Modelling and control of micro grid with solar system

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ABSTRACT

Solar power generation using photovoltaic (PV) array is one of the big challenges nowadays we are facing, in our current scenario. Numbers of efforts are being undertaken by the Governments around the world to explore alternative energy sources and to achieve pollution reduction. Grid connected PV systems are becoming the most important application of solar PV generation. In this paper, deal with problem that persists with the modelling of grid connected PV systems. The objective of this work is to analyze the performance and dynamic behavior of grid connected PV systems. Maximum Power Point Tracking (MPPT) Algorithm is used to obtain the maximum power of grid connected PV systems. The dc/dc converter and inverter setup are connected in between the solar panel and grid. The impacts of grid connected PV systems were analyzed. The simulation of grid connected PV systems is done under the MATLAB/SIMULINK environment.

KEY WORDS: Boost Converter, MPPT Algorithm, Micro grid, Photo Voltaic (PV) system, Voltage Source Inverter.

1. INTRODUCTION

In recent decades, diverse procedure of supply and demand, in addition to the high level of environmental pollution resulted by fossil energy, have made renewable energy as a hot topic for researchers. Among all renewable energy strategies, photovoltaic systems own several fundamental advantages compare to others. Governments around the world are facing a rising demand on global electric power. To face this challenge, the Grid and renewable energy applications. The power-electronic technology plays an important role in distributed generation and in integration of renewable energy sources into the electrical grid, and it is widely used and rapidly expanding as these applications become more integrated with the grid-based.

Photovoltaic (PV) power supplied to the utility grid is gaining more and more visibility, while the world's power demand is increasing. Not many PV systems have so far been placed into the grid due to the relatively high cost, compared with more traditional energy sources such as oil, gas, coal, nuclear, hydro, and wind. Solid-state inverters have been shown to be the enabling technology for putting PV systems into the grid.

Distributed generations used in micro grids are technically not suitable for direct energy supply to the grid. They have to be interfaced with Micro Grid through power conditioning devices and appropriate control strategies in order to provide the required voltage and frequency at PCC.

In this paper, discuss about the grid connected photovoltaic system, the power electronics interface and the method to track the maximum power point (MPPT) of the solar panel.

2. MODELLING OF PV ARRAY

A photovoltaic array (PV system) is an interconnection of modules which in turn is made up of many PV cells in series or parallel. The power produced by single module is not enough to meet the requirements of commercial applications, so modules are connected to form array to supply the load. In an array the connection of the modules is same as that of cells in a module. The modules in a PV array are usually first connected in series to obtain the desired voltages; the individual modules are then connected in parallel to allow the system to produce more current. In order to study the photovoltaic system in distributed generation network, a modeling and circuit model of the PV array is necessary. A photovoltaic device is a nonlinear device and the parameters depend essentially on sunlight and temperature. The photovoltaic cell converts the sunlight into electricity.

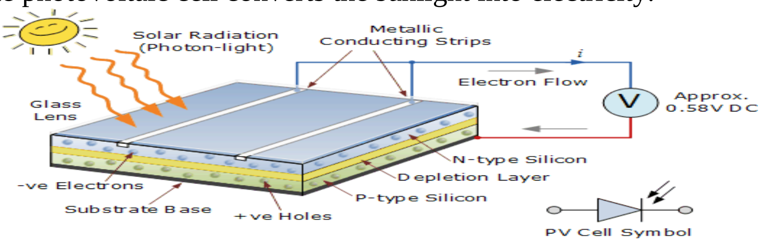

Figure.1.Model of photovoltaic cell

PV arrays are built up with combined series/parallel combinations of PV solar cells, which are usually represented by a simplified equivalent circuit model such as the one given in Fig. 2 and/or by an equation as in (3). The PV cell output voltage is a function of the photocurrent that mainly determined by load current depending on the solar irradiation level during the operation.

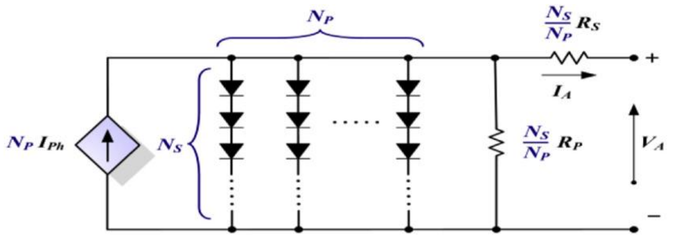

Figure.2.Equivalent Circuit of photovoltaic cell

The photocurrent I_{Ph} for any operating conditions of the PV array is assumed to be related to the photocurrent at standard test conditions (STC) as given in equation (1).

$$I_{ph} = f_{AM} f_{1A} [I_{SC} + \alpha_{ISC} (T_C - T_R)] \frac{S}{SR} \qquad (1)$$

$$f_{AMa} = \sum_{i=0}^{4} a\, i({}_{AM_a})i =_{M_P} \sum_{i=0}^{4} ai\, ({}_{AM})i \qquad (2)$$

Where; *ai:* Polynomial coefficients for fitting the absolute air mass function of the analysed cell material, AM_a: Absolute air mass, corrected by pressure; AM: Atmospheric optical air mass, MP: Pressure modifier.

The voltage serves as one of the main functions of the photocurrent, which is identified or measured by solar irradiation. The voltage equation is given by

$$V_C = \frac{AKT_C}{e} \ln\left(\frac{I_{Ph} + I_O - I_C}{I_O}\right) - R_S I_C \qquad (3)$$

Where, Ic: cell output current; Iph: photocurrent, function of irradiation, I_0: reverse saturation current; Rs: series resistance of cell; Tc: reference cell operating temperature, Vc: cell output voltage.

2.1. Power conditioning devices: A grid-connected solar PV system is use to transfer the maximum power obtained from the sun into the electric grid. The use of an appropriate electronic interface with maximum power point tracking (MPPT) capabilities and the ability of effectively connecting to the AC power grid is required. The power conditioning system (PCS) is an electronic device that permits to achieve the objective, of controlling the active power generation and reactive power compensation in the micro grid. It matches the voltage injected into the grid, and also for controlling the current flow and power flow in the micro grid system. Including the DC/DC boost converter between the PV array and the inverter linked to the electric grid, various control objectives are possible to be pursued simultaneously and independently of the PV array operation without changing the PCS topology. A three-phase DC/AC voltage source inverter (VSI) using IGBTs (Insulated Gate Bipolar Transistors) is employed for connecting to the grid.

2.2. Grid connected system: Photovoltaic systems were first used as stand-alone systems to provide electricity to rural areas where no other sources of energy were present. The advances in the technology and the concerns about global warming are encouraging both utilities and customers to expand the use of grid-connected PV systems. However, the intermittent nature of the output power of these systems might impose some challenges on the operation of the electric network. The aim of this chapter is to explore the pros and cons of installing grid connected photovoltaic systems can be used to study the impacts of these systems on the electric network.

A grid-connected photovoltaic power system will reduce the power bill as it is possible to sell surplus electricity produced to the local electricity supplier. Grid connected PV systems are comparatively easier to install as they do not require a battery system. Grid interconnection of photovoltaic (PV) power generation systems has the advantage of effective utilization of generated power because there are no storage losses involved.

3. RESULTS

Fig.3 shows the simulation of grid connected PV system. The complete simulation is done using MATLAB software.

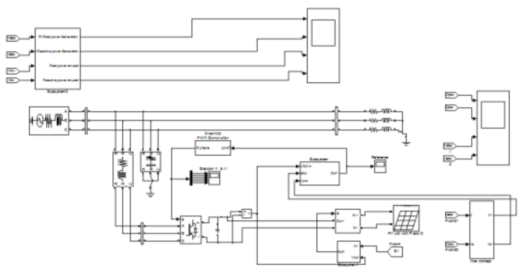

Figure.3.Simulation of grid connected PV system

Fig .4, Fig .5, Fig .6 shows the Output waveform of PV panel, Real Powers and Reactive Power for PV system and Demand, Voltages and Current Waveform for Grid and Load. Table 1 shows the output values of PV system.

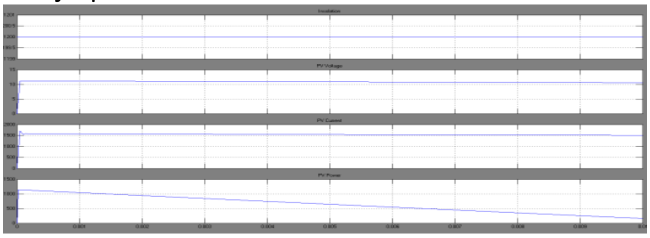

Figure.4.Output waveform of PV panel

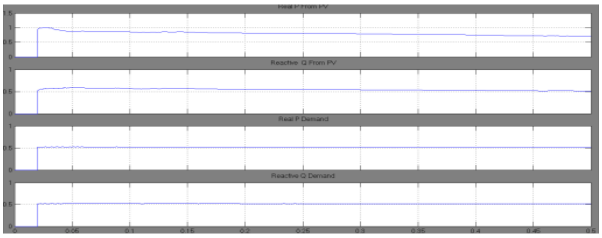

Figure.5.Real Powers and Reactive Power for PV system and Demand side

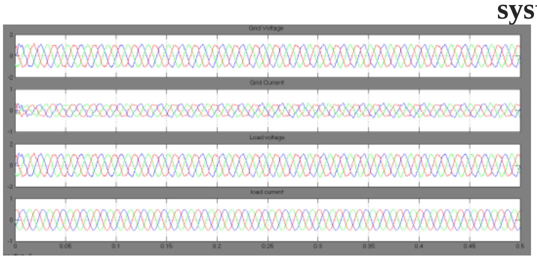

Figure.6.Voltages and Current Waveform for Grid and Load side

Table.1.Output values of pv system

Open circuit voltage(V_{OC})	17.92v
Short circuit current(I_{SC})	4.95A
Insolation level	800-1500 Lumen
Power(Pmax)	85 w
Maximum power by MPPT	207 w
Temperature	25 ^{o} celsius

4. CONCLUSION

In this work, the study of the photovoltaic system with maximum power point controller has developed. A mathematic model of the PV has been presented. The complete system was simulated using MATLAB/SIMULINK environment. The simulations of the PV panels showed that the simulated models were accurate to determine the voltage and current characteristics, In addition, when the irradiance or temperature varies, the PV models output voltage current change. The PV performance and the maximum power point was analyzed, the results showed that the DC voltage generated by the PV array could produce an AC current sinusoidal at the output of the inverter. The amplitude of the current depends on the PV power. The simulation of grid systems was improved the voltage profile and dynamic performance of PV system was analyzed.

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