SOLAR BASED 100KW MICRO-GRID USING MPPT MODULE WITH PID CONTROLLER

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Abstract - Renewable Energy Source is now taking further attention for transubstantiating the new generation of electricity. The reason for this includes its dependability and lack of a final stoke. Now a days solar-powered production has gained more notoriety for providing electricity on a large-scale to small-scale basis. This paper binds the recent work development in the field of solar integration in the power world. It also focuses on a specific area of the MPPT operation from the work of several authors or experimental work. This paper describes the relative simulation study of Grid connected to MPPT (Maximum Power Point Tracking) algorithm. MPPT algorithms are important in PV systems because it's cost effective as it reduces the number of PV panels needed to achieve the desired power output. Proportional-integral controller parameter derivation (PID) is always based on checking set (system) characteristics. The two algorithms used in this paper for comparison are P&O (Perturbation and Observation) and Inc (Incremental Conductance). These algorithms are extensively used because of its minimal cost and ease of implementation. Important parameters such as voltage and output power vary from person to person & a combination of both algorithms are being created. MATLAB Simulink tool box has been used for performance evaluation of a solar based 100 kW micro-grid.

Index Terms - Solar PV (Photovoltaic) System, RES (Renewable energy sources), MPPT (Maximum Power Point Tracking), PID (Proportional Integral Derivative) Controller, Utility Grid

I. INTRODUCTION

Utility grids have become the world's leading mode of power supply over the last decade as demand for electricity has increased. However, some problems gradually arise, such as: Operational difficulty and high cost. Also, with the ever-increasing demand, it is difficult to meet safety and reliability requirements under load. The 2003 Northeast blackout fully exposed utility grid vulnerabilities and other problems. Micro-grids are therefore formally considered by our researchers. Prior to the 2003 Northeast Blackout, the concept of micro-grids was proposed in a 2002 Consortium for Electric Reliability Technology Solutions white paper. A micro-grid consisting of loads, distributed generation (DG), and energy storage can provide electricity and heat simultaneously. Power electronic devices convert power to the micro-grid and provide the necessary control to the micro-grid. By using various renewable energies, micro-grids can ensure uninterrupted power supply, improve the stability of the local power grid, and balance the voltage to the local power grid. We have P/Q control and droop control for the control objective. We are aware that the micro-grid's active and reactive power, voltage, current, and frequency are crucial parameters. To determine whether the effective performance of the micro-grid is stable, we can observe these parameters with meters. The relative error signal and the subsidiary error signal make up the activating sign. As a result, Necessary Control provides the impetus for subsidiary control activity: The relative blunder signal and the necessary of the mistake signal make up the activating sign for vital control activity. Consequently, even though a PID controller is one of the best controllers for control action systems, it also has some limitations and provides the actuating signal for integral control action. PID control is effective for many control actions, but it is not effective for optimal control. The main problem is with the feedback path. PID does not receive a process model. The PID is a linear system, and the derivative part is sensitive to noise. Noise can have a significant impact on output, even if it is only a small amount. To attain maximum module output power Maximum Power Point Tracking (MPPT) is used. The output power varies as a function of voltage in such a way that power generation can be optimized by varying the system voltage to find the maximum power point. This proposed method using PID Controller concludes that it is in effective in achieving MPPT in comparison to other models.

II. LITERATURE SURVEY

Kalman et al. [1] introduces Modern control concepts which began with the linear quadratic controller (LQR). The application of the predictive heuristic control (MPHC) model to large-scale industrial processes for more than a year. The micro-grid provides various methods for the distributing generation connecting to the grid. It helps to improves the reliability of the supply of electric power system. For the moment, the micro-grid application can be used to solve the power supply problem in some remote region and minimum is the loss in transmission. The control system in the micro-grid is a very remarkable in the field of research. In the conventional micro-grid control system, the proportional-integral-derivative (PID) based controllers are used broadly. It simplifies a complex system into the single-input, single-output loop. Thus, the conventional PID control has restrictions for the multiple-input and output (MIMO) or nonlinear control systems with limitations. However, the model predictive control (MPC) can be attained by resolving a finite horizon open-loop optimal control issue in real time. The optimization on control variables yields an optimal control variable sequence, and the first control variable in this sequence is applied to the control system.

Carlos et al. [2] stated with the improvement of industrial process control requirements, the traditional PID controller has been difficult to meet the complex industrial process. Thanks to MPC's research, it is widely used in industry. MPC can effectively overcome process uncertainty and non-linearity, and can also handle variable constraints in the process of variable control and variable manipulation. The MPC is used for regulating robust system identification. The data of temperature is collected for the control system identification. This article shows that the MPC approach outperforms current PID controllers and can be easily implemented in current digital process control computers. However, the application of MPC in electrical networks has been proposed in recent years. Traditional proportional-integral-derivative (PID) control is widely used in electrical systems. With the continuous improvement of customers' power and quality requirements, some other control methods have started to be applied in power systems. Among them, the application of hybrid MPC in a DG, i.e., two generators connected to a distribution network is demonstrated.

Bayindir et al. [3] explained micro-grid as a group of renewable energy sources and energy storage devices controlled by a supervisory system to supply electricity to the load for which it is designed. Energy may or may not include the local power grid. The electrical grid consists of two main systems, the transmission system, and the distribution system. Traditional grids consist of power stations from which electricity is transmitted to distribution centers and then to customers. The problem with this is that it is not completely reliable, and since the generation is far from the load, it is difficult to deal with disturbances that occur on the load side. On the other hand, micro-grids made up of distributed generation are better suited to these needs.

III. METHODOLOGY

(1)MPPT

MPPT (Maximum Power Point Tracking) is a method used to optimize the output power of a photovoltaic (PV) solar panel by adjusting the electrical load of the panel to match the maximum power point of the panel. The MPP is the point on the current-voltage (I-V) curve of a solar panel where the product of the current and voltage is maximized. The MPP depends on various factors, such as the intensity and angle of the sunlight, the temperature of the panel, and the characteristics of the panel itself.

The following is a typical methodology for MPPT:

- Measure the voltage and current output of the solar panel.
- Use a microcontroller or other control device to determine the power output of the panel from the voltage and current measurements.
- Adjust the load of the panel to ensure that the panel operates at the maximum power point.
- This is typically done by changing the duty cycle of a DC-DC converter that is connected to the panel.
- Continuously monitor the power output of the panel and adjust the load as necessary to maintain the maximum power point.
- The MPPT algorithm is typically implemented in software and uses a feedback loop to adjust the load of the solar panel in real-time based on the measured voltage and current output.
- The algorithm is designed to track changes in the operating conditions of the panel, such as changes in the intensity and angle of the sunlight.

MPPT is important for maximizing the efficiency and output power of a solar panel, which can lead to significant increases in energy generation and cost savings.

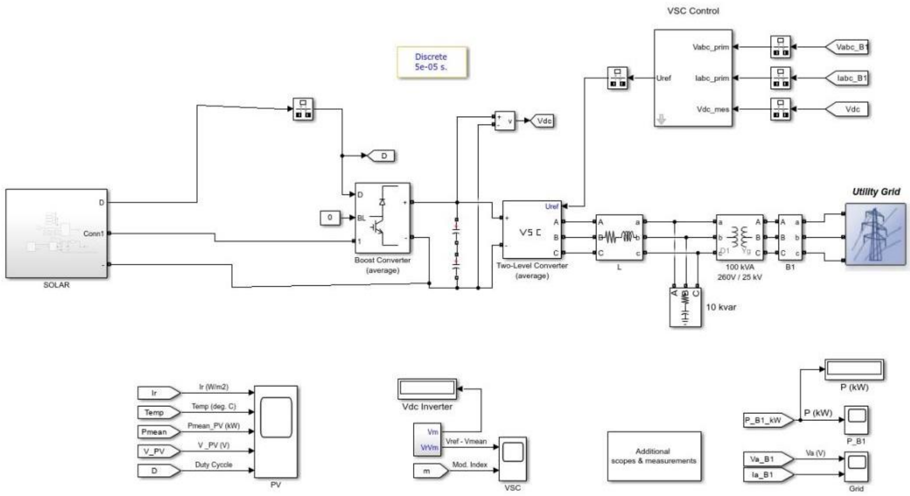

Figure 1: Before Simulation

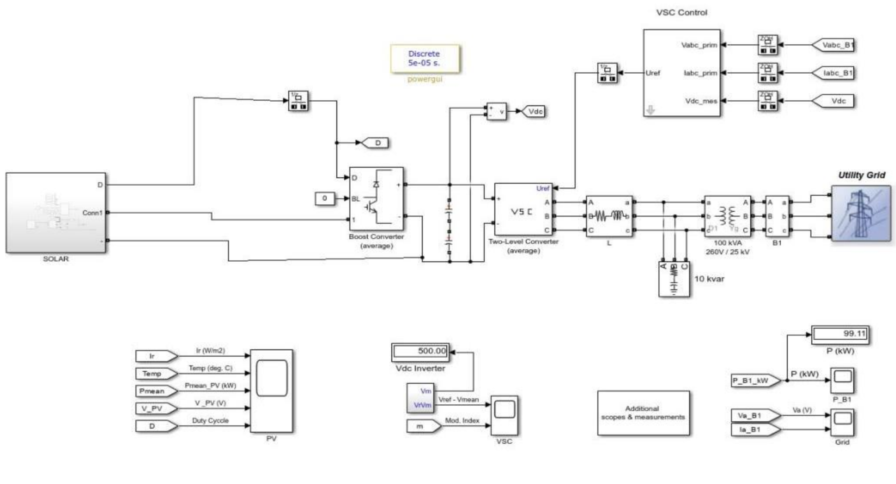

Figure 2: After Simulation

(2)Solar Panels

Solar panels are a renewable source of energy that does not produce harmful emissions, making them an environmentally friendly alternative to fossil fuels. However, the initial cost of installation can be high, and the amount of electricity generated by solar panels depends on factors such as the location and weather conditions.

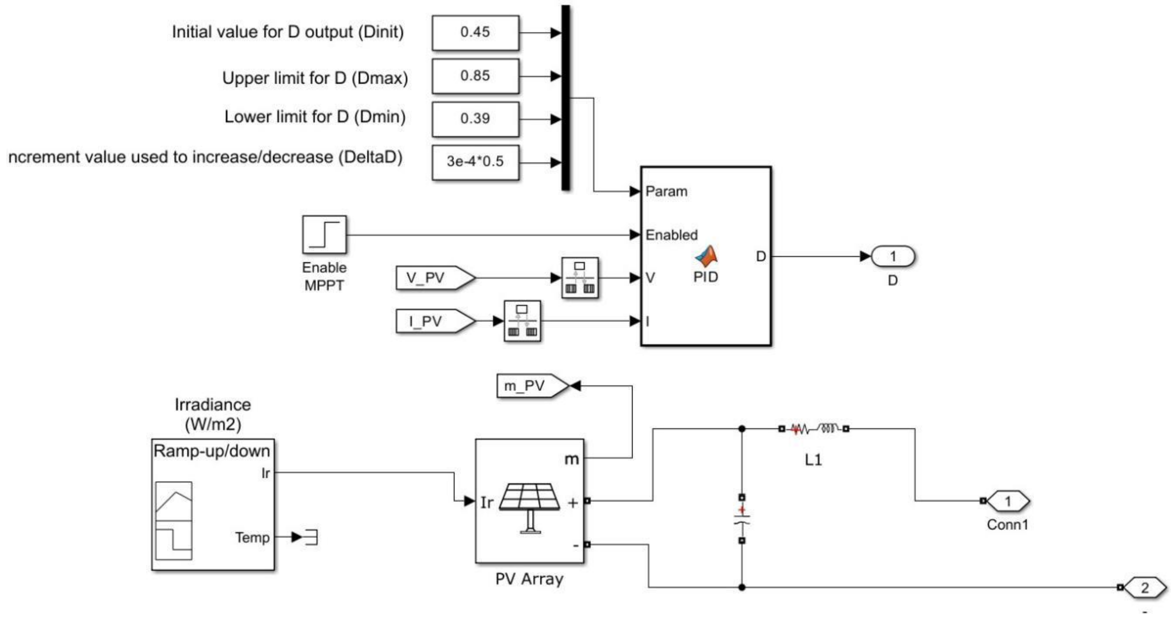

Figure 3: Solar PV System

The methodology for installing solar panels typically involves the following steps:

1. Site assessment: The first step is to evaluate the site where the solar panels will be installed. Factors to consider include the orientation of the roof, shading, and available space.

2. System design: Based on the site assessment, the solar panel system is designed. This includes determining the number and size of panels, the type of inverter, and the wiring and mounting system.

3. Permitting and interconnection: Before installation can begin, permits must be obtained from local government agencies. Additionally, the solar panel system must be interconnected with the local utility company's electrical grid.

4. Installation: Once the permits are in place and the interconnection is approved, the solar panels can be installed on the roof or on the ground. This typically involves attaching the panels to mounting racks and wiring them to the inverter.

5. Inspection and commissioning: After installation is complete, the solar panel system is inspected to ensure that it is functioning properly and meets all safety requirements. Once the system is approved, it can be commissioned and connected to the electrical grid.

6. Maintenance: Ongoing maintenance is required to ensure that the solar panel system continues to operate at maximum efficiency. This includes regular cleaning of the panels, monitoring of the inverter, and periodic inspections of the wiring and mounting system.

It is important to note that the specific methodology for installing solar panels may vary depending on factors such as the size and complexity of the system, local regulations, and the experience of the installer.

(3)Micro-grid

Microgrids can provide a range of benefits, including improved energy efficiency, reduced greenhouse gas emissions, increased reliability and resiliency of power supply, and potentially lower energy costs. They are particularly useful in remote or isolated areas, or in places where the traditional grid is unreliable or costly to maintain. They are also becoming increasingly popular in urban areas as a way to enhance grid resiliency and support the integration of renewable energy sources.Microgrids can be owned and operated by a variety of entities, including utilities, communities, businesses, or individual homeowners. The development and implementation of micro-grids require careful planning, design, and management to ensure their safe and effective operation, as well as compliance with relevant regulations and standards.

The methodology for designing and operating a micro-grid can be broken down into the following steps:

1. Define the system requirements: The first step is to determine the energy needs and goals of the micro-grid. This involves identifying the loads that need to be served, the desired level of reliability, and any other specific requirements such as renewable energy targets or grid independence.

2. Assess the available resources: The next step is to identify the potential energy resources that can be used to power the micro-grid. This includes evaluating the availability and reliability of renewable energy sources like solar, wind, and biomass, as well as the potential for energy storage and backup generation.

3. Design the system: Based on the system requirements and available resources, the micro-grid system can be designed. This involves selecting the appropriate components, sizing the equipment, and determining the optimal configuration to meet the desired performance criteria.

4. Implement the system: Once the system design is complete, the micro-grid components can be installed and integrated. This includes setting up the energy generation, storage, and distribution equipment, as well as implementing control and communication systems to manage the micro-grid.

5. Monitor and optimize the system: After the micro-grid is operational, ongoing monitoring and optimization are necessary to ensure that it is performing effectively and efficiently. This includes monitoring energy production and consumption, adjusting control strategies to optimize performance, and performing maintenance and repairs as needed.

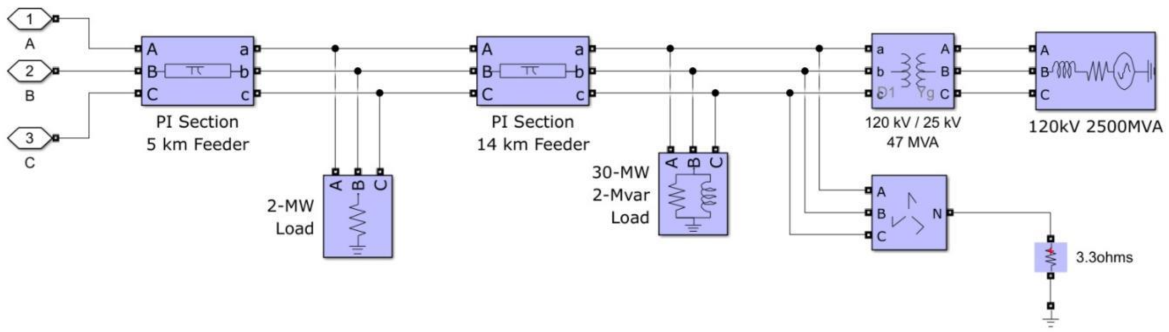

Figure 4: Utility Grid

Overall, the methodology for designing and operating a micro-grid involves a detailed analysis of energy requirements, available resources, and system design considerations to create a reliable, efficient, and sustainable energy system.

(4)PID Controller

PID stands for Proportional-Integral-Derivative, which is a control algorithm used to regulate and maintain a desired output value in a system. PID controllers are commonly used in industrial, mechanical, and electrical systems to control variables such as temperature, pressure, flow rate, and speed. The PID controller works by continuously measuring the error between the desired output value and the actual output value, and adjusting the system's input to minimize the error. The controller uses three types of control actions:
Proportional (P) Control: The controller output is directly proportional to the difference between the desired and actual output values. This control action helps reduce the error quickly but can result in overshoot or instability.
Integral (I) Control: The controller output is proportional to the accumulated error over time. This control action helps reduce steady-state errors and ensures that the system reaches the desired output value.
Derivative (D) Control: The controller output is proportional to the rate of change of the error. This control action helps to reduce overshoot and oscillations in the system.
The PID controller combines these three control actions to create a more accurate and stable control algorithm. The controller parameters are tuned based on the characteristics of the system, such as its response time, stability, and overshoot.

Overall, the PID controller is an important tool for controlling and maintaining the output of a system to ensure its efficient and stable operation

IV. PROPOSED SIMULATION

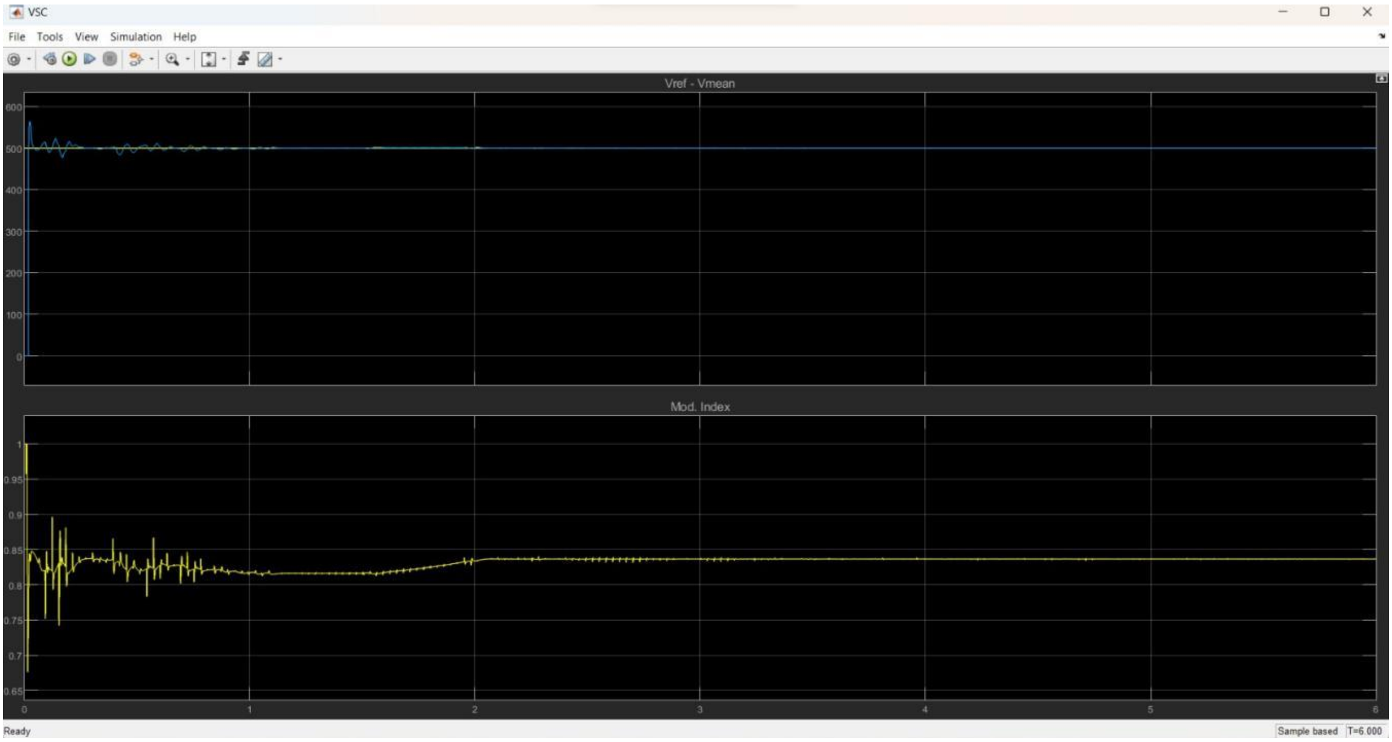

Figure 5: Graph Representing Vsc

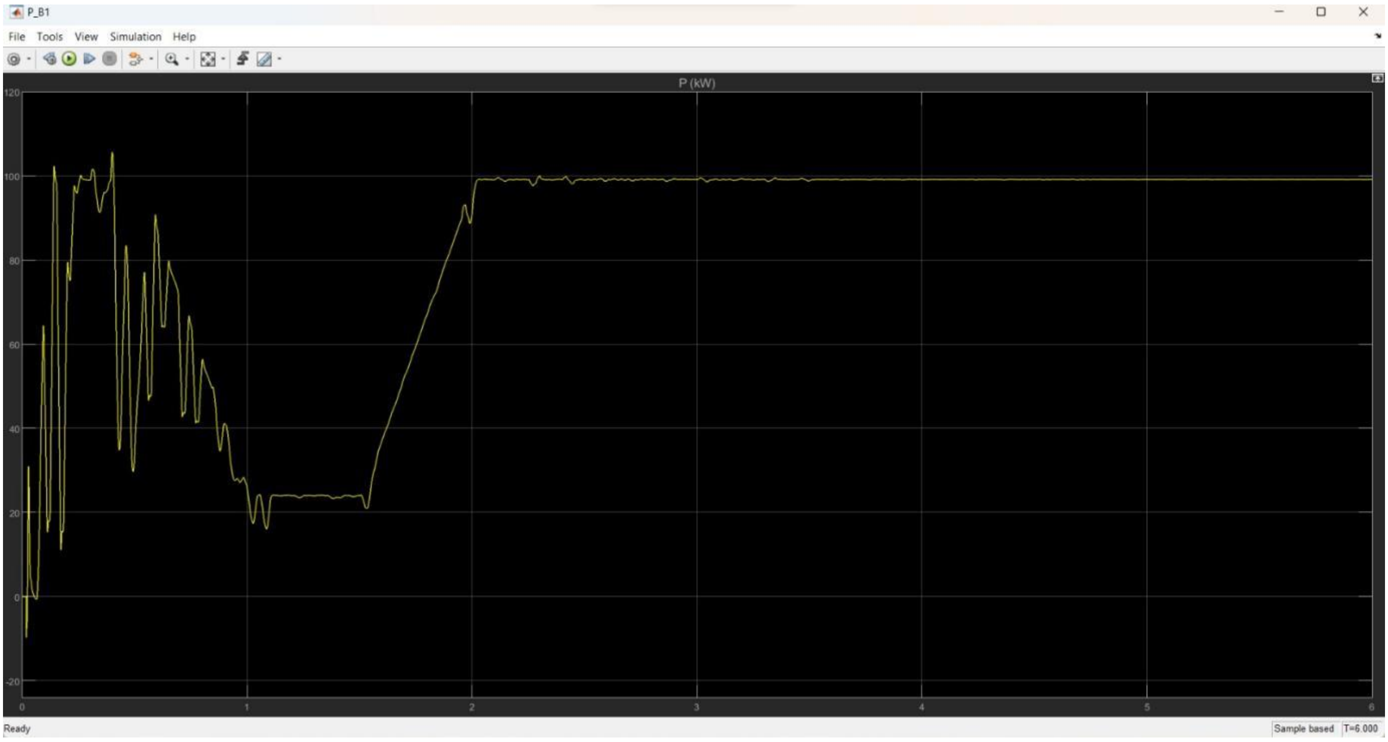

Figure 6: Graph Representing Power

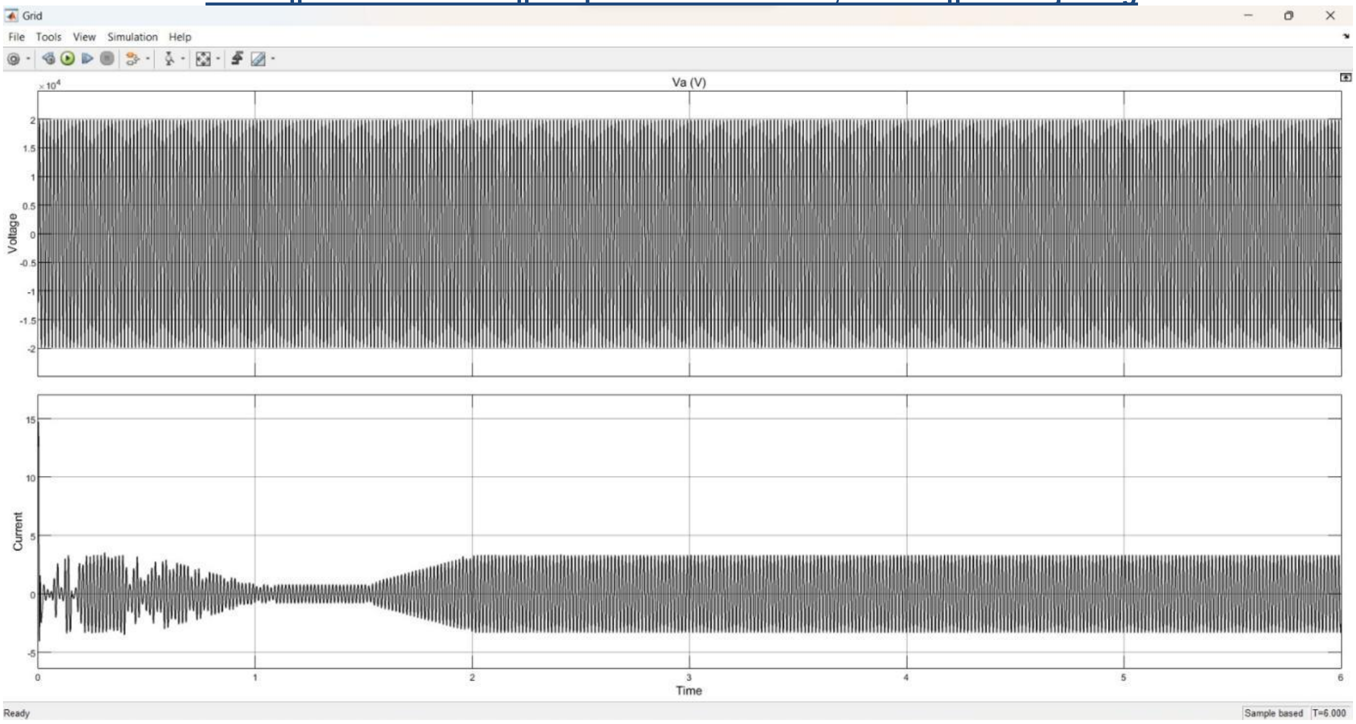

Figure 7: Grids Voltage and Current wrt. Time

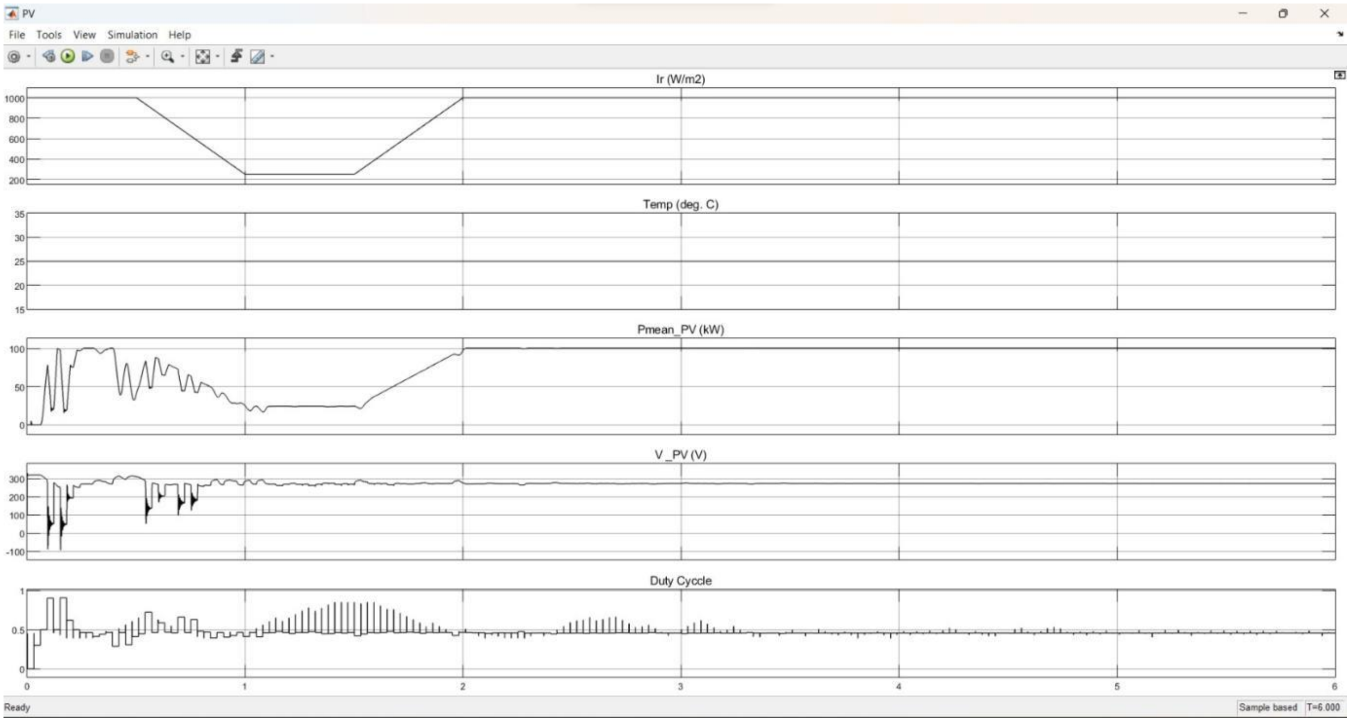

Figure 8: Temperature Duty Cycle

V. CONCLUSIONS

This thesis provides information on solar energy and micro-grids. It covers PV system models, advanced maximum power point tracking (MPPT) methods, and circuit structure analysis. This work designs a new MPPT method based on PID Controller. For this new method, MPPT is easy to implement, but sufficient data is needed to derive the necessary reference curves. The project aims to study the option of a direct current system and its feasibility. A 100-kW photovoltaic system (micro-grid) based on alternating current for this project. The DC voltage level chosen for this project was 350V because it can be used for distribution and consumption. To achieve this level of distribution voltage, the system requires a DC-DC converter. Simulink and PVsyst software are used to model DC-based photovoltaic systems. According to the results of Simulink and PVsyst, the power is calculated at 99.11 kW.

A DC system would have a slight cost advantage. The two main areas for reducing the cost of DC systems are power distribution and power electronics. It turns out that the DC system has a slight cost advantage when it comes to conductors, as it is designed for less current than AC, but not by much. However, this cost difference may be greater if the allocation period is longer. For power electronics, direct current uses a DC-DC converter instead of an inverter.

For systems where most micro-grids are rated below 100 kW, the cost difference will be significant, but when considering larger system sizes, the difference is negligible. In addition to cost savings, DC systems also deliver higher quality electricity, promise relatively less power loss, and can be easily integrated with inherently renewable DC technologies. As per Glasgo (2016), reducing the power conversion steps associated with DC systems has the potential to reduce conversion losses, reduce PV system costs throughout the life cycle, and improve system reliability related to power electronics. Studies based on the different aspects above have shown the operability of photovoltaic based DC systems. From futuristic view, direct current could replace alternating current in energy distribution and consumption as more and more home appliances are based on direct current, direct current also has the advantage of being directly integrated with most renewable energy technologies. Distributed micro-grids could be the start of the DC boom as AC grids penetrate most cities.

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