International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Modified MPPT Algorithm for PV System Based on P&O

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ABSTRACT

Maximum Power Point Tracking MPPT technology is an important part of the design of solar PV systems to maximize the output power of PV arrays that vary with weather conditions. Although several technologies have been developed, Perturb and Observe P & O are widely used for MPPT due to their low cost and easy implementation. However, the main drawbacks of this method are low convergence time, high vibration around the maximum power point, and drift problems associated with fast illumination changes. This dissertation presents a P&O Based MPPT Techniques. To evaluate this change, the existing P&O method and the changed P&O method are simulated by MATLABSIMULINK. The simulation results show that the very effective in solving the existing P&OMPTT problem.

LIST OF ABBREVIATION

AGC- Automatic Generation Control
ATP- Alternative Transient Program
BEGED -Breakeven Grid Extension Distance
BESS- Battery Energy Storage System
CAES- Compressed Air Energy Storage
CERTS -Consortium for Electric Reliability Technology Solutions
CHP- Combined Heat and Power
CM- CERTS MICROGRID

I.INTRODUCTION

The power system consists of four sections: power generation, power transmission, power conversion, and power consumption. In remote farms, forest farms, and islands, it is not easy to set up transmission and transmission systems for small power demands. In addition, storms and other catastrophic events will cause power outages to continue to the plate. Global warming is of great concern, and shifting energy production based on renewable energy production is an excellent way to reduce fossil fuel emissions. Therefore, for these reasons, it is necessary to build a renewable energy system outside the grid. One of the benefits of mixing different power sources is to provide sustainable power in areas that conventional power grids cannot supply. They are instrumental in many applications, but due to their non-linearity, hybrid energy systems have been proposed to overcome this problem and make essential improvements. In general, hybridization involves combining multiple energy and storage units in the same approach to optimize production and energy management. The combination of renewable energy sources, wind & solar are used for generating power called as wind solar hybrid system. This system is designed using the solar panels and small wind turbines generators for generating electricity. To better understand the working of solar wind hybrid system, we must know the working of solar energy system and wind energy system. Solar power system can be defined as the system that uses solar energy for power generation with solar panels. The block diagram of solar wind hybrid system is shown in the figure in which the solar panels and wind turbine are used for power generation. Wind energy is also one of the renewable energy resources that can be used for generating electrical energy with wind turbines coupled with generators.

II. RENEWABLE ENERGY TRENDS ACROSS THE GLOBE

The current trend in the developing economy has led to the expansion of renewable power. Over the past three years, Figure 1.3 shows that renewable energy and biomass energy account for a significant part of current renewable energy consumption. The recent development of solar photovoltaic

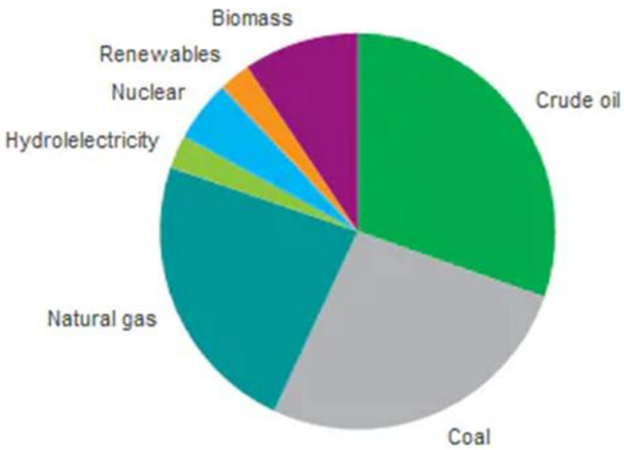

Figure 1: Global energy consumption in the year 2020

Knowledge or reliable introductions of projects in countries/regions such as Germany and Spain have also brought significant growth in the solar photovoltaic market. It is expected that there will be more than other renewable energy sources in the solar photovoltaic market. In 2019, more than 115 countries set political goals to achieve their predetermined role through renewable energy compared to 45 countries in 2005. Most of the objective is ambitious, reaching 30-90% of national production through renewable energy [7].

III. THE CONCEPT OF MICRO-GRIDS

1. Electrical Grid

The electricity grid connects power plants, transmission lines, or allotment lines to provide power to users. In power plants, electricity comes from renewable or non-renewable energy sources. The current is then transmitted from one place to another through the transmission line. Finally, the power is distributed among the users using distribution feeders. A micro-grid is defined as a "local grid that connects distributed energy sources with organized loads and is usually connected to the traditional central grid synchronously" [17]. Micro grid sources are called micro-sources: battery storage, solid oxide fuel cells, wind energy, solar energy, diesel generators, etc. Each source is proscribed in its way to connect it to the distribution network. The load is connected to a distributed network, and the micro-power source and the mains meet the power supply to the circulated network.

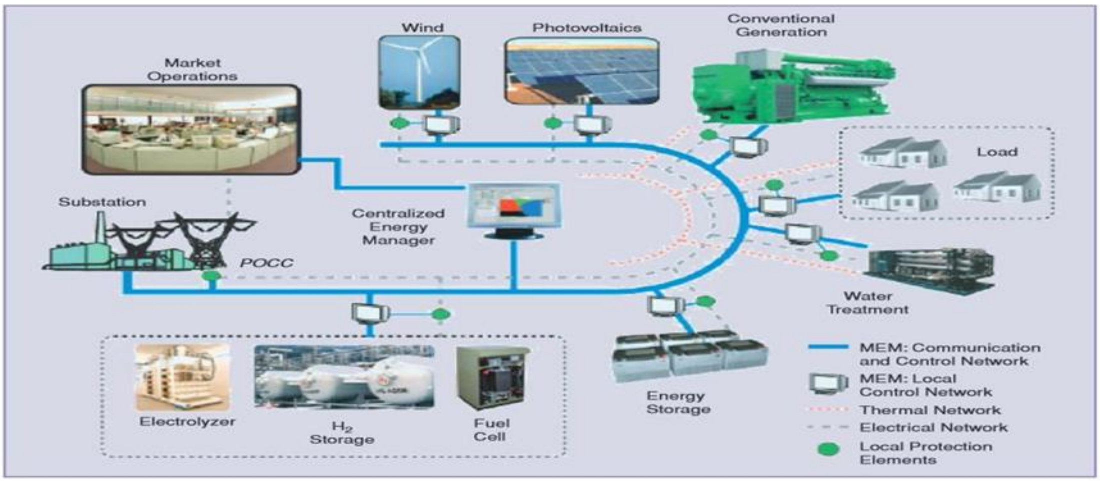

Figure 2.: Example of Micro Grid, GE MEM framework

2. The micro grid can operate in two modes-

Mains Connection Mode: Under normal operating conditions, the Micro grid is connected to the mains through a point coupling coil (PCC) and a circuit breaker (CB). The voltage and incidence of the Micro grid are synchronized with the mains.. The mains and the Micro grid share the power distribution to the distributed load. When the main is lacking power, the Micro grid source can provide excess power to balance the load. Similarly, suppose a fault occurs in one of the micro-power sources. In that case, the mains will provide extra power with the remaining active micro-power sources to balance the power shortage caused by the defective power source.

Island Mode: In the event of a mains failure, disconnect the MG from the mains on the PCC by operating a switch that separates the MG from the mains. After disconnection from the mains, the MG will work solely according to a predefined control strategy and supply power to the load by gradually increasing the power provided by all micro-sources. In this way, the load can be turned on, even during a power failure. If the load requirement exceeds the micro-source capacity in island mode, some non-emergency loads can be disconnected. Maintain mains voltage and frequency by operating at least one converter under V / f control. After troubleshooting, only when the voltage error is less than 3%, the frequency error is less than 0.1 Hz, or the phase angle error is less than 100 can MG be reconnected to the mains [3].

IV. BACKGROUND

A hybrid energy system is the engineering design of hybridizing power supply components or pairing them. For example, it is common to arrange multiple energy sources to work in parallel (equal) to the power supply. Therefore, hybridization is defined as hybrids that form paired reagents to work together to achieve a goal. Thus, hybrid refers to the manual and automatic adaptation of a power source or two and more components to provide power to the plate, thus creating a hybrid power system. A hybrid energy system is an infrastructure design that integrats diverse and multiple energy converters to energy storage, energy regulator, and energy management system .In general, the Hybrid Renewable Energy System (HRES) is an extension of the HES, which uses various hybrid energy sources as hybrid energy or new hybrid renewable energy sources to provide the energy system.

V.PROPOSED SYSTEM AND RESULT DISCUSSION

The entire system has been modelled on MATLA Simulink. The block diagram of the solar PV panel is shown in Figure 4.1 The inputs to the solar PV panel are temperature, solar irradiation, number of solar cells in series and number of rows of solar cells in parallel

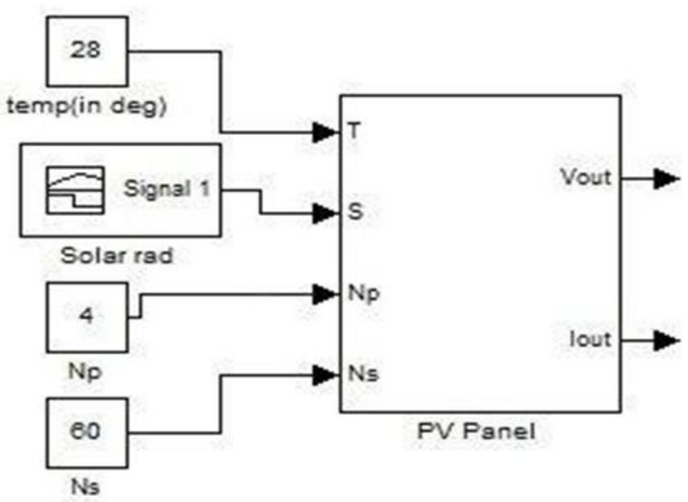

Figure 3 : Masked block diagram of the modeled solar PV panel

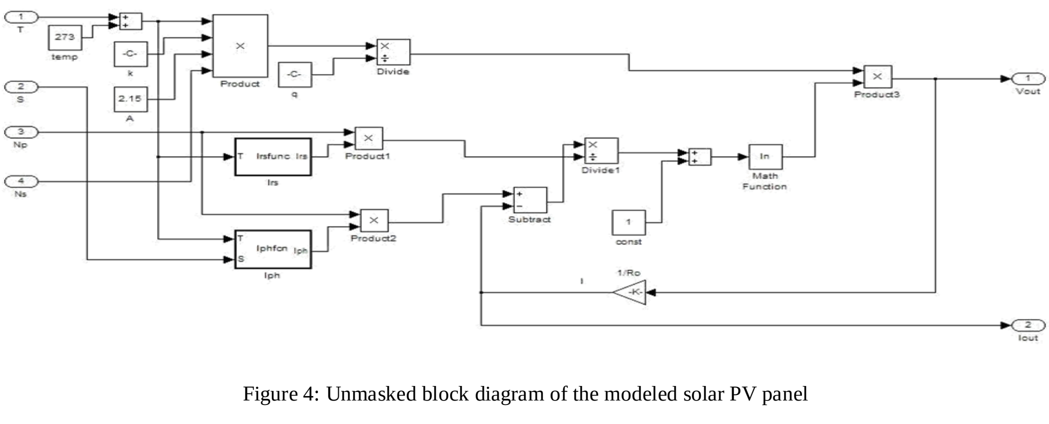

Figure 4: Unmasked block diagram of the modeled solar PV panel

The simulation is carried out for a cell surface temperature of 28° C, 60 solar cells in series and 4 rows of solar cells in parallel. The irradiation (shown in Figure 5.3) is taken to be varying, to reflect real life conditions and effectively show the use of an MPPT algorithm in field runs. It varies from 60 Watt per sq. cm. to 85 Watt per sq. cm, which is close to the day values of solar radiation received on the earth's surface. The simulation is run for a total of 0.12 seconds, with the irradiation taking up a new value every 0.03 seconds and staying constant for the consequent 0.03 seconds.

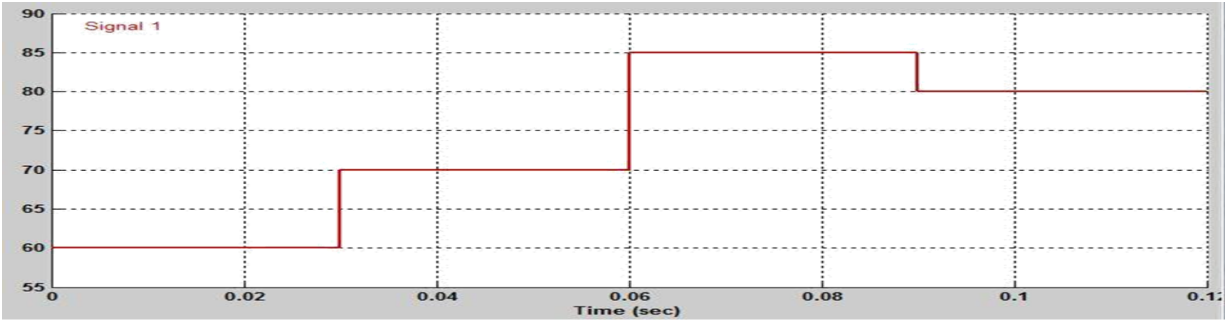

Figure 5 : Irradiation signal (Watt per sq. cm. versus time)

VI.Proposed system Simulink model

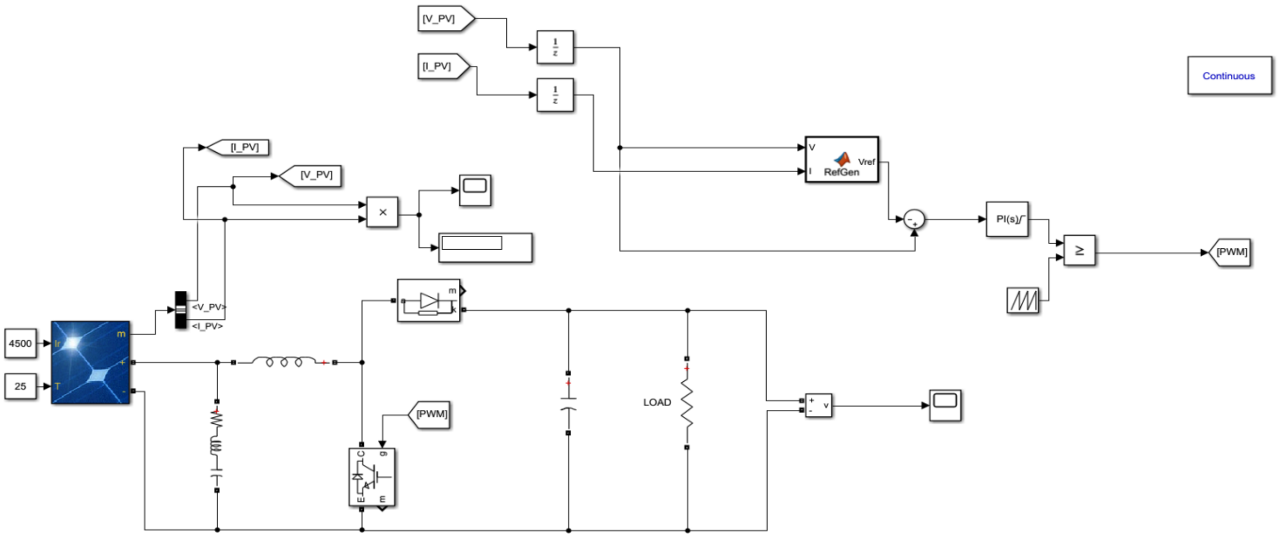

Figure 6 : MATLAB Simulink model of proposed system

VII. MPPT Interfacing

The controlled voltage source and the current source inverter have been used to interface the modeled panel with the rest of the system and the boost converter which are built using the SimPowerSystems module of MATLAB. The block diagram for the model shown in Figure 4.4 is a simulation for the case where we obtain a varying voltage output. This model is used to highlight the difference between the power obtained on using an MPPT algorithm and the power obtained without using an MPPT algorithm.

To compare the power output in both the cases stated above, the model is equipped with a manual switch as shown. When the switch is thrown to the left the circuit bypasses the MPPT algorithm and we obtain the desired power, voltage and current outputs through the respective scopes. Contrarily when the switch is thrown to the right, the embedded MPPT function block is included in the circuit and we obtain the desired outputs through the respective scopes.

VIII. Simulation results

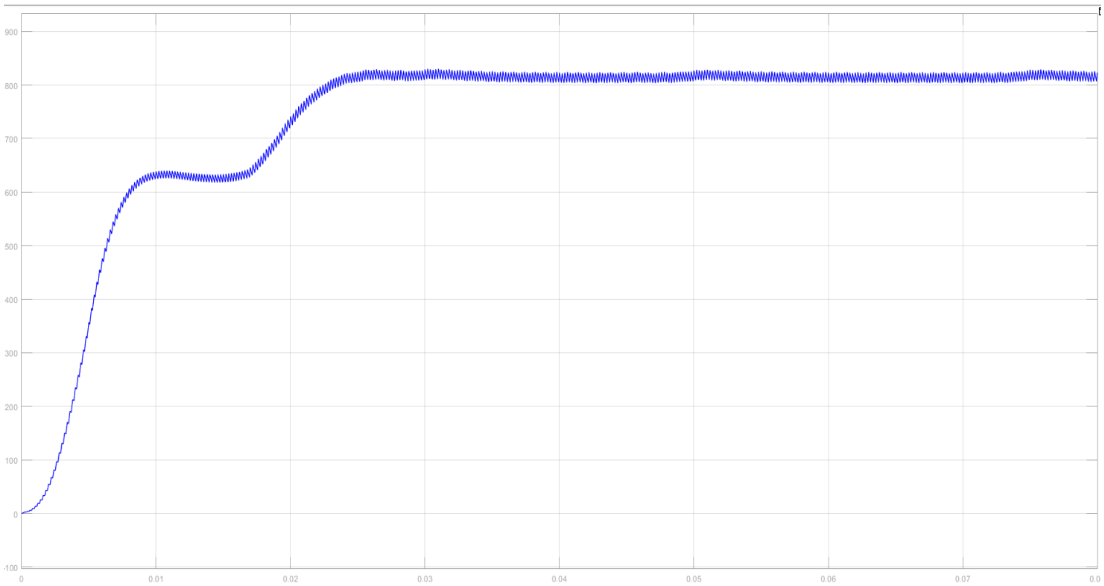

Figure 7 : output voltage without R-load

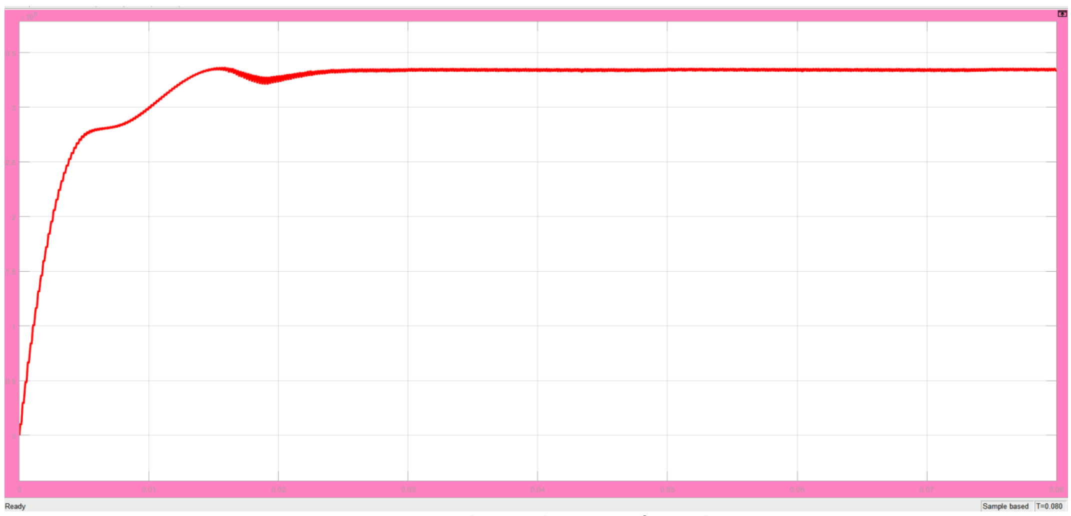

Figure 8 : input voltage with transient for irradiation

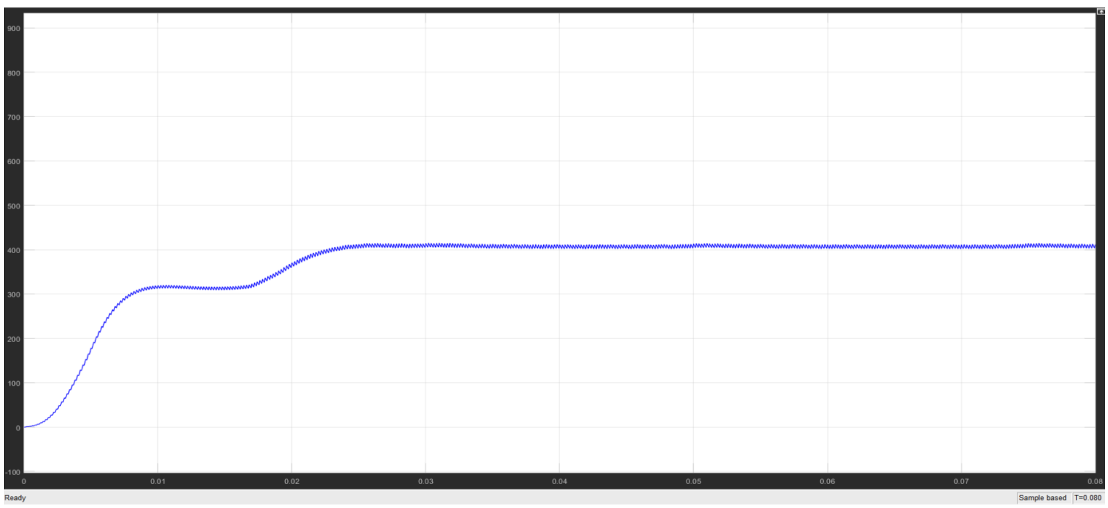

Figure 9 :output current for R-Load with transient for irradiation

IX. RESULT DISCUSSION AND CONCLUSION

The model shown in Figure 5.4 was simulated using SIMULINK and MATLAB. The plots obtained in the different scopes have been shown in above figure .The simulation was first run with the switch on no MPPT mode, bypassing the MPPT algorithm block in the circuit. It was seen that when we do not use an MPPT algorithm, the power obtained at the load side was around 95 Watts for a solar irradiation value of 85 Watts per sq. cm. It must be noted that the PV panel generated around 250 Watts power for this level of solar irradiation. Therefore, the conversion efficiency came out to be very low.

The simulation was then run with the switch on MPPT mode. This included the MPPT block in the circuit and the PI controller was fed the Vref as calculated by the P&O algorithm. Under the same irradiation conditions, the PV panel continued to generate around 250 Watts power. In this case, however, the power obtained at the load side was found to be around 215 Watts thus increasing the conversion efficiency of the photovoltaic system as a whole.

The loss of power from the available 250 Watts generated by the PV panel can be explained by switching losses in the high frequency PWM switching circuit and the inductive and capacity ve losses in the Boost Converter circuit.

Therefore, it was seen that using the Perturb & Observe MPPT technique increased the efficiency of the photovoltaic system by approximately 126% from an earlier output power of around 95 Watts to an obtained output power of around 215 Watts.

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