Design and Simulation of 100 MW Photovoltaic Power Plant Using Matlab Simulink

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ABSTRACT: The renewable energy of Solar system is most widely used in developed countries. In this solar PV system project a PV system is with grid connected. The aim of this project is to design a complete distributed energy resource system and to increase the efficiency of grid. The main objective of this project is to save fossil fuel and use of green energy in large amount. The PV module which will be controlled and optimized by maximum power point tracking (MPPT) algorithm. The DC-DC Boost converter with a three phase grid tie inverter will be used to increase the output voltage and to convert it to AC. In this project IC method is used for control methodology for the operating the PV at the MPPT point by controlling to switching the boost converter and also for operation of the three phase inverter and its integration with grid. The parameters of this controllers gives the best results.

Keywords: - Solar PV system, PV- Grid connected, MATLAB Simulink.

I.   INTRODUCTION:-

1.2 Overview of work:
Use of renewable solar energy has brought significant attentions. Photovoltaic (PV) power generation projects are Designed and installed in many countries. Many research works are carried out to observe and analyse and validate performance of PV modules. By Practical constraints the Implementation of experimental set

The author in [1] redesign a 10MW PV power plant. The simulation of PV power system implementation made easier the testing and observation of its stability and efficiency. The PV generation system behaves well in different conditions of solar radiance and temperature of PV panels. By using MPPT algorithm the stability and

This paper shows that the mathematical develop modelling of PV cell, boost converter,

up for Solar PV power generation with DC-DC Boost converter is not always possible to validate the performance.

Then By using Software application for simulatingthe model which helps to analyse the performance of PV system and a common circuit based model which could be used for validating any commercial PV module will be more helpful. Simulation of mathematical model for Photovoltaic (PV) module and DC-DC boost converter along with VSC converter is presented in this project. I-V characteristics and P-V characteristics of PV module under different temperature and irradiation level can be obtained using the model. Simulation of DC-DC Boost converter is performed and the results are obtained from constant DC supply fed converter and PV fed converter.

1.2 Motivational Aspect and Practical Relevance Related to Work:
Due to increase in demand of electricity the demand of fossil fuel is also increases which causes increase in pollution, reduce of natural resources, rising price of fossil fuels, climate change risks associated with power generation using fossil fuels. Therefore we have tried to make such a system which can be non-polluted, noise free, safe in operation, reliable and generated electricity from sun light which

II. LITERATURE SURVEY

succeeding in extracting the maximum power from the PV panels.

With reference to paper[2], the author extend a PV grid connected system which gives maximum output power and maximum efficiency at different irradiance conditions.

PWM based inverter and AC single phase grid. The maximum power point tracking algorithm P&O is

used, which gives maximum efficiency of the grid connected PV system. PWM based inverter with filter inductance is designed which gives sinusoidal output voltage. The grid voltage and frequency is synchronized by using PLL techniques. The sun irradiance are increase so increase the PV panel output power and also increase the PQ. PV energy is large than load demand, the excess energy is will exported to the utility.

According to reference [3] the author Mr. S. Sheik Mohammed and Dr. D. Devaraj, A PV module is developed using commonly used blocks in the form of masked subsystem block. I-V and P-V characteristics outputs are generated for MSX 60 PV module under different irradiation and different temperature levels and the model is simulated for GEPVp-200-M Moduleunder various conditions as presented in the data sheet. The results take from the simulation shows excellent matching with the characteristics graphs, which provided in the data sheet of the selected models. Thus, the model can be used to analyse the performance of any commercial PV module.[3]

With the reference no [4] Deepak Kumar Chy. And Md. Khaliluzzaman: Improvement of Perturb and Observe (IP&OA)algorithm. This algorithm is developed for MPPT based dc-dc Buck type and Boost type converter. The results show that notwithstanding varying atmospheric circumstances, this algorithmtrack the operating point at maximum value

Boost type converter shows higher efficiency as compare to Buck type converter by implementing IP&O algorithm. The wholework is done in hardware model with PIC-16F73A microcontroller.

With the reference no[5] the author Muhammad Ibrahim Munir and TasneimAldhanhani, The aim and objective of their project is to designed and developed a complete distributed energy resource system (DER). The project feature a PV module which controlled and optimized by maximum power point tracking (MPPT) algorithm. The system was confirmed by the simulation results in PSIM which gave a perfect sinusoid for the grid current. The system was also successfully operated at the MPPT point by applying the
P&O based MPPT algorithm.

III. SYSTEM ANALYSIS
In this PV power plant project it consist of PV array, DC-DC Boost converter, DC-AC converter, MPPT, controller, utility Grid system.

In First step the light energy will be converted into electrical energy by means of solar panels. This energy in DC voltage form.This DC voltage is enter into DC-DC converter. A boost converter (step-up voltage converter) is a DC-to-DC power converter that steps up voltage (while stepping down current) from its input (supply) to its output (load). The output voltage of the boost converter depends on the duty cycle of the control switch. So, the output voltage can be varied by varying the ON time of the switch. Thus, for the duty cycle
'D' the average output voltage can calculated using
$$\frac{Vo}{Vin} = \frac{1}{(1-D)}$$
A Maximum Power Point Tracker is an electronic DC to DCconverter that optimizes the match between the solar array (PV panels),and the utility grid. Itconvert a higher voltage DCoutput from solar panels.The output of the DC-DCconverter is now entersto the DC-AC converter. DC-AC converter is also known as Inverter. During conversion of DC to AC power, the harmonic is generated in the system. This harmonic is reduced by using filter in controller side. The output of the inverter is connected with the grid system and then by filtering the harmonics the efficiency of the grid is increases.
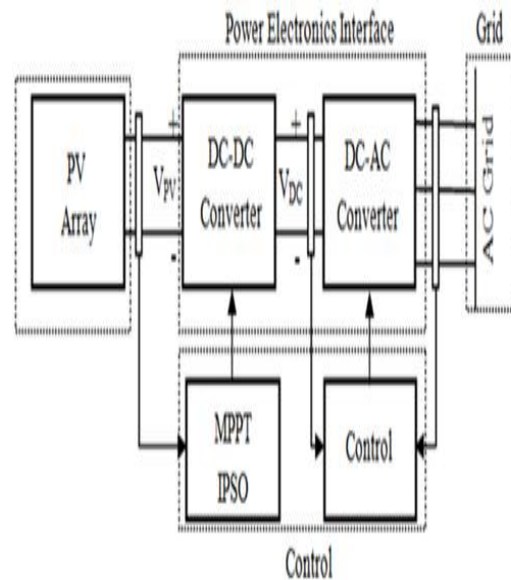

Fig 1: Block Diagram of proposed project.

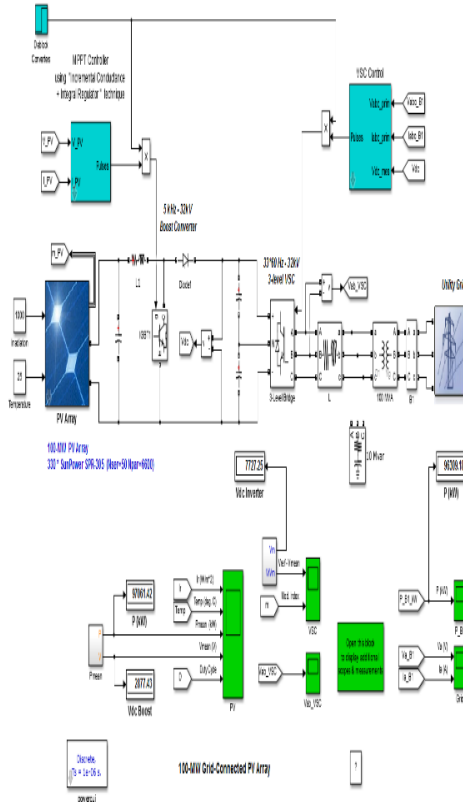## IV: SOFTWARE IMPLEMENTATION
A. Simulink Diagram

Fig 2: Circuit Diagram of Proposed Project

The SolarPV array is connected to grid system with power electronics interface which is DC-DC boost converter, MPPT, three-phase three-level Voltage Source Converter, and Controllers. Maximum Power Point Tracking (MPPT) is implemented in the boostconverter by means of a Simulinkmodel using the 'Perturb & Observe' technique which uses models for the DC_DC and VSC converters. In this model the MPPT controller is based on the IC+IR (Incremental Conductance + Integral Regulator)technique. The following components which used in Solar PV system

PV array delivering a maximum of 100 MW at 1000 W/m^2 sun irradiance and 25˚C temperature.

• DC-DC boost converter (step up the Voltage).
• 3-level 3-phase VSC Converter.
• 100-MVA 260kV/25MV
• Three-phase coupling transformer
• Utility grid system.

In this model the boost and VSC converters are represented by equivalent voltage sources generating the AC voltage averaged over one cycle of the switching frequency. Such a model does not represent harmonics, but the dynamics resulting from control system and power system interaction is preserved. In this model allows using much larger time steps. Which shows result in a faster simulation. The PV-array model contains an algebraic loop. This algebraic loop is required to get an iterative and accurate solution of the PV model when large sample times are used. This algebraic loop is easily solved by Simulink.

The "incremental conductance" MPPT algorithm is implemented in the MPPT Control MATLAB Function block.

The 100-MW PV array consists of 6600 strings of 50 series-connected 305.2-W modules connected in parallel (6600*50*305.2 W= 100.7 MW).

Manufacturer specifications for one module are:

• Number of series-connected cells : 96
• Open-circuit voltage: V_{oc}= 64.2 V
• Short-circuit current: I_{sc} = 5.96 A
• Voltage and current at maximum power :V_{mp} =54.7 V, I_{mp}= 5.58 A

The PV array block has two inputs that allow to varying sun irradiance (input 1 in W/m^2) and temperature (input 2 in deg. C). The irradiance and temperature profiles are defined by a Signal Builder block which is connected to the PV array inputs.
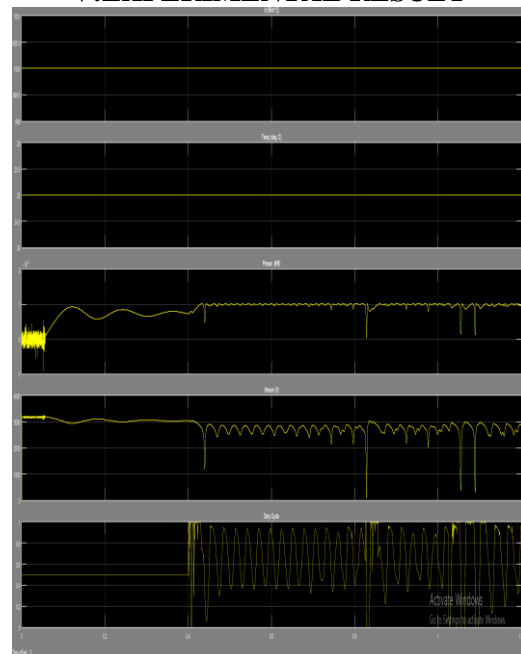
V:EXPERIMENTAL RESULT

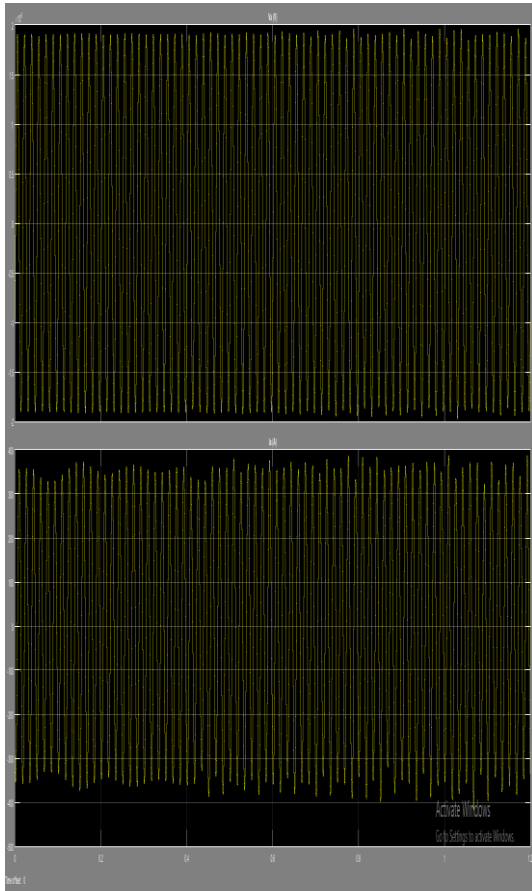**Fig 3:** Output Waveform of PV Panel

Fig 4: Output Waveform of Grid

In MATLAB Simulink Simulation starts with standard test conditions (25 deg. C, 1000 W/m^2).

From t=0 sec to t= 0.3 sec,duty cycle of boost converter is fixed (D= 0.5 as shown on PV scope). Resulting PV voltage is therefore V= (1-D)*Vdc.The PV array output power is 96 MW. Whereas specified maximum power with a 1000 W/m^2 irradiance is 100.7 MW. Phase A voltage and current at 25 MV bus are in phase (unity power factor) by observing ON grid scope.

At t=0.3 sec The MPPT is becomes enabled. By varying duty cycle in order to extract maximum power the MPPT regulator starts regulating PV voltage. When duty cycle is D=0.453 then Maximum power (100.7 MW) is obtained.

From t=0.3 sec to t=0.5 sec, the PV array operates at standard test conditions (25 deg. C, 1000 W/m^2). Duty cycle D varies between 0.450 and 0.459. PV voltage = 2735 V (Nser * Vmp=50*54.7= 2735 V) and mean power = 100.7 MW is expected from PV module specifications.

From t=0.5 sec to t=1.0 sec, sun irradiance is ramped down from 1000 W/m^2 to 250 W/m^2. It

can be seen that this type of MPPT controller tracks maximum power only while irradiance stays constant.

From t=1.0 sec to t=1.5 sec when irradiance stays constant and equal to 250 W/m^2, duty cycle D varies between 0.466 and 0.474. Corresponding PV voltage and powerare V_PV= 2650V and Pmean =24.4MW.

From t=1.5 sec to t=6.0 sec sun irradiance is restored back to 1000 W/m^2 and then temperature is varied between 50 deg. C. and 0 deg C. in order to observe impact of temperature observe the PV output power (107.5MW) at minimum temperature.

V. CONCLUSION
The Simulation of designed PV power system by using MATLAB Simulink, Its made possible the testing and observations of its stability and efficiency. In this proposed model Solar panels take sunlight irradiance and cell temperature as input parameters. We can analyse I-V and PV output characteristics under various conditions are obtained. Sun power PV module can be easily applied with other PV module parameters. By using DC-DC boost converter the output voltage of PV module is increased and also reduces the total harmonic distortion by VSC controller. In this proposed module successfully100MW power is generated and fed to the grid and improving the efficiency of the grid system.

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