JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

DESIGN OF ANN MPPT BASED HYBRID SOLAR WIND SYSTEM USING MATLAB /SIMULINK

Mubassir Javed, IEC College of Engineering & Technology, Greater Noida, India

Dr. Manoj Kumar Garg ,Electronics & Communication Department, IEC College of Engineering & Technology, Greater Noida, India

Arpit Varshney ,Assistant Professor, Department of Electrical Engineering, IEC College of Engineering & Technology, Greater Noida, India

Abstract: During the previous decade, the burden on the electrical power supply has grown. The power generators (PGs) installation takes a long time and costs a lot of money. As a result, solar plants are seen as a viable alternative for meeting current electricity demands. However, crucial care and output power balance in solar plants are the main difficulties. In order to reduce balancing output power and caring difficulties in solar plants, a correct approach is required. This paper proposes a unique single maximum power point tracking (MPPT) technique for hybrid PV and wind energy systems (WES) to track maximum power. The suggested MPPT approach is based on an artificial neural network (ANN). The hybrid PV and WES systems are connected to the grid through a separate converter and a source inverter.

Keywords: - PV system, WECS, MPPT, ANN

1. Introduction

Energy is critical for the globe to improve living standards and to sustain all of society's other basic parts. Increases in fossil fuels, environmental considerations, and their effects on human health are all issues that traditional energy sources confront. Researchers are hopeful that using renewable energy sources, they would be able to provide pollution-free power. Sun, fuel cells, and water are examples of sustainable energy sources that have been regarded clean and limitless. Solar energy, among the other sustainable energy sources, is mostly used to generate electrical energy due to its cheap maintenance and low operating costs.

Solar energy harvesting has lately gotten a lot of attention, and it's mostly used for stand-alone and grid-connected devices [1]. The flat solar panel configuration or solar farms are used in the majority of present solar power generating. The energy harvesting systems based on flat solar PV panels take up a lot of functional area. The solar PV system, on the other hand, uses only a portion of that land space to produce the same amount of electricity. The solar PV tree is a tree-shaped arrangement of solar panels that is more efficient than flat panels.

The solar PV tree model is the most practical approach that can be applied to meet electricity demand alone during the power outage. The PV output is affected by factors such as temperature, weather conditions is utilized in a variety of applications such as light sources, battery charging, water pumping, space, satellite power system, remote islanded power system, and so on. This paper investigates the use of an artificial neural network (ANN) to improve the efficiency of MPPT in order to improve the smoothness of a solar power system.

The ANN mechanism includes essential qualities that allow it to maximize the input data and deliver the desired outputs. Furthermore, the ANN technique is now frequently employed in a variety of domains to optimize structure complexity and forecast predicted outcomes. For example, the ANN methodology is used to anticipate droughts [8], the ANN method is explored to properly detect wind speed and predict its outcomes [9], the specific subject for the Ankara city is discussed using ANN [10], and the ANN is used to forecast solar system generation [11]. As a result, in this suggested study, the ANN mechanism is approximated in order to maximize the output of MPPT. Some traditional methods include simulated annealing (SA) [12], particle swarm optimization (PSO) [13], the genetic algorithm (GA) [14], cuckoo search (CS) [15].

2. Related Work

The solar energy is the alternative for controlling current electric load needs, a number of research studies have been conducted, the results of which are summarized below:

The P&O approach is a traditional MPPT algorithm that is widely utilized due to its ease of control. It is relatively simple and straightforward to implement, and it results in improved performance under typical test settings. The rate of change of PV array output is utilized as input to the proportional–integral controller in the P&O algorithm proposed in [17] to create various perturb values depending on the input change. The incremental conductance (INC) approach with direct control was implemented in [18], and the optimal point was promptly found by selecting an appropriate iteration step size.

The solar PV output is regulated using this technology based on the maximum power point location, which is determined by the instantaneous and incremental conductance of the PV array.

When compared to the traditional technique, soft-computing-based MPPT algorithms such as FLC and NN compute the optimum point with more accuracy and provide a faster response. RBFN is one of the NN strategies that can effectively regulate time-varying conditions and non-linear effects while also providing the quickest convergence and simplest network configuration [19, 20].

The authors of [12, 13] explored the two artificially based methods in terms of variable and fixed step load. Analyses are being conducted for the MPPT controller and simulation. The MPPT approach, which is based on an improved neural network, was proposed by the authors in [14]. The suggested ENN-based control can automatically modify the step size for MPPT tracking and improve the stable performance of PV panels. Because of the minimal produced data, the suggested ENN approach is simple to apply.

The authors of [19] offered many intelligence techniques, including as neural networks (NN), fuzzy logic (FL), genetic algorithms (GA), and neuro-fuzzy. The intelligence approach effectiveness in form of accuracy, rapid reaction, power consumption, adaptability, and simplicity is described in a comparison examination of all controllers. The authors of [20] suggested two strategies for MPPT of PV cells: ANN and Fuzzy logic controller (FLC). They use MATLAB/Simulink to investigate the planned task.

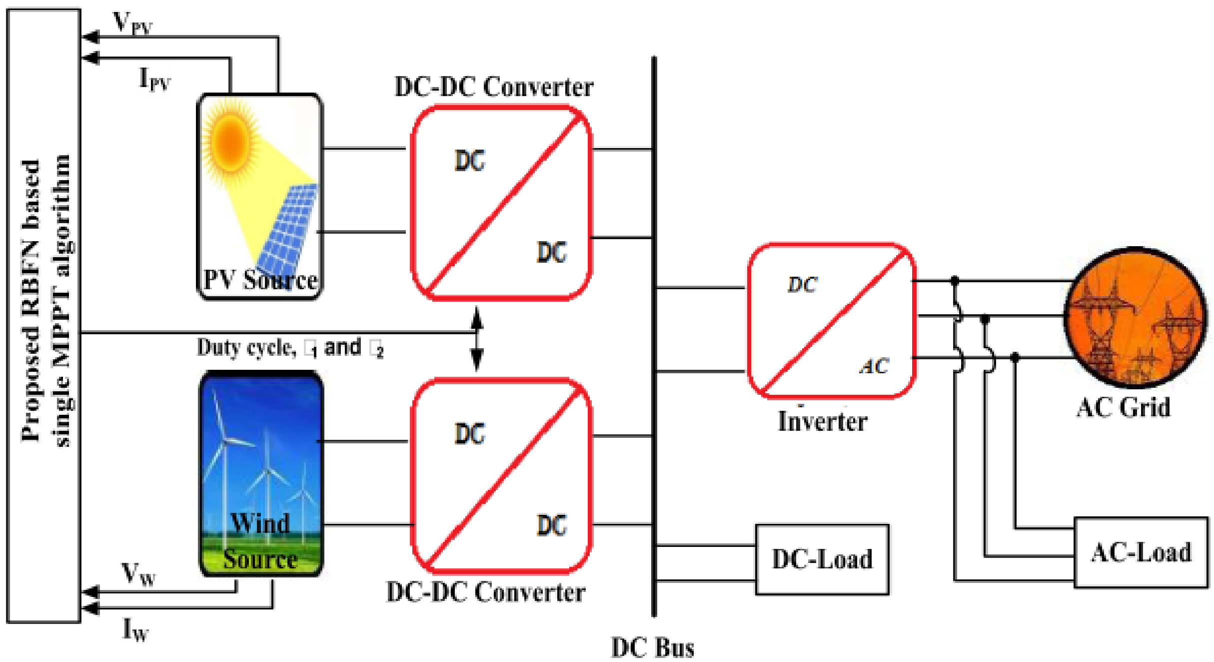

Figure 1: The proposed system

3. Design of Proposed system

The PV and wind energy sources are combined with individually specialized Boost converters to create a hybrid system. To create a hybrid system, both sources are combined at a shared DC link bus capacitor. The proposed hybrid energy system is depicted in Fig. 1 as a schematic figure with a single MPPT. The maximum power from both sources (PV and wind) is retrieved in this suggested MPPT control technique by running the tracing algorithm concurrently. The modelling of a PV system, a wind system, and the construction of a simple Boost converter are covered in the subsections that follow.

3.1 PV system Design

The solar panel single unit is solar cell. When the number of solar cell is connected then the solar panel is build. This model is also known as single diode model of solar cell. In the two resistances one is connected in series with current source and another is connected in parallel.

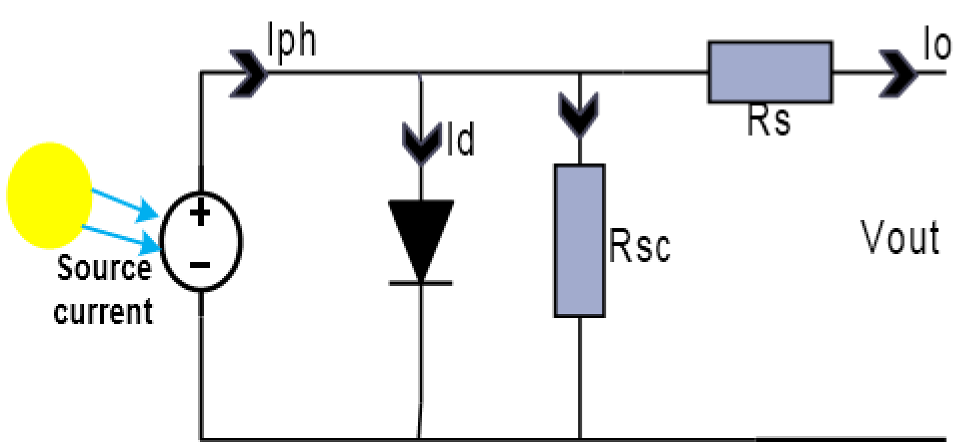

Figure 2: Photovoltaic cell Equivalent circuit

The figure 2 showed the circuit diagram of single diode solar cell model. The output current I am solar cell output current and V is solar cell output voltage.

$$I = I_{ph} - I_0\left[\exp^{\frac{ev_d}{KFT_C}} - 1\right] - \frac{V_d}{R_{sh}} \qquad (1)$$

$$I_{ph} = \left[\mu_{sc}(T_c - T_r) + I_{SC}\right] + G \qquad (2)$$

$$I_0 = I_{0\alpha}\left(\frac{T_C}{T_r}\right)^3 \exp\left[\frac{eV_g}{KF}\left(\frac{1}{T_r} - \frac{1}{T_C}\right)\right] \qquad (3)$$

Where

I_{ph}	Photo current
I_0	Dark saturation current
e	Electric charge (1.6×10^{-19} C)
K	Boltzmann's constant (1.38×10^{-23})
F	Cell idealizing factor
T_c	Absolute temperature
T_r	Cell's reference temperature
V_d	Diode voltage
R_{sh}	Parallel resistance
R_s	Series resistance
$I_{o\alpha}$	Cell saturation current
V_{oc}	Open circuit voltage
μ_{sc}	Temperature coefficient cell's short circuit current
V	Output voltage of solar cell
I	Output current of solar cell
G	Solar irradiation in kw/m2

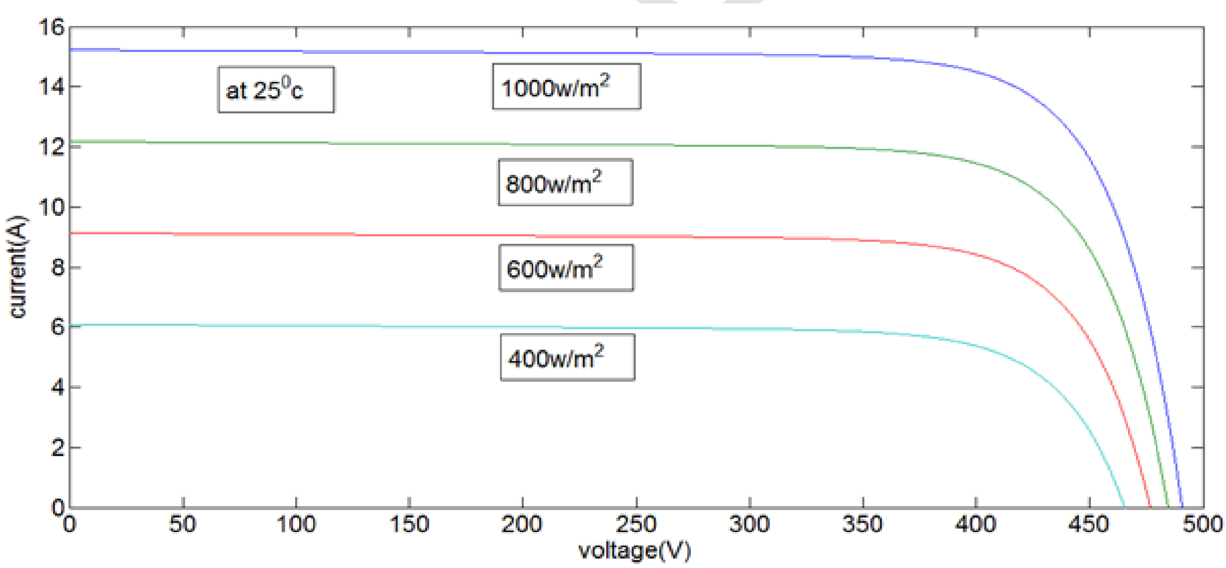

Figure 3 V-I curve

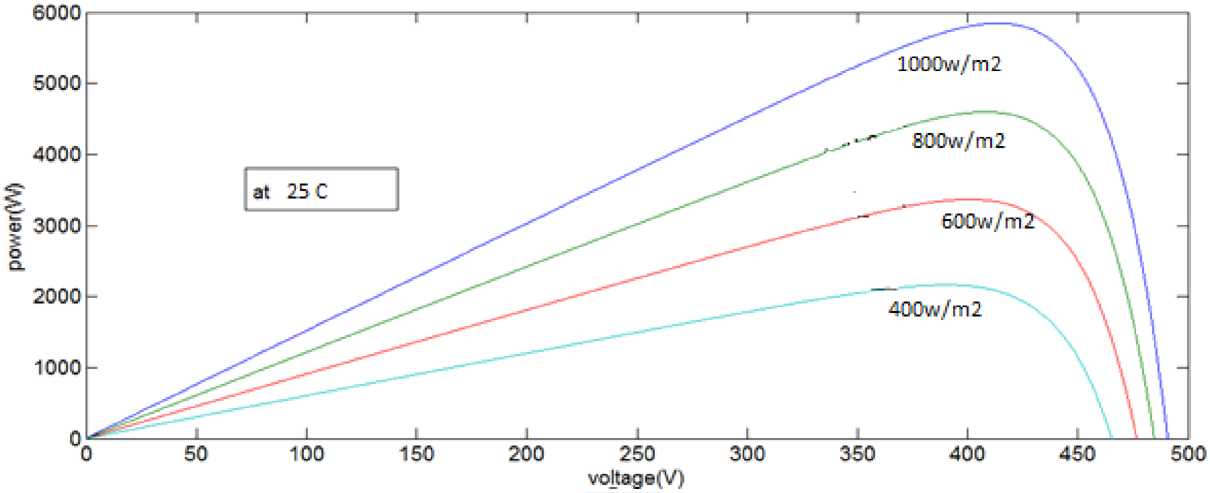

Figure 4 P-V curve

3.2 Wind energy conversion system

The wind turbine is the most fundamental equipment in a wind energy conversion system, as it converts kinetic energy into mechanical energy. A connection device gear train connects the wind turbine to the electrical generator. Wind energy is turned into mechanical power and therefore into electrical power using wind turbines [14-17]. The mechanical power is determined using the following equation:

$$Pm = 0.5\rho ACp(\lambda,\beta)vwind \quad (4)$$

where, ρ = air density which ranges from 1.22- 1.3 kg/m3 ,
A = area swept out by turbine blades (m2)
νwind = wind speed (m/s), Cp(λ,β) = power coefficient

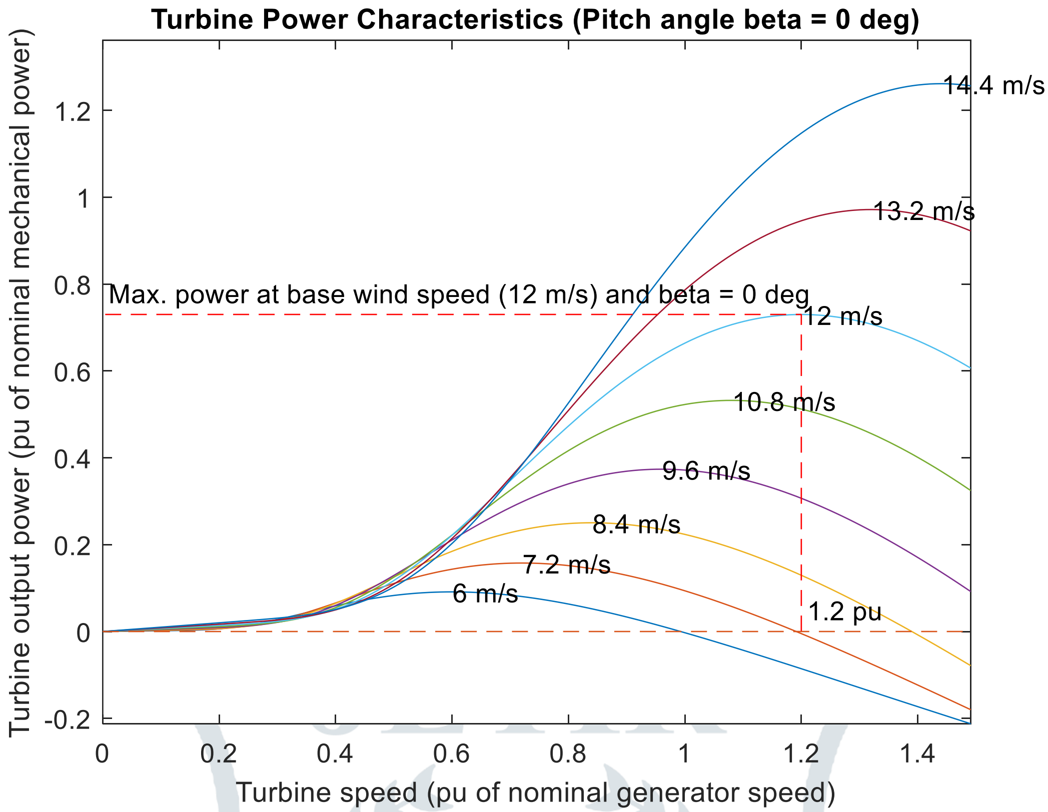

Figure 5 Turbine power curve

3.3 Boost Converter

The boost converter is a device which steps up the input voltage to the desired voltage level at output terminal. The boost converter circuit consisting one inductor, a diode and high frequency switch. By control the duty cycle of switch gate pulse supplied to the switch achieved the output voltage greater than input voltage.

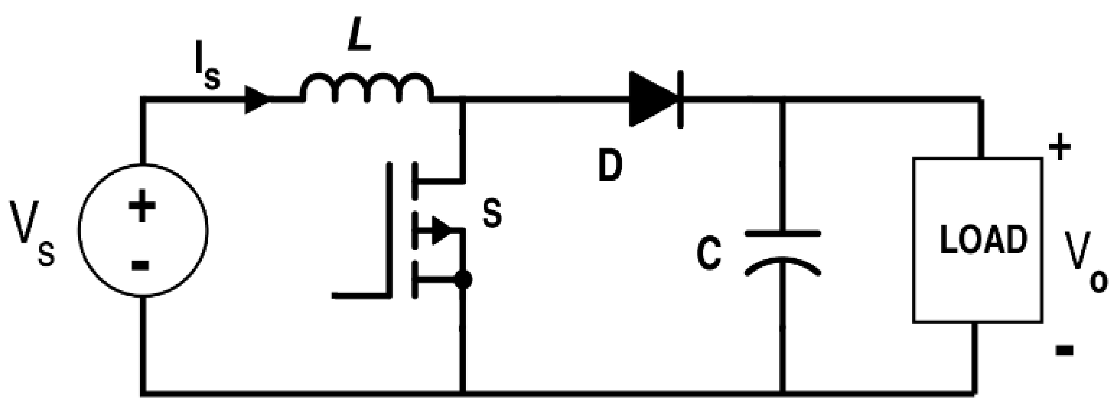

Figure 5 boost converter circuit

This mode is known as charging mode because the inductor is charged by the source. The switch is closed, and the source voltage charges the inductor. It is supposed that charging current varies linearly [11], In charging mode, just the inductor is charged to the required level by the source voltage, and no load is transferred. In the mode second the diode is in forward biased and the switch is open [11].this mode is called discharging mode because in this mode charged inductor is start discharging. The load is now connected with source voltage and capacitor which meets the load demand in this mode of operation in boost converter.

3.4 ANN MPPT

To track maximum power from both the PV and wind energy systems in this hybrid renewable energy system, an RBFN-based intelligent MPPT controller is used. Figure 7 depicts the fundamental architecture of an RBFN-based network. The performance of the RBFN network is determined by the system's interconnection layout, weights, and activation function. It necessitates a separate MPPT controller for each renewable energy source, increasing the size and complexity of system implementation.

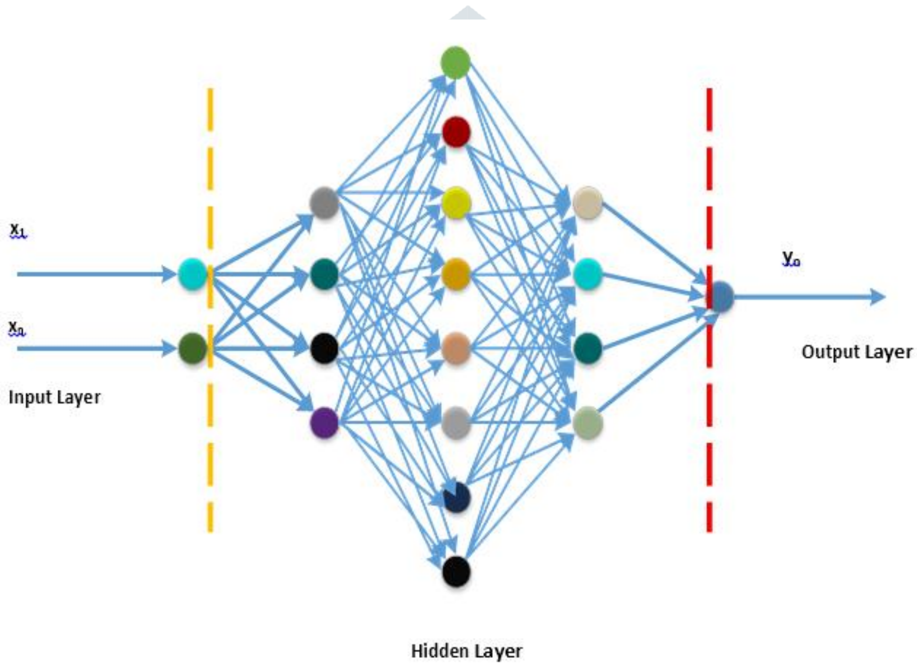

Figure 7 ANN internal structure

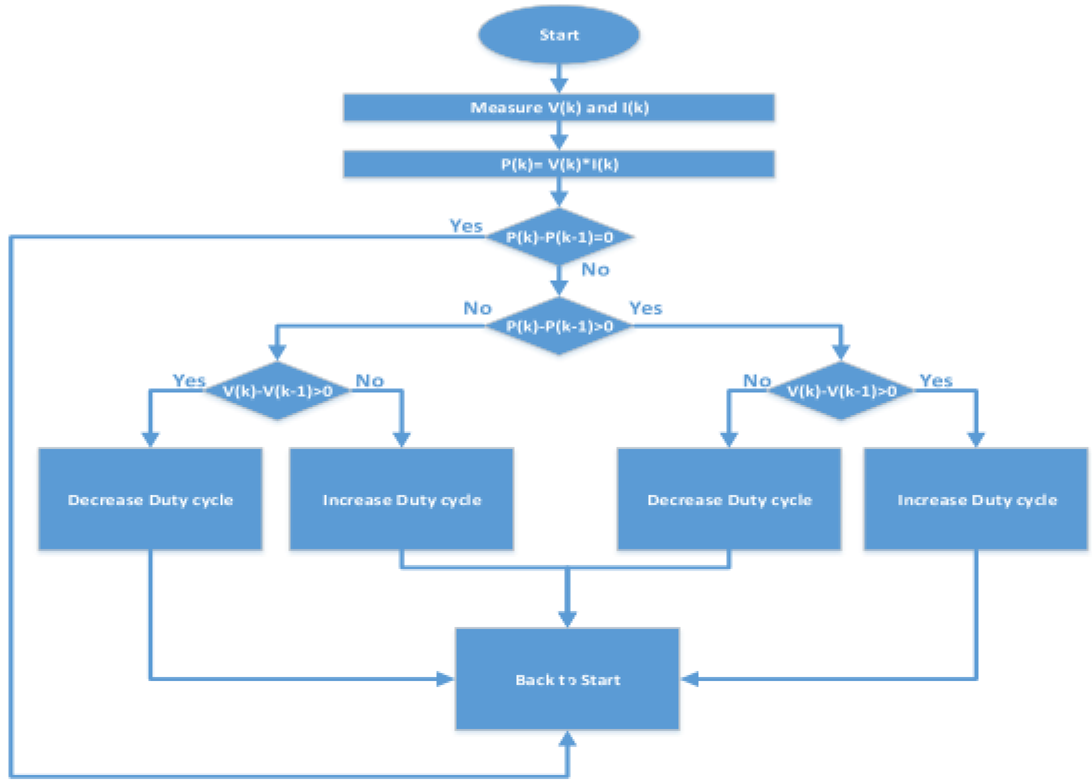

Figure 8 Proposed MPPT algorithm

4. Results and Discussion

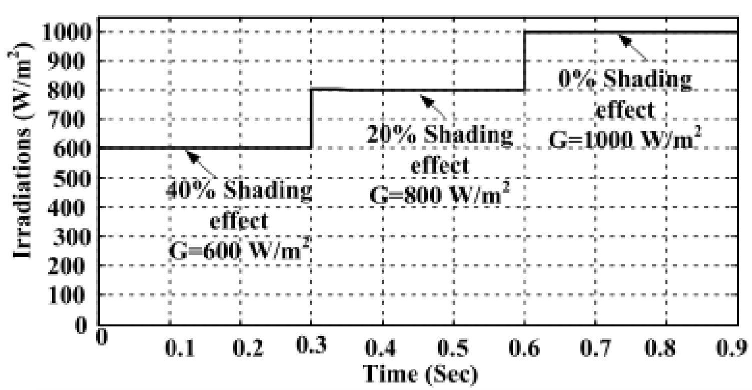

Figure 9 Input Irradiance

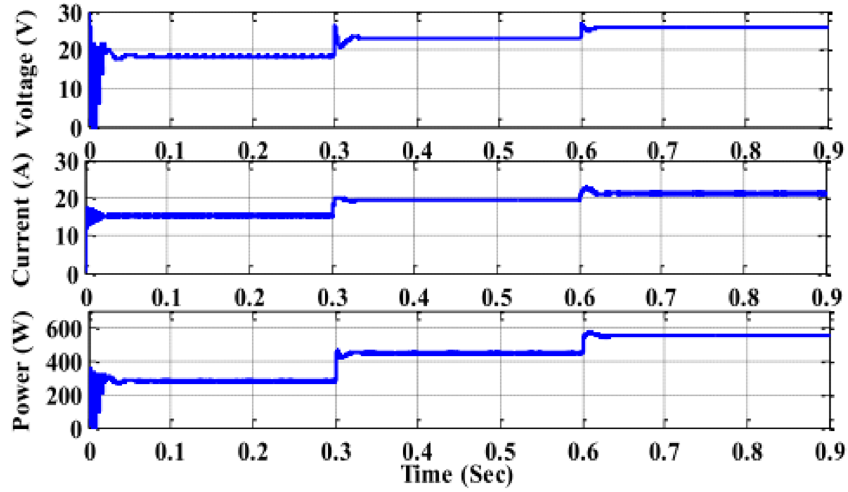

Figure 10 PV output

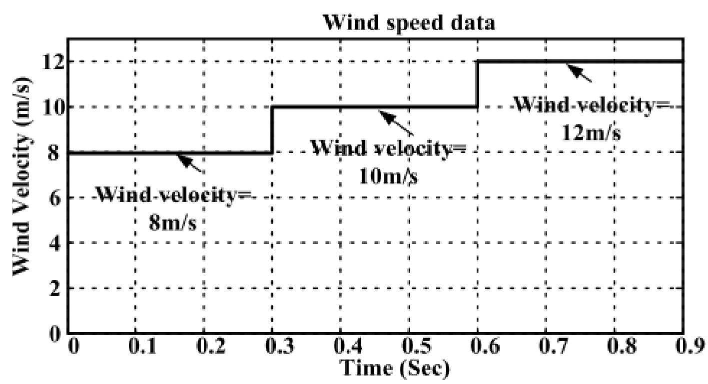

Figure 11 Wind speed input

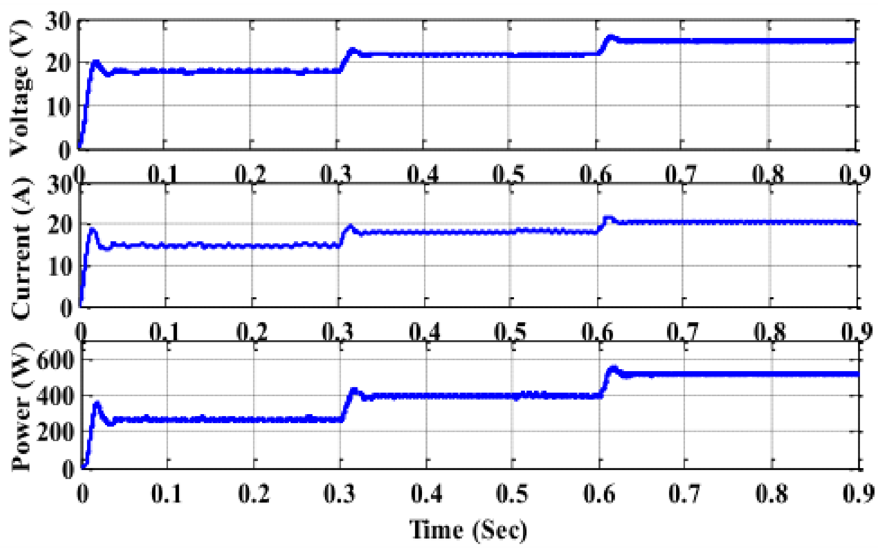

Figure 12 WECS output

The following factors are taken into account when determining the solar irradiation availability for the proposed system: As shown in Fig. 9, 600 W/m2 for a period of 0 to 0.3 sec, 800 W/m2 for a period of 0.3 to 0.6 sec, and 1000 W/m2 for a period of 0.6 to 0.9 sec are calculated by assuming a 40%, 20%, and 0%

shading impact on solar irradiation, respectively. Figure 10 depicts the output voltage, current, and power waveforms of a PV panel when available solar irradiation is taken into account.

The created hybrid system with a single MPPT provides an average DC link power of 587 W from 0 to 0.3 sec, 721 W from 0.3 to 0.6 sec, and 858.8 W from 0.6 to 0.9 sec.

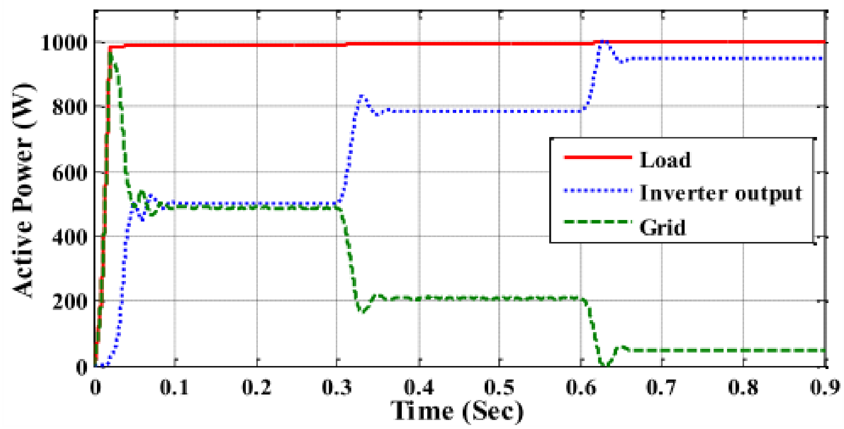

Figure 13 Active power in system

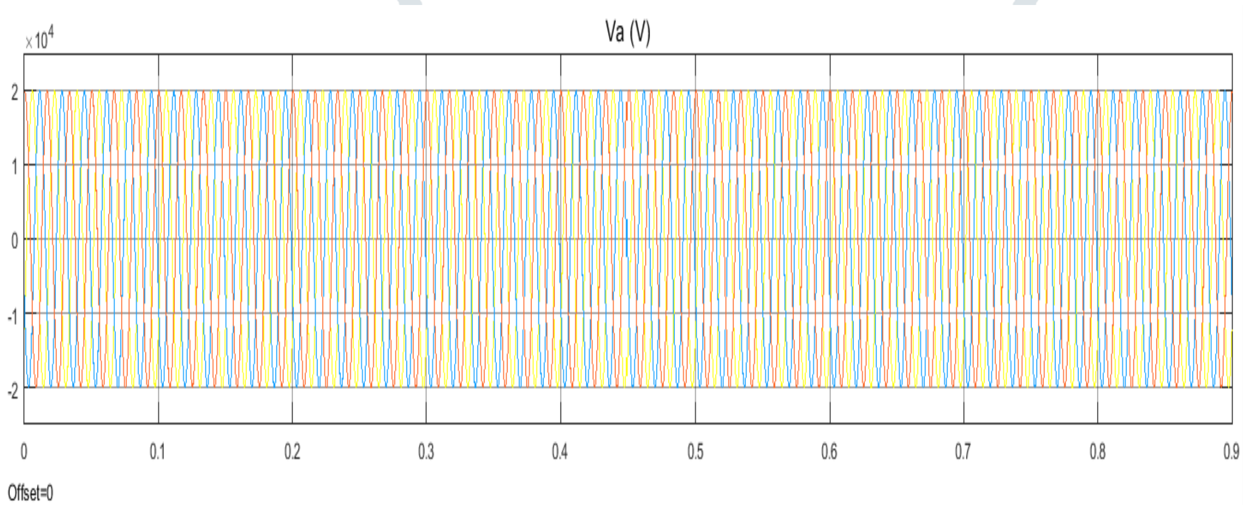

Figure 13 Grid voltage

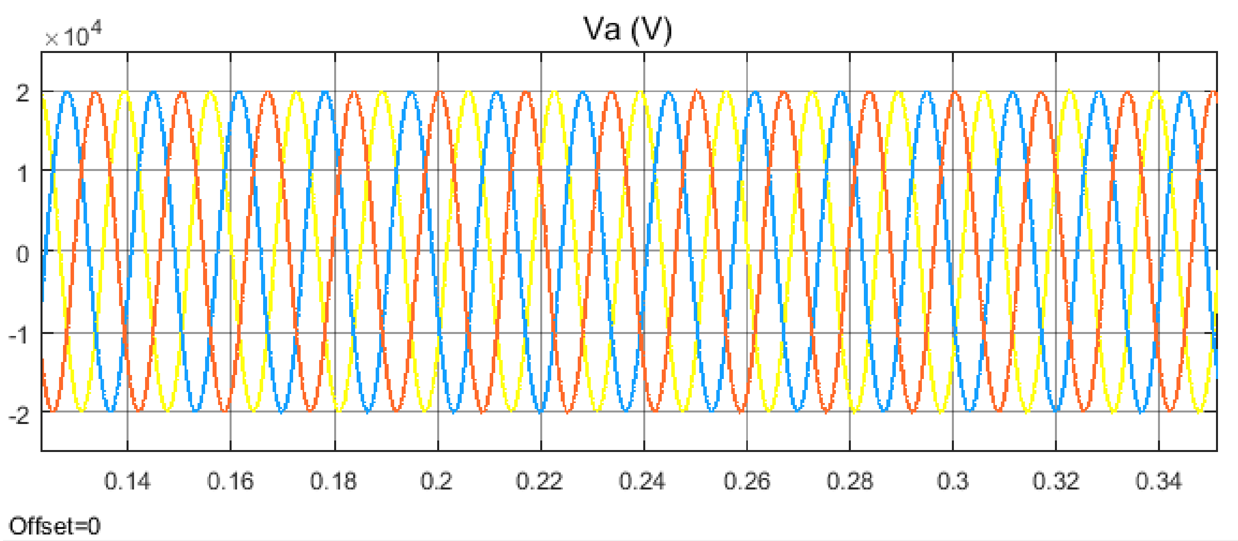

Figure 14: Three phase grid voltage

5. Conclusion

During the recent decade, there has been a rise in electric load. Solar power plants are a beneficial alternative for reducing the strain on the major power systems. The ANN-based MPPT and a hybrid boost converter used for load control is explored in this work. Furthermore, a smart transformer is fitted before load distribution to preserve output power. The MPPT controller based on ANN with converter has quick tracking and low fluctuations. MPPT approaches for extracting power in a system that are accessible in the literature are addressed. The proposed MPPT performance is evaluated in stand-alone and grid-connected modes by taking into account in solar irradiation change and wind speed data.

References

1. Inthamoussou, F.A.; Battista, H.D.; Mantz, R.J. New concept in maximum power tracking for the control of a photo- voltaic/hydrogen system. Int. J. Hydrog. Energy **2012**, 37, 14951–14958.
2. Femia, N.; Petrone, G.; Spagnuolo, G.; Vitelli, M. A technique for improving P & O MPPT performances of double-stage grid-connected photovoltaic systems. IEEE Trans. Ind. Electron. **2009**, 56, 4473–4482.
3. Munir, H.K.; Nur, S.M.; Ahmed, E.-S. Wavelet based hybrid ANN-ARIMA models for meteorological drought forecasting. J.Hydrol. **2020**, 590, 125380.
4. Ruiz-Aguilar, J.J.; Turias, I.; González-Enrique, J. A permutation entropy-based EMD–ANN forecasting ensemble approach for wind speed prediction. Neural Comput. Appl. **2021**, 33, 2369–2391.
5. Akbal, Y.; Ünlü, K.D. A deep learning approach to model daily particular matter ofAnkara: Keyfeatures and forecasting. Int. J. Environ. Sci. Technol. **2021**.
6. Abdul, R.P.; Damhuji, R.; Kharudin, A.; Muhammad, Z.M.; Ahmed, N.A.; Moneer, A.F. Solar irradiance measurement instrumen- tation and power solar generation forecasting based on Artificial Neural Networks (ANN): A review of five years research trend. Sci. Total Environ. **2020**, 715, 136848.
7. Esram, T.; Chapman, P.L. Comparison of photovoltaic array maximum power point tracking techniques. IEEE Trans. Energy Convers. **2007**, 22, 439–449.
8. Femia, G.N.; Petrone, G.; Spagnuolo, G.; Vitelli, M. Optimization of perturb and observe maximum power point tracking method. IEEE Trans. Power Electron. **2005**, 20, 963–973.
9. Li, G.; Wang, H.A. Novel stand-alone PV generation system based on variable step size INC MPPT

and SVPWM control. In Proceedings of the IEEE 6th International Power Electronics and Motion Control Conference, IEEE-IPEMC'09, Wuhan, China, 17–20 May 2009; p. 2155e60.

10. Safari, A.; Mekhilef, S. Simulation and hardware implementation of incremental conductance MPPT with direct control method using cuk converter. IEEE Trans. Ind. Electron. **2011**, 58, 1154–11561.
11. Reisi, A.R.; Moradi, M.H.; Jamasb, S. Classification and comparison of maximum power point tracking techniques for photovoltaic system: A review. Renew. Sustain. Energy Rev. **2013**, 19, 433–443.
12. Xiao, W.; Dunford, W.G. A modified adaptive hill climbing MPPT method for photovoltaic power systems. In Proceedings of the 35th Annual IEEE Power Electronics Specialists Conference, Aachen, Germany, 20–25 June 2004; pp. 1957–1963.
13. Liu, F.; Kang, Y.; Zhang, Y.; Duan, S. Comparison of P & O and hill climbing MPPT methods for grid-connected PV converter. In Proceedings of the 3rd IEEE Conference on Industrial Electronics and Applications, Singapore, 3–5 June 2008; pp. 804–807.
14. Mutoh, N.; Matuo, T.; Okada, K.; Sakai, M. Prediction-databased maximum-power-pointtracking method for photovoltaic power generation systems. In Proceedings of the IEEE 33rd Annu. Power Electronics Specialists Conference, Cairns, QLD, Australia,
23–27 June 2002; pp. 1489–1494.
15. Chao, K.H.; Li, C.J.; Wang, M.H. A Maximum Power Point Tracking Method Based on Extension Neural Network for PV Systems [Part I, LNCS 5551]; Springer: Wuhan, China, 2009; pp. 745–755.
16. Yasushi, K.; Koichiro, Y.; Masahito, K. Quick Maximum Power Point Tracking of Photovoltaic Using Online Learning Neural Network. In Proceedings of the International Conference on Neural Information Processing ICONIP 2009: Neural Information Processing, Bangkok, Thailand, 1–5 December 2009; pp. 606–613.
17. Majed, B.A.; Maher, C.; Zied, C. Artificial Neural Network based control for PV/T panel to track optimum thermal and electrical power. Energy Convers. Manag. **2013**, 65, 372–380.
18. Shahzad, A.; Hafiz, M.; Muhammad, A. Iftikhar, A.; Muhammad, K.A.; Zil, H.; Safdar, A.K. Supertwisting Sliding Mode Algorithm Based Nonlinear MPPT Control for a Solar PV System with Artificial Neural Networks Based Reference Generation. Energies **2020**, 13, 3695.
19. Liu, Y.H.; Liu, C.L.; Huang, J.W.; Chen, J.H. Neural-network-based maximum power point tracking methods for photovoltaic systems operating under fast changing environments. Sol. Energy **2013**, 89, 42–53.