MODELLING AND CONTROLLING OF MICROGRID

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***Abstract*—In the recent trend of using green energy, grid-connected photovoltaic (PV) systems are becoming more and more popular. This paper presents a simpler approach to modeling a 3MW grid-connected photovoltaic (PV) system using MATLAB/Simulink. The proposed model consists of 1D Look up block, PV array, maximum power point tracking, Boost converter, inverter. The modeling of these components was described and demonstrated in detail. The maximum power is taken from the PV array under different environmental conditions. The effect of solar radiation and temperature on the total energy production of a grid-connected photovoltaic system was studied. The modeling method is quite simple and can be easily used to study the characteristics of the system under different conditions of temperature and solar radiation.**

Photovoltaic system, inverter control, PV array, Maximum Power Point Tracker, Boost converter.

I. INTRODUCTION

Most of the world's energy comes from fossil fuels, mainly by burning coal. However, this traditional way of generating electricity is a challenging problem as it contributes to greenhouse gas emissions. In addition, fossil fuels and all non-renewable sources of electricity generation will also be depleted over time and the population will increase. On the other hand, renewable energy sources offer promising alternative solutions to these problems, as they are considered permanent and clean resources. Therefore, these problems are currently being addressed by adopting renewable sources that include solar photovoltaic, wind, tidal, wave and biomass as alternative sources of electricity generation. Over the last few decades, solar photovoltaic energy has turned into one of the important sources of renewable energy because it requires less maintenance and is noise and pollution free. Solar PV panels are used with power converters to deliver power efficiently. This constitutes a photovoltaic system. There are different configurations of PV systems. Among these stand-alone and networked system configurations are the most important. A grid-tied solar system has more advantages than a stand-alone PV system because electricity can be taken from or sent to the grid depending on the load demand. It reduces the cost of the bill because the net electricity consumption can be reduced by sending more electricity to the grid. They can also be installed without a backup battery. Any PV system installed without battery backup produces more energy because there is no storage loss in the system. In this paper, a 3MW grid-connected PV system was modeled using MATLAB /Simulink. The presented system consists of a 1D look up block to give input to the solar PV array, a maximum power tracker for extracting the maximum power from the PV array, a DC-DC boost converter for regulating and boosting the output of the PV array, an inverter for converting DC power to AC power.

II. LITERATURE SURVEY

The demand for more power combined with interest in clean technologies has driven researchers to develop distributed power generation systems using renewable energy sources. On the other hand, the integration of a large number of distributed generations into distribution networks is restricted due to the capacity limitation of the distribution networks and their unidirectional power flow behavior. Such barriers leads to find alternative solutions to enhance the integration of distributed generation into the distribution networks. An alternative approach called "Micro-grid" was proposed as a means of integrating distributed generations into the distribution networks. Micro-grid (MG) is the combination of loads, micro-generation (or distributed generation) units, storage systems, and associated power conditioning units that operates as a single controllable system and provides power or both power and heat to loads. Distributed generation in micro-grid operation can provide benefits to the utility operators, distributed generation owners and consumers in terms of reliable power supply, efficient power transmission, reduction in

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transmission system expansion, and enhancement of renewable power penetration. MG systems configuration depends on the size and nature of the micro-generation units in the micro-grid, as well as the site and the availability of the primary energy resources on the site, especially for renewable power sources. Microgrids are local power systems of different size, operating inside the distribution systems.” Due to their ability to: reduce environmental impact, reduce investment in power plant construction, equipment and cost, increasing energy stable efficiency, ride-through capability provided by energy storage, and alleviate consequences of sudden grid outages microgrids are becoming popular. Renewable energy sources like the wind, solar energy, and hydro are cost-effective in meeting their share of the energy requirement. As to power supply, the microgrid technology provides important opportunities in remote communities with improved local energy security. This technology is highly contributing in assuring more secure energy by reducing the need to import energy.” By connecting renewable energy microgrid to the utility grid, no additional effort is needed for frequency regulation. The most relevant challenges in microgrid consist of: stability, bidirectional power flow, modeling, low less inertia, the effect of load

10 perturbation, and uncertainty. Microgrids are small-scale energy grids, where renewable energy generation and storage technologies are integrated to provide adequate energy supply to cover regional demand. There are a various set of benefits stemmed from microgrids, including but not limited to, enriched reliability by enabling self-healing, enhanced resiliency by responding to extreme events and utility grid supply interruptions, increased efficiency by reducing losses, deferred transmission and distribution upgrades by providing a local supply of loads, and enhanced integration of approachable and adjustable loads.

From a technical perspective, there are significant drawbacks in integration of renewable energy resources to the electric power system. source of renewable energy, solar, is significantly dependent on meteorological factors. This resource is highly unpredictable and cause considerable variability in power generation. Two major characteristics of renewable generation are intermittency (i.e., not always available such as solar generation which is not available during nighttime), and volatility solar generation which could radically change as the cloud cover changes).

III. Methodology

A. 1D lookup block

The 1D view table interacts with the given data and input values to generate the output signal.The block maps inputs to output values by looking at or appending a table of values that you define using block parameter. It supports Block, Flat, Linear (Linear point slope), Lagrangian (Linear Lagrangian), Nearest, Cubic Spline, and interpolation methods. Here, we have used 1D lookup table to upload the input excel sheet in which irradiance data of sun depending on the time is given. So through this 1D lookup table we can give this input data to the Solar PV panel.

B. PV array

If photovoltaic solar panels consist of individual photovoltaic cells connected together, then a Solar Photovoltaic Array, also known simply as a Solar Array, is a system made up of a group of solar panels connected together. So a photovoltaic array is multiple solar panels that are electrically connected together to form a much larger photovoltaic installation (PV system) called an array, and in general, the larger the total area of the array, the more solar electricity it produces. Photovoltaic cells and panels convert solar energy into direct current (DC) electricity. Connecting solar panels in one photovoltaic field is the same as for PV cells in one panel. Panels in an array can be electrically connected together either in series, in parallel, or a mixture of both, but generally a series connection is chosen to increase the output voltage. For example, when two solar panels are connected in series, their voltage doubles while the current remains the same.

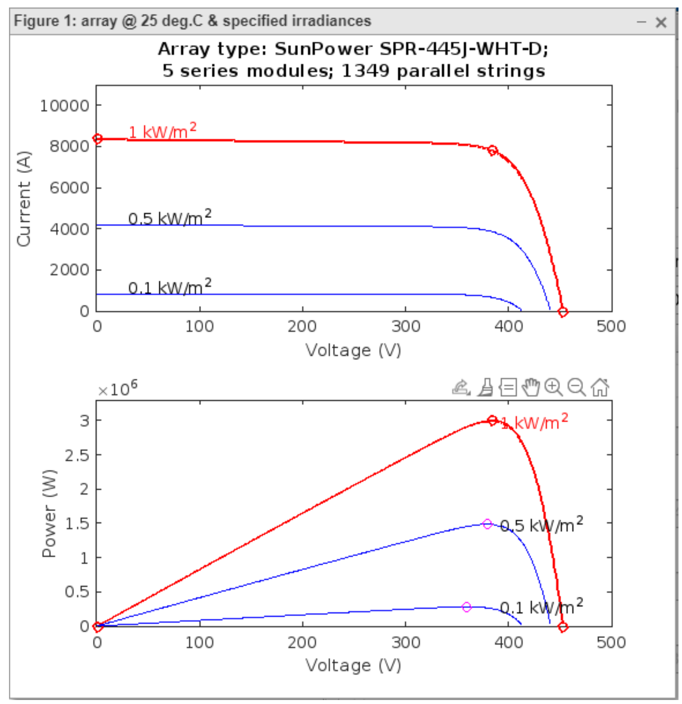

Fig. 1. I-V and P-V characteristics of complete array at constant temperature.

C. Maximum Power Point Tracker (MPPT)

Automatically change the loading conditions of the PV array so that it can produce maximum output power. This is necessary because the PV cell has non-linear current-voltage characteristics. As the current draw increases, the power delivered by the field increases to some extent. The maximum power point (MPP) is at the knee of the curve. Any additional current drawn from the array results in a rapid drop in cell voltage, reducing the output power of the array. The goal of the MPPT subsystem is to determine exactly where this point is and regulate the current accordingly. Aging effects and external factors such as temperature and partial field shading make locating and tracking the point of maximum power a bit more challenging. In most cases, there is only one maximum. However, rapid changes in irradiance (moving clouds) or temperature (rain, etc.) can briefly introduce multiple local maxima.

D. Boost Converter

A DC-DC boost converter is used to boost and regulate the output voltage of the PV array and to implement Maximum power point tracking.

E. Inverter

Three-phase three level voltage source converter has been used to convert DC power into AC. Capacitors at the output of boost converter provide neutral point N for the inverter. Gate signals at the inverter controls the IGBT switches on and off period.

IV. Discussion and simulation results

In this project we have simulated grid connected solar PV system in MATLAB software. Here we have to give variable input (variable irradiance) to the Solar PV panel keeping the temperature constant, to get variable output (voltage, current, power) according to the time. The simulation of the system is shown in the figure 2. Here we have imported the variable input (which was in excel sheet format) in the 1D lookup block which is connected to the solar PV array. There is a boost converter which is connected to the output of the solar PV array and it consists of IGBT whose gate is connected to the MPPT. The high DC output of the boost converter is then converted to AC through an inverter and will be fed to the grid. The grid connected PV system is employed beneath

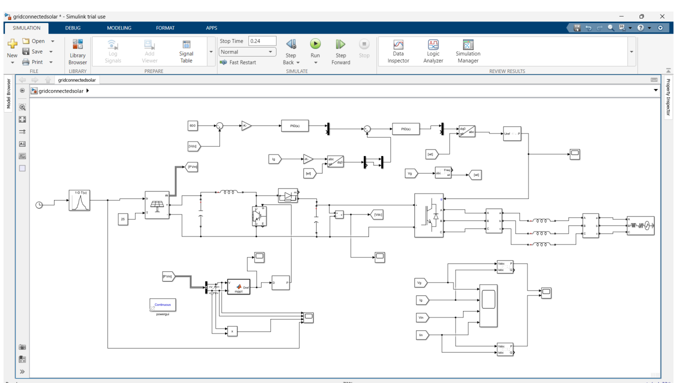

Fig. 2. 3 MW grid connected solar PV system.

variable irradiance with constant ambient temperature. The result of this system is explained in three different stages which is shown in figure 3. In the first stage, the irradiation is increased from minimum to maximum. In this stage the current and power increases as irradiance increases. In second stage we have tried to keep irradiance constant. Here we can see that DC voltage is obtained from DC-DC converter and is fed to the voltage source inverter for the conversion of DC into the AC. In the third stage irradiation is decreased from maximum to minimum. Here we can see that the current and power decreases as irradiance decreases.

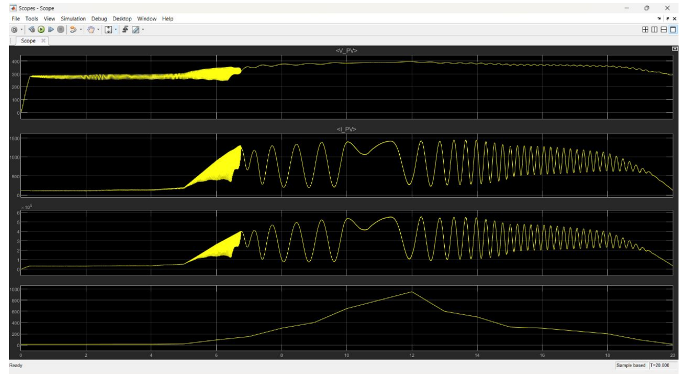

Fig. 3. Voltage, Current, Power, Irradiance during the variation of irradiation.

V. Conclusion

In the present work, the MPPT solution in order to interconnect the Solar PV system of 3 MW with the utility grid is presented and the results are discussed above. PO and MPPT algorithm is used for obtaining Maximum Power Point from the PV array. The simulation results have shown the dynamic behavior of this system under variable irradiation conditions. Various PWM algorithm can be used in future scope of this work or we can show how to vary temperature as we varied the irradiance in future work.

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