certain condition.

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