ADAPTIVE PERFORMANCE OF PV SYSTEM WITH P&O MPPT ALGORITHM UNDER DYNAMIC OPERATING LOADS

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ABSTRACT :

The performance of photovoltaic (PV) systems can be significantly influenced by dynamic load conditions, which can result in fluctuating power demands and varying irradiance levels. This project presents a modeling and simulation of a PV system integrated with a Perturb and Observe (P&O) Maximum Power Point Tracking (MPPT) algorithm, optimizing energy extraction under dynamic load conditions. The PV system model includes the solar array, DC-DC converter, and the P&O MPPT controller, which dynamically adjusts the operating point to maintain maximum power output despite load variations. The simulation, implemented using MATLAB/Simulink, captures the transient behavior of the PV system, including the effects of changing environmental conditions such as irradiance and temperature, along with fluctuating load profiles. The results show that the P&O MPPT algorithm effectively adapts to dynamic load conditions, ensuring maximum power delivery, improving efficiency, and enhancing system stability. The impact of various load profiles on system performance is also analyzed, demonstrating the robustness of the P&O algorithm in maintaining optimal energy generation. The findings of this study contribute to the development of more efficient PV systems for applications in areas with highly variable energy demands

Key-words : Photovoltaic (PV) system, Maximum Power Point Tracking (MPPT), Perturb and Observe (P&O) algorithm, dynamic load conditions, MATLAB/Simulink, DC–DC converter, irradiance variation, temperature variation, power optimization, transient analysis, renewable energy efficiency, system stability.

1.Introduction:

The global energy sector is undergoing a significant transformation driven by the urgent need to address climate change, enhance energy security, and support sustainable development. Renewable energy technologies have become central to this transition because of their low environmental impact, scalability, and long-term economic advantages. International organizations such as the International Renewable Energy Agency (IRENA) emphasize that the rapid deployment ofrenewable energy,supported by strong policy frame work and institutional reforms,is esentional for achieving global decarbonisation goals. As a result, even economies traditionally dependent on fossil fuels are increasingly restructuring their energy systems to incorporate cleaner and more resilient alternatives.

In Nigeria, Africa's largest economy and a major oil-producing nation, the energy transition represents both a critical challenge and a strategic opportunity. Despite the country's abundant energy resources, Nigeria continues to face persistent electricity shortages, low per-capita power consumption, and a heavy dependence on fossil fuels. Previous studies by Akorede et al. (2017) and Akuru and Okoro (2010) indicate that renewable energy contributes only a small fraction to the national energy mix, despite the availability of substantial solar, biomass, and municipal solid waste resources. Key barriers to renewable energy development include weak policy implementation, inadequate grid infrastructure, limited access to financing, and regulatory inconsistencies, which have hindered the effective execution of the Renewable Energy Master Plan (REMP) and related initiatives.

Policy-focused research highlights that achieving sustainable energy development in Nigeria requires coherent regulatory frameworks, long-term strategic planning, and the integration of renewable energy objectives into national development agendas. Emodi and Boo (2015) stress the importance of aligning energy policies with environmental and economic goals to improve energy security while reducing emissions. Similarly, Efurumibe et al. (2014) argue that although Nigeria has considerable renewable energy potential, its effective utilization depends on strengthened institutional capacity, attractive investment incentives, and active collaboration between the public and private sectors.

Among the various renewable energy options, solar photovoltaic (PV) technology emerges as the most practical solution for large-scale deployment in Nigeria due to the country's high solar irradiance across most regions. However, the performance and reliability of PV systems are significantly influenced by climatic conditions, system design, and grid integration challenges. Bhattacharjee and Bhakta (2013) demonstrate that irradiance fluctuations and cloudburst events can lead to notable variations in PV output, highlighting the need for reliable performance assessment methods. To address regional performance differences, Brecl and Topič (2016) propose standardized indicators such as the Apparent Performance Ratio (APR), which allow for consistent evaluation of PV systems across different climatic zones.

Effective monitoring, diagnostics, and fault detection are essential for ensuring the reliable operation and optimal energy yield of PV systems, particularly in grid-connected applications. Daliento et al. (2017) provide a comprehensive review of PV monitoring techniques, fault diagnosis methods, and power forecasting approaches, demonstrating their importance in minimizing system downtime and improving overall efficiency. These methods are particularly valuable indeveloping countries, where environmental conditions and maintenance limitations often contribute to system performance degradation.

In addition to solar energy, biomass and waste-to-energy technologies offer viable options for diversifying Nigeria’s renewable energy portfolio while simultaneously addressing environmental and waste management challenges. Studies by Diji, Ekpo, and Adadu confirm the technical feasibility of biomass-based power plants for industrial and commercial use, while Ekpo (2019) highlights the substantial potential for electricity generation from municipal solid waste in major Nigerian cities. These technologies support circular economy principles by converting waste materials into useful energy.

Hybrid renewable energy systems and smart-grid integration further enhance the reliability and sustainability of renewable power generation. Techno-economic studies of hybrid wind–solar systems show improved system stability and reduced emissions when such systems are effectively integrated into existing power networks. Additionally, advances in modeling and simulation tools, including computational fluid dynamics (CFD) applications in energy systems and turbine design, provide valuable insights for optimizing system performance and improving overall efficiency.

In conclusion, Nigeria’s transition toward a sustainable energy future requires a comprehensive and integrated approach that combines effective policy implementation, accurate resource assessment, advanced performance diagnostics, and modern modeling techniques. This paper builds on existing research by synthesizing policy and technological perspectives to support renewable energy development, with a particular focus on solar PV systems, hybrid energy solutions, and grid integration strategies suited to Nigeria’s evolving energy landscape.

2.Mathematical Expression of PV System

Assuming negligible system losses, a peak solar irradiance (PSI) of 1 kW/m^2, and a standard test condition (STC) temperature of 25°C, the configuration of a photovoltaic (PV) system can be determined based on the required output power and rated operating voltage. The PV array is designed by selecting appropriate numbers of series- and parallel-connected modules to achieve the desired voltage and power levels.

Series and Parallel Configuration of PV Modules

The number of PV modules connected in series, N_s, required to achieve a specified input voltage is given by:

$$N_s = \frac{V_{\text{in}}}{V_{\text{mp}}} \qquad (1)$$

where $V_{\text{mp}}$is the voltage at the maximum power point of a single PV module, and $V_{\text{in}}$is the required input voltage of the system.

The number of parallel-connected PV strings, N_p, required to meet the desired output power is expressed as:

$$N_p = \frac{P_{\text{out}}}{N_s \times P_{\text{max}}} \qquad (2)$$

where P_{out} is the required system output power and $P_{\max}$ is the maximum power rating of a single PV module.

Electrical Parameters of the PV System

The operating current of the PV system is calculated as:

$$I = \frac{P}{V} \qquad (3)$$

where P is the electrical power and V is the operating voltage.

The equivalent electrical resistance of the PV system is given by:

$$R = \frac{V}{I} \qquad (4)$$

Fill Factor of the PV Module

The fill factor (FF) is an important indicator of PV module quality and performance. It represents the ratio of the actual maximum obtainable power to the theoretical maximum power and is defined as:

$$\text{FF} = \frac{P_{\max}}{V_{\text{oc}} \times I_{\text{sc}}} = \frac{V_{\text{mp}} \times I_{\text{mp}}}{V_{\text{oc}} \times I_{\text{sc}}} \qquad (5)$$

where V_{oc} and I_{sc} are the open-circuit voltage and short-circuit current, respectively, and V_{mp} and I_{mp} are the voltage and current at the maximum power point.

Incident Solar Energy on the PV Module

The total solar energy incident on the top surface of the PV module under STC is expressed as:

$$E_{\text{in}} = T_g \, \alpha_{sc} \, P_{sc} \, G \, A_{sc} \qquad (6)$$

where T_g is the glass transmissivity, α_{sc} is the absorptivity of the solar cell, P_{sc} is the packing factor, G is the solar irradiance, and A_{sc} is the surface area of the solar cell.

Thermal Losses Due to Convection

The convective heat loss from the PV module to the ambient is given by:

$$E_l = U_{sca}(T_{sc} - T_{amb})A_{sc} \qquad (7)$$

where U_{sca} is the overall heat transfer coefficient from the solar cell to the ambient, T_{sc} is the solar cell temperature, and T_{amb} is the ambient temperature.

The solar cell temperature is calculated as:

$$T_{sc} = \frac{P_{sc}G(T_g\alpha_{sc}\eta_{sc}) + U_{sca}T_{amb} + U_tT_{bs}}{U_{sca} + U_t}$$

(8)

where η_{sc} is the reference electrical efficiency of the PV module, U_t is the total heat transfer coefficient, and T_{bs} is the back-surface temperature of the module.

Electrical Energy Output of the PV Module

The electrical energy generated by the PV module is expressed as:

$$E_{pv} = G \, T_g \, \eta_{sc}[1 - \mu_{sc}(T_{sc} - T_r)] \qquad (9)$$

where μ_{sc} is the temperature coefficient of the PV module and T_r is the reference temperature (25°C).

The electrical energy output converted from solar radiation is given by:

$$E_e = \eta_{sc} \, P_c \, G \, A_{sc} \qquad (10)$$

where P_c is the power conversion factor.

Thermal Energy Component

The remaining portion of the absorbed energy that is converted into thermal energy is expressed as:

$$E_t = U_t(T_{sc} - T_{bs}) \qquad (11)$$

Overall Energy Balance of the PV Module

The complete energy balance of the PV module is given by:

$$E_{\text{in}} = E_l + E_e + E_t \qquad (12)$$

2.1.Maximum Power Point Tracking (MPPT)

Photovoltaic (PV) systems exhibit nonlinear current–voltage (I–V) and power–voltage (P–V) characteristics that are strongly influenced by variations in solar irradiance and cell temperature. For each operating condition, there exists a unique point on the P–V curve at which the PV module delivers its maximum available power, referred to as the Maximum Power Point (MPP). Operating the PV system away from this point results in reduced power extraction and lower overall efficiency. Maximum Power Point Tracking (MPPT) is therefore employed to continuously adjust the operating point of the PV system to ensure maximum energy harvesting under changing environmental conditions.

The electrical output power of a PV module is expressed as:

$$P = V \times I$$

At the MPP, the slope of the P–V curve is zero, which is mathematically represented as:

$$\frac{dP}{dV} = 0$$

Expanding the above expression gives:

$$\frac{d(VI)}{dV} = I + V\frac{dI}{dV} = 0$$

Hence, the MPP condition is defined by:

$$\frac{dI}{dV} = -\frac{I}{V}$$

This fundamental relationship forms the basis for several MPPT algorithms and is widely used in analytical and control-based tracking methods.

MPPT is implemented using a power electronic interface, typically a DC–DC converter, placed between the PV array and the load or grid-connected inverter. By adjusting the duty cycle of the converter, the MPPT controller regulates the PV terminal voltage and current, thereby forcing the system to operate at the MPP. Without MPPT control, the operating point of the PV system is dictated by the load characteristics, which rarely coincide with the MPP, leading to significant power losses.

The necessity of MPPT becomes more pronounced under real operating conditions, where solar irradiance and ambient temperature vary continuously throughout the day. An increase in irradiance generally raises the PV output current, while an increase in temperature reduces the open-circuit voltage, causing the MPP to shift dynamically. MPPT algorithms respond to these variations by continuously tracking the new optimal operating point, thereby maintaining maximum power extraction.

Several MPPT techniques have been developed, ranging from simple conventional methods to advanced intelligent algorithms. Conventional techniques, such as Perturb and Observe and Incremental Conductance, rely on electrical measurements of voltage and current to estimate the direction of movement toward the MPP. These methods are widely adopted due to their simplicity and ease of implementation. However, they may exhibit steady-state oscillations around the MPP or reduced accuracy under rapidly changing irradiance conditions.

Advanced MPPT techniques employ intelligent control strategies, including fuzzy logic, artificial neural networks, and metaheuristic optimization algorithms. These approaches offer improved tracking accuracy, faster convergence, and better performance under partial shading conditions, where multiple local maxima appear on the P–V curve. However, their implementation requires higher computational resources and increased system complexity.

The effectiveness of an MPPT algorithm is commonly evaluated using performance indicators such as tracking efficiency, convergence speed, steady-state oscillations, and robustness to environmental variations. High-performance MPPT controllers are essential for maximizing energy yield, improving system reliability, and enhancing the economic viability of PV installations.

2.2.Perturb and Observe (P&O) Maximum Power Point Tracking Method

The Perturb and Observe (P&O) method is one of the most commonly used Maximum Power Point Tracking (MPPT) techniques in photovoltaic (PV) systems because of its simple structure and ease of implementation. The basic idea of the P&O algorithm is to slightly disturb the operating condition of the PV system and then observe how the output power responds to this disturbance. Based on this response, the algorithm decides whether the operating point is moving closer to or farther away from the Maximum Power Point (MPP).

The output power of a PV module is determined by the product of its voltage and current. When the operating voltage is slightly increased or decreased, the resulting change in power indicates the relative position of the operating point on the power–voltage (P–V) curve. If the applied perturbation causes the output power to increase, the algorithm assumes that the operating point is moving toward the MPP and continues perturbing in the same direction. If the output power decreases, the perturbation direction is reversed, indicating that the operating point has moved away from the MPP. This process is repeated continuously, causing the operating point to oscillate around the MPP.

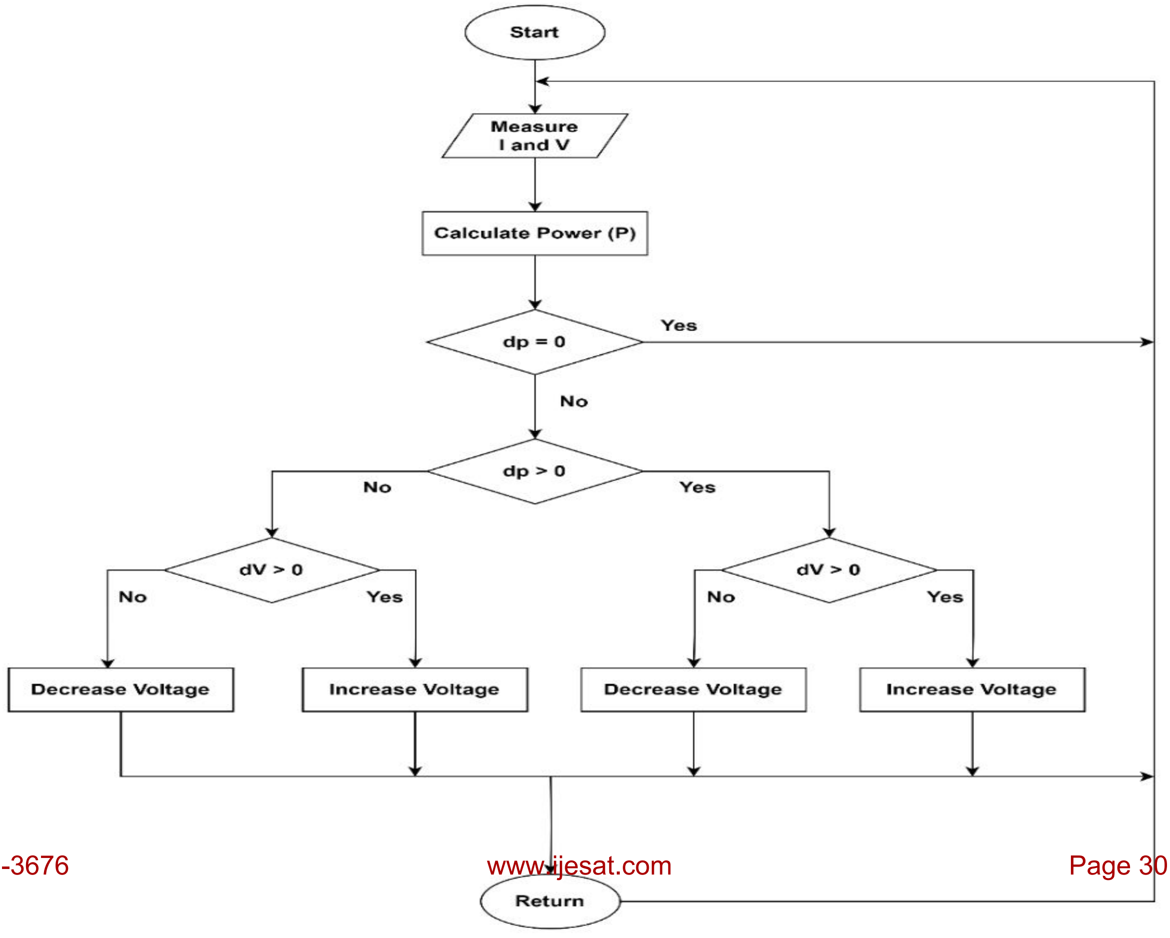
In practical PV systems, the P&O algorithm is implemented by adjusting the duty cycle of a DC–DC converter connected between the PV array and the load or inverter. Changing the duty cycle alters the PV terminal voltage, allowing the controller to move the operating point along the P–V curve. The size of the perturbation step significantly affects the performance of the algorithm. A larger step size enables faster tracking but leads to greater oscillations around the MPP, while a smaller step size reduces oscillations but slows down the response to changing environmental conditions.

One inherent drawback of the P&O method is its steady-state oscillation around the MPP. Since the algorithm continuously applies perturbations, it cannot settle exactly at the optimal point under constant irradiance. These oscillations result in small but unavoidable power losses. Another limitation occurs during rapid changes in solar irradiance. Under such conditions, the algorithm may incorrectly attribute power variations caused by environmental changes to the applied perturbation, which can lead to temporary tracking errors.

Despite these limitations, the P&O method remains widely adopted in both standalone and grid-connected PV systems due to its low cost, minimal sensor requirements, and ease of digital implementation. It typically requires only voltage and current measurements and can be readily implemented using microcontrollers or digital signal processors.

To address the shortcomings of the conventional P&O method, several improved versions have been proposed in the literature, including adaptive step-size P&O and hybrid control strategies. These enhancements aim to reduce steady-state oscillations, improve tracking speed, and enhance performance under rapidly changing irradiance conditions.

3.Modeling of the pv system with P&O mppt in matlab/simulink



From the above equations(eqn 1 to 12) are applied to design the pv system to calculate necessary output power calculations of the system.The specifications are given in Table 1 were employed to model the PV system accurately.

Table 1: specifications of PV module parameters

SNO	Component Description	Rating
1	Maximum power ($Pmax$)	213.15W
2	Open circuit voltage (Voc)	36.3V
3	Voltage at maximum power (Vmp)	29V
4	Short circuit current (Isc)	7.84A
5	Current at maximum power (Imp)	7.35A
6	Input voltage	250-300V

We can determine how many PV arrays must be connected in series to provide the necessary output power using equation 1:

$$Ns = Vin/Vmp = 31929 = 11\ seriesstring$$

As a result, 11 PV arrays must be connected in series. Equation (2) will be used to calculate how many arrays must be connected in parallel:

$$Np = Pout/NsXPmax$$

The number of parallel connected strings will be ascertained as follows, given that the required power output $Pout$ is 3MW, the series connected string $Ns = 11$, and the maximum power $Pmax = 213.15$W.

$$Np = 3{,}000{,}000/213.15 * 11$$
$$= 1300 parallelstring$$

Thus, in order to provide the desired output power, 1300 parallel strings are needed. The necessary resistance is determined using the following formula:

$$Given\ that\ current\ (I) = poweroutputvoltage$$
$$(I) = 3{,}000{,}000/319 = 9555\ watts$$

Ohm's law, which can be expressed as RVI, can be used to calculate the resistance.

$$R = 319/9555 = 0.033\Omega$$

The solar power system was designed with a combination of series and parallel PV connections to achieve the required 3 MW output. Each PV module operates at a maximum power voltage (Vmp) of 29V and a current of 7.35A. To obtain the required system voltage, 11 panels are connected in series, resulting in a DC voltage of 319V. A total of 1300 parallel strings ensure adequate current for power generation.

To align with standard MW-scale grid requirements (typically 4000V or higher), the system employs a boost converter to step up the 319V DC to 4000V DC before feeding it into the inverter. The inverter then converts this 4000V DC into AC for grid integration, ensuring compatibility with the standard transmission network.

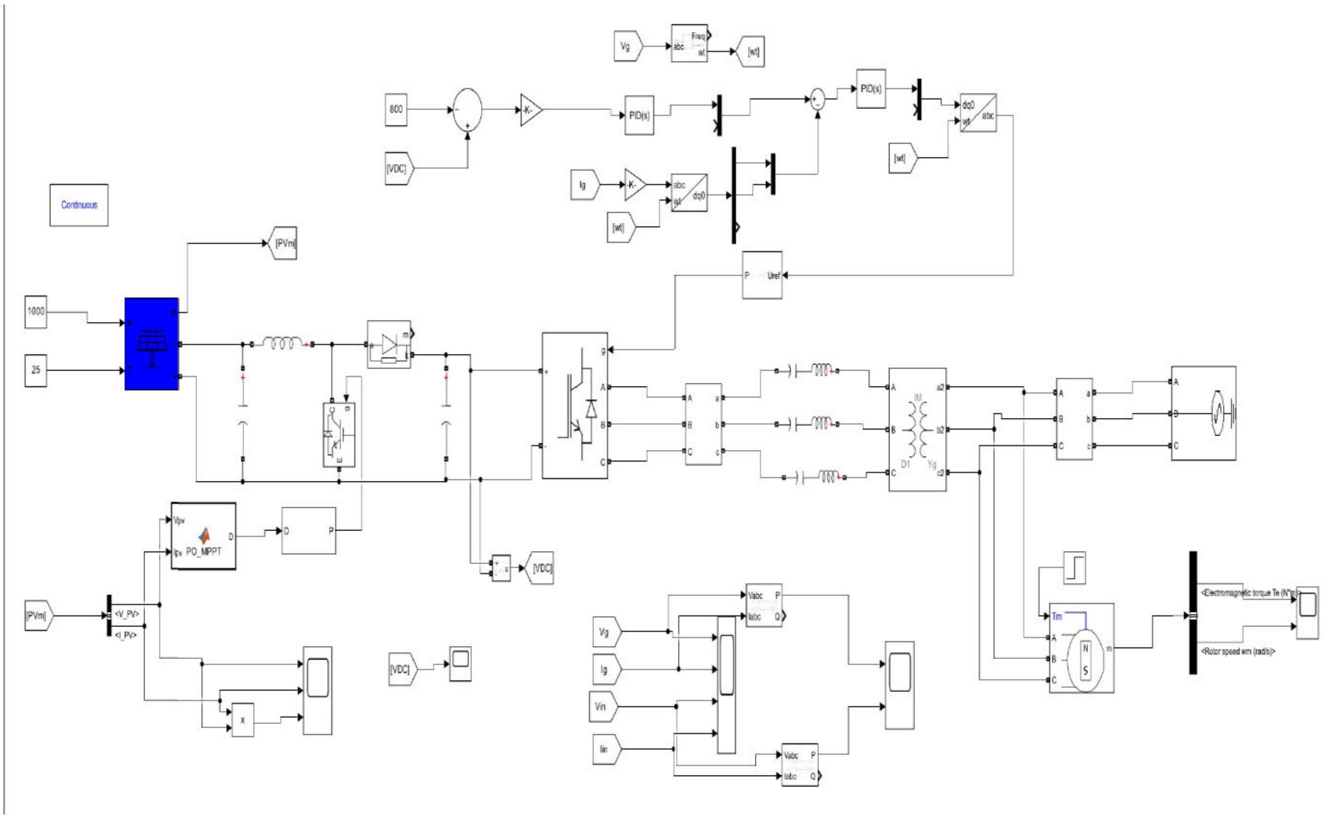
This design optimizes power efficiency while minimizing transmission losses due to high current levels. The use of a boost converter is essential in achieving the necessary voltage for seamless integration with the grid, addressing concerns related to operating at lower voltage levels.

A total power output of system was obtained by entering the aforementioned values into the relevant Simulink fields and visualizing the results with graphical plots. Table 2 provides a summary of the PV parameters specifications, and Fig. 2 shows the completed model

Table 2. Summary of PV Module Parameters Specifications

Number	**Component Description**	**Value**
1	Input voltage (Vin)	250-350V
2	Numbers of linked series in a string	11 strings
3	Numbers of linked parallel in a string	1300 strings
4	Computed current value	9555 Amps
5	Computed current resistance value	0.033Ω
6	PV's system output	3MW

Fig. 2. Simulation setup as represented in MATLAB's workspace



4. RESULTS AND DISCUSSION

Results of the Modeled PV Array in Simulink

This section presents the graphical results obtained from the photovoltaic (PV) array modeled using Simulink. The extracted characteristics clearly illustrate the three fundamental operating points of a solar PV cell: the open-circuit voltage (V_{OC}), the short-circuit current (I_{SC}), and the maximum power point (MPP). These points are essential for understanding the electrical behavior and energy conversion efficiency of the PV system under varying conditions.

Table 3 summarizes the key parameters used in configuring the simulated PV array to achieve the required voltage and power output for integration with the transmission line. These parameters ensure that the modeled system operates within the desired performance limits and meets the design specifications

The PV array was simulated in Simulink to evaluate its performance under different operating conditions, particularly variations in solar irradiance. The resulting characteristic curves provide insight into the dynamic response of the solar cell. Figure 3 illustrates the current–voltage (I–V) characteristics at different irradiance levels, highlighting the effect of solar intensity on the output current and voltage. Figure 4 presents the corresponding power–voltage (P–V) characteristics, demonstrating the shift in the maximum power point as irradiance changes.

Number	Required Parameters	Value
1	Irradiance	1000 W/m2
2	Number of parallel strings	1300
3	Number of series connected modules per string	11
4	Number of cells per module	60
5	Open circuit voltage (Voc)	36.3V
6	Voltage at maximum power (Vmp)	29V
7	Short circuit current (Isc)	7.84A
8	Current at maximum power (Imp)	7.35A
9	Temperature coefficient of short circuit current (Isc)	0.1020c
10	Temperature coefficient of open circuit voltage (Voc)	-0.360990c
11	Solar cell maximum power	213.15W

Table 3. Required Parameters of the Modelled PV Array

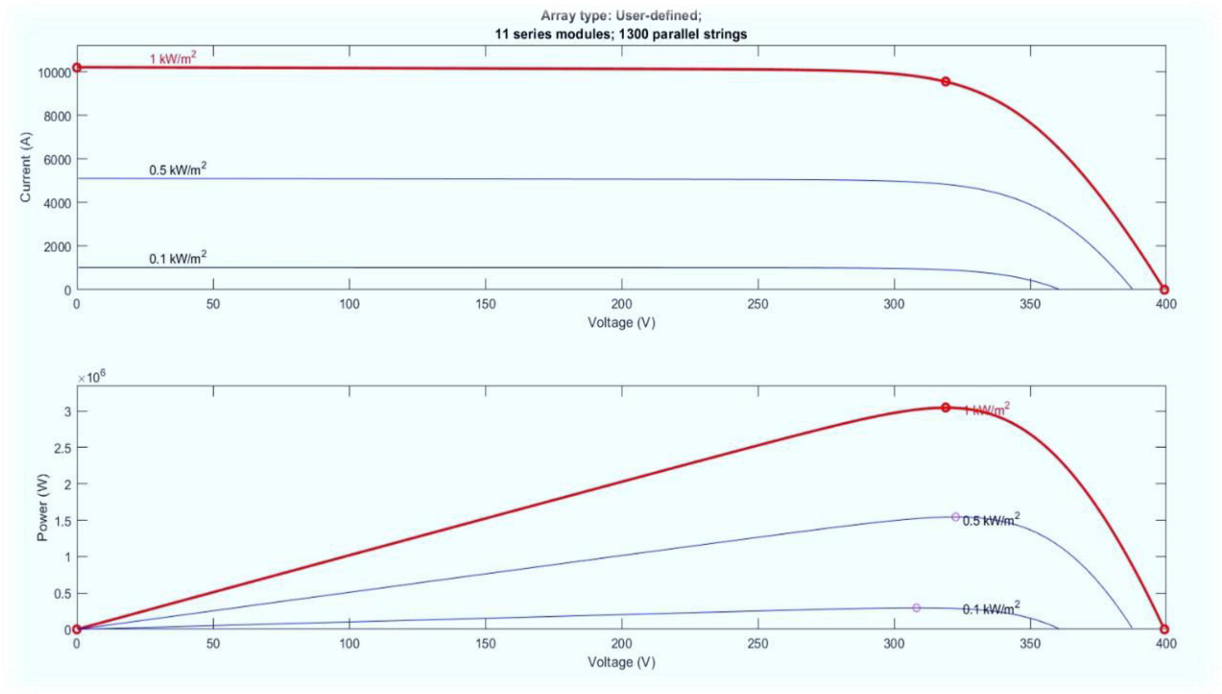


Fig. 3. Current Vs Voltage& voltage Vs power Relationship of Solar PV Module

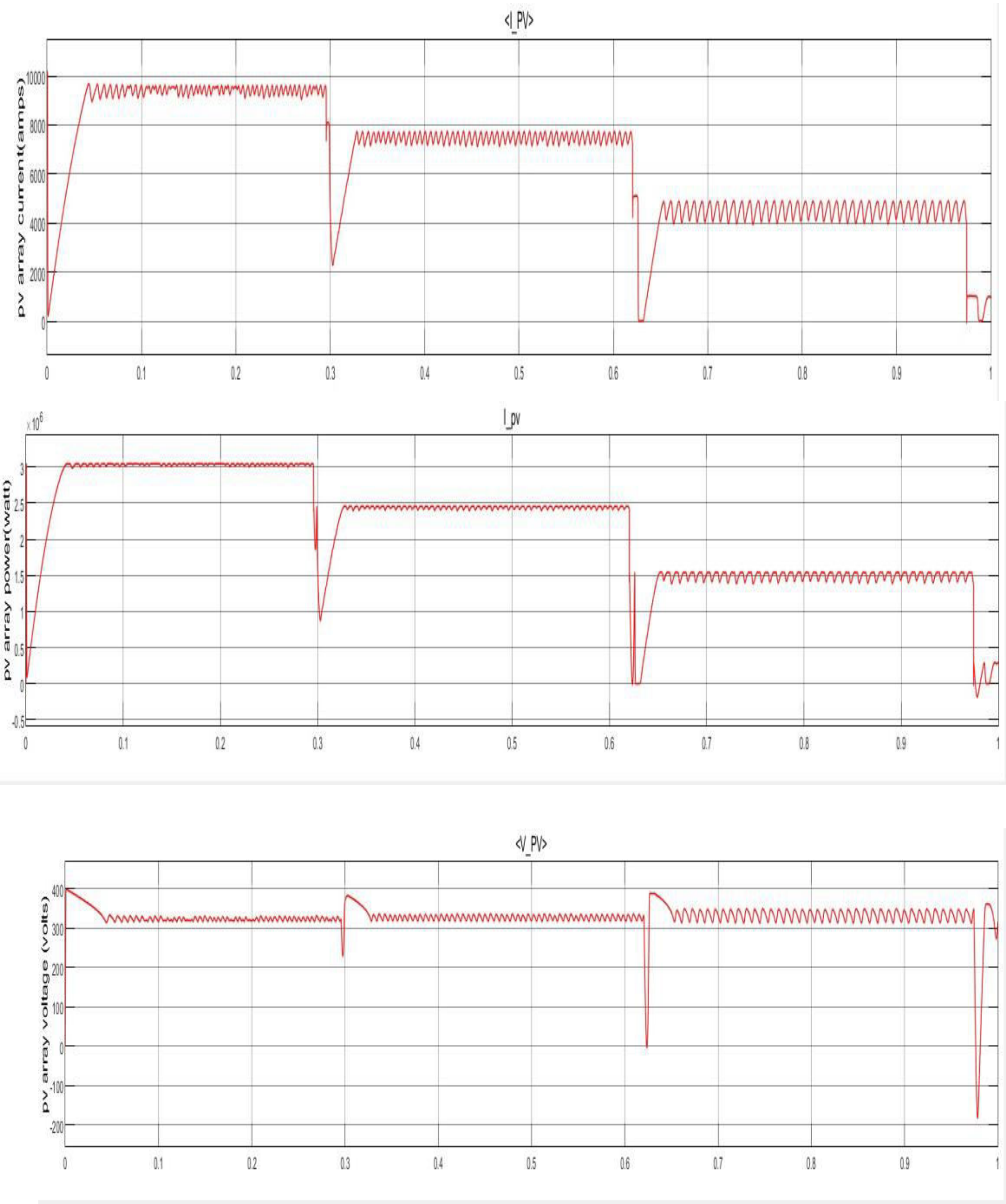
From the simulated I–V and P–V characteristics, it is observed that the performance of the PV array is strongly influenced by solar irradiance. As the irradiance increases from 0.1 kW/m² to 1 kW/m², the output current rises significantly, while the open-circuit voltage remains almost constant with only a slight variation, indicating that current is more sensitive to irradiance changes than voltage. Each I–V curve exhibits a clear knee point corresponding to the maximum power point (MPP), which shifts upward with increasing irradiance, allowing the array to deliver higher power at nearly the same operating voltage. This behavior is further confirmed by the P–V curves, where the peak power increases substantially at higher irradiance levels and drops proportionally under reduced sunlight. Overall, the smooth nature of the curves and the consistent location of the MPP voltage demonstrate stable operation of the modeled PV array and emphasize the importance of effective MPPT control to ensure optimal energy extraction under varying environmental conditions.

PV Array Output Analysis

The simulation results clearly show how the PV array voltage, current, and power respond to changes in operating conditions over time. Initially, the PV voltage stabilizes around 330–350 V, while the array current remains close to 9–10 kA, resulting in a power output of approximately 3 MW, indicating operation near the maximum power point under high irradiance. Around 0.3 s, a noticeable disturbance occurs, causing the current to drop to about 6–7 kA and the power to reduce to roughly 2–2.3 MW, while the voltage remains relatively stable with small oscillations, showing the voltage’s lower sensitivity compared to current. A more significant change is observed near 0.72 s, where the PV current sharply decreases to around 2–3 kA, and the output power falls to nearly 1–1.5 MW, corresponding to a reduction in irradiance or load variation. Throughout these transitions, the PV voltage fluctuates within a narrow band of 300–360 V, while the current and power experience proportional reductions. The small oscillations seen in all waveforms are due to switching actions and MPPT dynamics, indicating that the controller continuously tracks the new operating point.

Overall, the results confirm that the modeled PV array responds realistically to changing conditions, with current and power strongly dependent on irradiance, while the voltage remains comparatively stable, validating the effectiveness of the PV model and control strategy.

Fig 6: PV Array Output Voltage(volts)



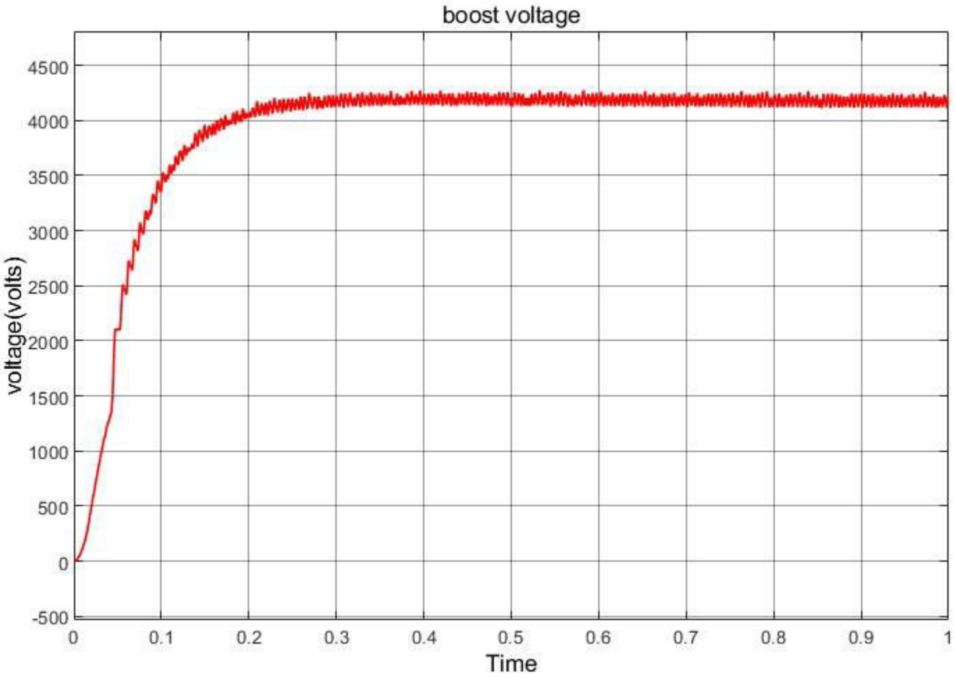


Fig 7: Boost Converter Voltage(volts)

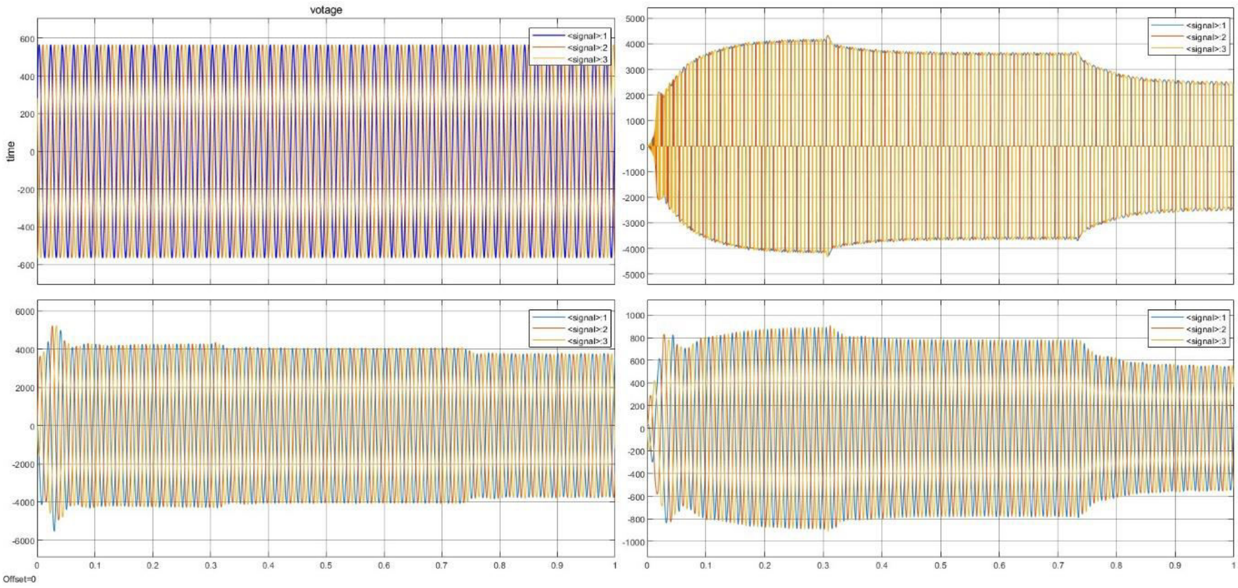


Fig 8: Inverter and grid voltage(volts) and current(amps)

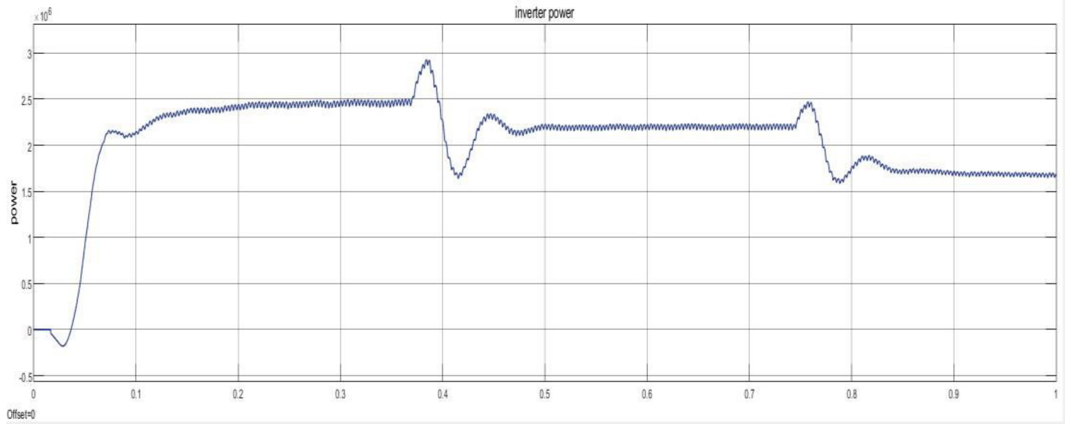


Fig 9(a): Inverter Power

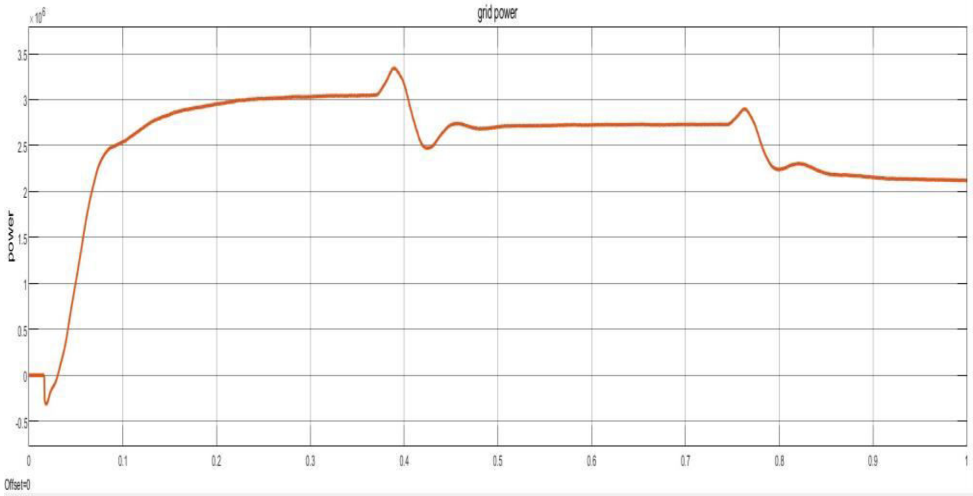


Fig 9(b): grid Power

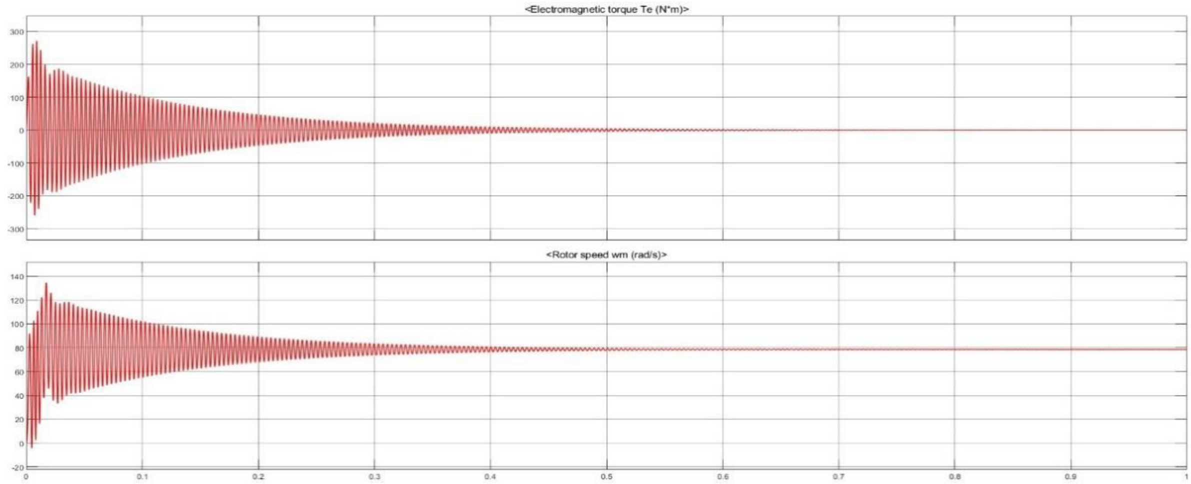


Fig 10: PMSM Output

From the boost converter is connected between the solar PV array to the AC inverter for stepping up of the PV arrays DC voltage to 4000 V, the boost converter ensures the inverter has input voltage, to reduce the power losses during the DC-AC conversion process.

Fig 8 show the output voltage and currents of the inveter and grid

5. CONCLUSION

The proposed photovoltaic (PV) system with the Perturb and Observe (P&O) MPPT algorithm demonstrates effective performance under dynamic load and varying irradiance conditions. The simulation results show that the system can successfully track the maximum power point, ensuring optimal power extraction and stable operation. While current and power vary significantly with environmental changes, the voltage remains relatively stable. The P&O algorithm provides fast response and adaptability, with minor oscillations around the maximum power point. The use of a boost converter enhances voltage levels for efficient grid integration. Overall, the system is efficient, reliable, and suitable for large-scale solar power applications.

6. REFERENCES

1. Akorede et al. (2017) – Current status, challenges, and development outlook for renewable energy in Nigeria.
2. Akuru & Okoro (2010) – Review of the Renewable Energy Master Plan (REMP) and investment landscape in Nigeria.
3. Efurumibe, Asiegbu & Onuu (2014) – Renewable energy prospects and adoption potential in Nigeria.
4. Emodi & Boo (2015) – Policy options for sustainable energy development in Nigeria.
5. Asmelash & Gorini (2021, IRENA) – Role of international oil companies (IOCs) in the global energy transition and decarbonisation.
6. Bhattacharjee & Bhakta (2013) – PV system performance indices under cloudburst/irradiance variations.
7. Brecl & Topič (2016) – Apparent performance ratio (APR) methodology for evaluating PV performance across regions
8. Diji, Ekpo & Adadu (2013a) – Design of biomass power plants for commercial clusters.
9. Diji, Ekpo & Adadu (2013b) – Exergo-environmental analysis of cement manufacturing processes using biomass/thermal resources
10. Ekpo (2019) – Electricity generation potential from municipal solid waste in Nigerian cities.
11. Daliento et al. (2017) – Monitoring, fault diagnosis, and power forecasting techniques for PV fields.
12. Bhattacharjee & Bhakta (2013) (also above) – Impact of climate anomalies on PV performance.
13. Brecl & Topič (2016) (also above) – Standardized metrics for PV system evaluation.
14. Chong et al. (2011) – Wind–solar hybrid system with integrated rainwater harvesting for high-rise buildings.
15. Adam & Apaydin (2016) *(from earlier list)* – Grid-connected solar PV as a tool for emission reduction.
16. Adebanji et al. (2022) *(from earlier list)* – Smart-grid integration of renewable energy in Nigeria.
17. Bassey, Ekpo & Gentle (2024) – CFD analysis of convergent–divergent flow characteristics (useful for energy systems modelling and turbine design).
18. Daliento et al. (2017) – Review of PV monitoring and diagnostics methods.
19. Efurumibe et al. (2014) – Review of Nigeria's renewable energy prospects.
20. Emodi & Boo (2015) – Policy review for sustainable development.