International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 8 Issue 2, March-April 2024 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Performance of Grid Connected Solar PV Power Plant at Clear Sky Day

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ABSTRACT

Nowadays, solar PV based electricity generation become a popular and commonly used renewable energy system (RES) due to their advantages. The interest for sustainable imperativeness-based power production has been expanded due to numerous reasons, such as to reduce the level of carbon outflow, to limit the utilization of non-renewable energy source and to keep up the environment pollution free. Among the sustainable resources, solar energy has increased a lot of consideration by scientists in the ongoing many years everywhere on the world. This paper is presented the performance of grid-connected 40 MW large PV power plant in this paper is modelled by using MATLAB/SIMULINK. The grid voltage and power on the transmission grid have been verified by the simulation results.

KEYWORDS: *Grid connected PV Plant, DC DC Converter, Transformer, PV panel, Inverter*

How to cite this paper: Khin Moe Moe | Hla Aye Thar "Performance of Grid Connected Solar PV Power Plant at Clear Sky Day" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-8 | Issue-2, April 2024, pp.348-351, URL: www.ijtsrd.com/papers/ijtsrd64649.pdf

IJTSRD64649

INTRODUCTION

Energy demand is on the rise all over the world. In the past, the majority of energy demand came from fossil fuels such as coal, oil and gas. Analysts and researchers are trying to find alternatives to meet the demand. Sustainable energy sources such as solar power, wind power, biomass and others are cost-effective and pollution-free ways to provide environmentally friendly energy to a broad range of uses. Among the renewable energy sources, solar energy is the most popular choice due to its availability and its potential for a wide range of applications. PV systems are used to generate electricity in areas where power lines cannot reach. This technology has been widely used and integrated into the utility grid in developed countries, and is now the main use of PV systems [1]. One of the reasons why this is becoming more and more popular is because of all the advantages that RES can bring to the table when it comes to distributed generation power [2]. In PV systems connected to the grid, solar-based modules convert DC to AC to generate capacity to the utility, and a variety of topologies are used for this purpose [3]. This paper is presented the modelling and simulation of grid-connected solar PV power plant at clear sky day.

GRID CONNECTED SOLAR PV POWER SYSTEM

Photovoltaic systems are categorized into two major classes. There are grid-connected photovoltaic systems and stand-alone photovoltaic systems. Grid-connected systems are made up of a number of modules and a power conditioning equipment with an inverter to change the DC electricity from the photovoltaic cells into the AC required by the grid. Grid-connected photovoltaic systems are collected of PV arrays related to the grid through a power get used to unit and are intended to control in similar with the electric utility grid. The power plant used to include the MPPT, the inverter, the grid interface as well as the control system needed for effective system performance [1].The output voltage/intensity of PV system is low and should be improved for the applications like grid- tied PV system, water pumping system and so on Subsequently DC-DC converter assumes a huge function in the engineering of grid tied PV system [4]. Inverter is valuable in changing over DC capacity to AC power for various applications. The PV array, MPPT, DC-DC converter, inverter and control algorithm have to be operated in synchronism to improve the overall efficiency of this complete system.Fig.1 is shown Grid Connected PV Power System.

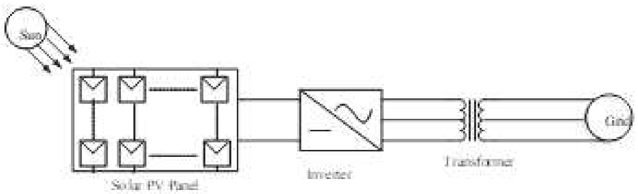

Fig.1 Grid Connected Solar PV Power System

COMPONENT OF GRID CONNECTED SOLAR PV PLANT

Photovoltaic panels connected to the utility grid provide energy for grid-connected photovoltaic power systems. Grid connected power systems comprise of PV panels, Solar inverters, DC DC Converter, and transformer.

A. Photovoltaic module

Solar modules produce DC power directly from sunshine. One or more modules are used conditional on the power requirements and the amount of sunshine obtainable. The modules are characterized the basic structure unit of a photovoltaic generator. The structure of a module is constructed on crystalline or semi-crystalline silicon cells. The cells in a module are connected in series. The reason approaches from the electrical characteristic of an individual solar cell. The nominal output is typically called the highest power of a module, and expressed in peak watts, W. The three greatest important electrical characteristics of a module are the short-circuit current, open-circuit voltage and the maximum power point as functions of the temperature and irradiance [5].

B. Maximum Power Point Tracking

MPPT is executed in PV system to constantly track the maximum power point for a specified solar irradiance and temperature. Maximum power point is the voltage at which the photovoltaic module can generate its maximum power. MPPT is applied using P & O algorithm because it has simple application and the tracking time is rapid. This system perturbs the operating voltage to certify maximum power point. The increase/ decrease in voltage depends on the difference between power produced at the current instantaneous and the current is previous instant. The output of the PV Panel is given to the boost converter. The boost converter steps up the voltage up to a level so that inverter produces system voltage [6].

C. Inverter

In grid connected PV system inverter are used for interfacing the utility grid. Inverter is a device that transforms DC from PV array to AC power. Photovoltaic modules produce DC power. Most load are scheme to operate on AC electrical power. Inverters are very essential part of PV systems where alternating current output power is necessary. The DC-DC Converter is to certify constant DC input into DC-AC inverter because of deviation of PV output due to fluctuating environmental temperature, irradiance and the effect of maximum power point tracking. The inverter is scheme to track the maximum power points of the PV so as to improve power production and as well support additional services similar reactive power control and frequency parameter. Grid- tied system inverter will execute both MPPT and grid synchronization [7]. A continuous current injection will make sure the constant voltage of the DC-link and limited deviation in the output voltage variation. Therefore, the inverter will get the constant input DC voltage, which is necessary to improve the performance and efficiency of an inverter [8].

SIMULATION AND RESULTS

The Simulink model of grid connected solar PV power plant is shown in Fig. 2. The Simulink model is obtained by using Matlab/Simulink. To observe and analyze the performance of the system, measurements are carried out at PV output and grid voltage at a clear sky day. For the operation of the system, a PV module is utilized as the primary source in the model. The PV array consists of 20 modules series string and 396 parallel strings. There are 20 arrays are used.

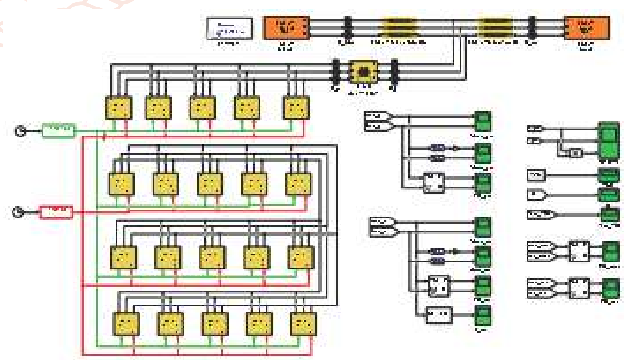

Fig.2 Simulink model of grid connected PV power plant

In this simulation, the input irradiation and temperature to the PV system are set as clear sky day data. The Active and Reactive Power of large PV Power Plant and Grid voltage are as shown in the following figures.

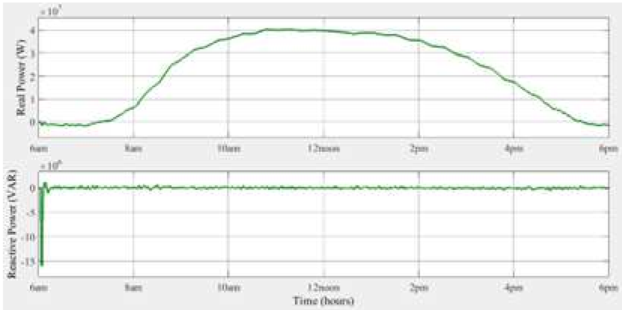

Fig.3 Simulation Result of Primary Real Power and Reactive Power

In Fig. 3, In solar power plant, the primary real power output is zero at starting and than singnificantly increase to 40 MW at noon. And then frequently decreased to zero at sunset. The reactive power is maintain at about zero according to the simulation result

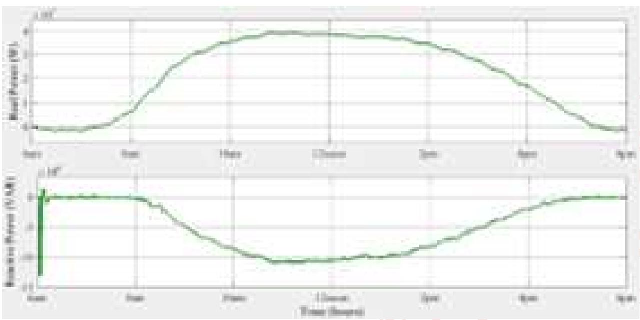

Fig.4 Simulation Result of Secondary Real Power and Reactive Power

Fig:4 is shown the secondary real power and reactive power. The secondly real power output is zero at starting and than singnificantly increase to nearly 40 MW at noon. and then frequently decreased to zero at sunset. The reactive power is -10 MVAR at noon as shown in figure. The reactive power is taken from the grid.

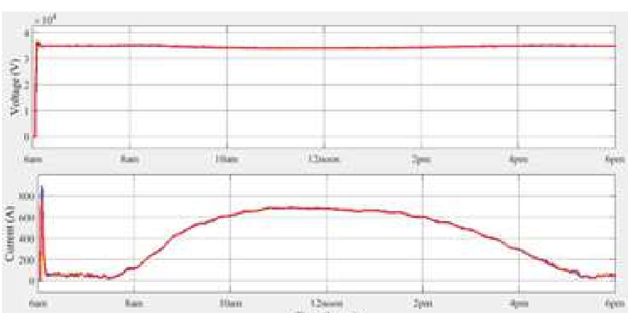

Fig.5 Simulation Result of Primary Voltage and Current of Transformer

Fig. 5 is shown the primary voltage and current of grid side Transformer. The primary voltage is about 33 kV and the current is over 600 A at maximum power condition.

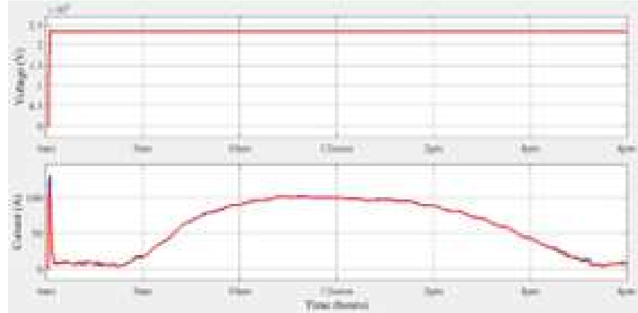

Fig.6 Simulation Result of Voltage and Current of 230 kV Transmission Line

Fig. 6 is shown the secondary voltage and current of grid side Transformer. The secondary voltage is about 230 kV and the current is about 100 A as shown in Fig.5.

CONCLUSION

In this paper, the generated power from solar power plant is injected to the grid on 230 kV transmission Line. With Solar PV Power Plant, the power flow to the grid is depends on the irradiation condition. the simulations are executed with actual radiation data for a clear sky day. Measurements are carried out for voltages and power flows. the primary maximum real power output is 40 MW at noon. The reactive power is maintain at about zero. The secondary real power is nearly 40 MW at noon and reactive power is -10 MVAR at noon and the reactive power is taken from the grid. The primary voltage is about 33 kV and the current is over 600 A at maximum power condition. The grid side voltage is about 230 kV and the current is about 100 A. The grid connected PV power plant is very popular for all over the world and can sold electricity to connected the grid.

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