

## A Review On Hybrid Energy Based On Mppt Techniques

M.Tech. Scholar Anshu Bala, Professor Vinay Pathak

Department of Electrical & Electronics Engg.

BITS, Bhopal, MP, India

Anshubala1996@gmail.com, pathakvinay2000@gmail.com

**Abstract-** This Paper provides a succinct and well-organized overview of different maximum power point tracking (MPPT) algorithms used in photovoltaic (PV) generating systems that may operate in partial shade. To far, a broad range of algorithms, PV modelling methods, PV array designs, and controller topologies have been investigated. However, every method has both benefits and drawbacks; as a consequence, while building a PV generating system (PGS) under partial shade conditions, a thorough literature study is required. The thorough review of MPPT algorithms has been done in this article. The review of MPPT methods has been divided into four major categories. The first group consists of entirely new MPPT optimization algorithms, the second group consists of hybrid MPPT algorithms, the third group consists of novel modelling approaches, and the fourth group consists of different converter topologies. This article offers an accessible reference for doing large-scale research in PV systems under partial shadowing conditions in the near future.

**Keywords-** PV systems, Maximum Power Point Tracking (MPPT) Techniques, Hybrid MPPT Techniques.

### I. INTRODUCTION

Renewable energy is power derived from natural possessions, such as solar, wind, waves, or geothermal energy. These resources are renewable and can be recycled naturally. Therefore, compared to the depletion of traditional fossil fuels [1], these sources of information are considered inexhaustible. The global power crunch provides a new impetus for the development or maturity of clean or renewable energy. [2]. In addition to the decline in fossil fuel transportation worldwide, another major reason fossil fuels do not work is the pollution associated with burning fossil fuels. In contrast, it is well known that compared to traditional energy sources, renewable energy sources are cleaner, or energy produced has no adverse effects on pollution.

Wind turbines can be used to harness the power generated by the airflow [3]. The power of turbines used per day is around 600 kW to 5 MW [4]. Because power output is a function of wind speed, it amplifies hastily as wind speed increases. Recent advances have become wind turbines, which are more resourceful than better aerodynamic construction. 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 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]. 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.

**Solar Photovoltaic-** Correspondingly, the solar power generation system is proposed in Figure 1. A solar cell or panel comprises a model derived from solar cells connected in series or parallel to provide the required currents and energy. solar intertie photovoltaic (PV) systems are not particularly complex. First there are panels, which collect the sunlight and turn it into electricity. The DC signals are fed into an inverter, which converts the DC into grid-compatible AC power (which is what you use in your home). Various switch boxes are included for safety reasons, and the whole thing is connected via wires and conduit.

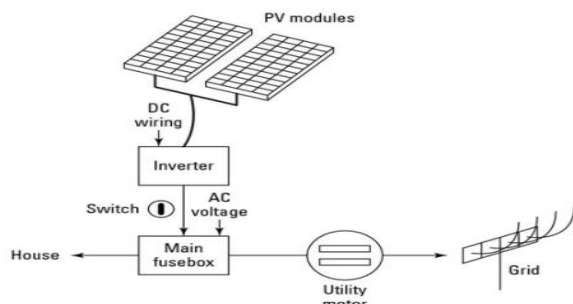


Figure 1 Basic Solar (Photovoltaic) System [6].

Storage batteries can provide protective power during periods of free sunlight by storing more or part of the power from solar panels. Solar power generation systems are used for private power consumption, weather stations, and radio or television stations, entertainment venues, such as cinemas, hotels, restaurants, villages, and islands. The traditional p-n junction solar cell is the most advanced solar energy collection technology. The fundamental physics of energy input and carrier output functions the physical properties and the associated electrical properties (i.e., the band distance).

The electron needs to have energy greater than the bandgap to excite electrons from the valence band to the conduction band. An ideal solar cell has a direct band gap of 1.4 eV to absorb the maximum number of photons from the sun's radiation. The seemingly infinite lattice creates bands of allowed energy states; silicon creates a band gap where no electrons exist (a band gap that is 1.1 eV wide). However, the sun's radius is close to the black spectrum of about 6000 K. Therefore, most of the rays from the sun reaching the earth have a source of energy greater than the radius of the sun silicon group.

These high-energy phonons will be cured by solar cells. Still, the distance between the phonons and the silicon band will be converted to heat (via an overflow called phonons) instead of usable energy. For a single meeting cell, this will set a maximum efficiency of around 20%. Current research methods to perform multi-node photovoltaic design to overcome efficiency limits do not seem to be an expensive solution. Even a built-in PV device can only be used during the day and needs direct sunlight (directly connected to the interior) for optimum performance.

## II. LITERATURE REVIEW

**Marina Babayeva et.al (2020)** In this paper, wind energy is considered as a promising trend for the development of alternative energy. The physical implementation of a wind generator based on the Magnus effect is explained, as well as its mathematical model. The relationship between the rotation speed of the blades of a wind generator, the rotation speed of the rotor of the generator and wind speed is considered. The influence of the parameters on the

mechanical power coefficient is evaluated. Algorithms for tracking the maximum power point and the effect of mechanical power coefficient on the amount of generated power are considered. Changes in the mechanical power coefficient during mathematical modelling under various conditions are analyzed.

**Chao Xing;et.al (2020)** This article briefly analyzes the technical advantages of the wind-solar hybrid power generation system, builds models of wind power generation systems, photovoltaic systems, and storage batteries, focusing on the key to wind and photovoltaic power generation systems-maximum power point tracking (MPPT) control, and detailed analysis of the maximum wind and solar power. The principle of power tracking and several commonly used MPPT methods, and the simulation and analysis of the MPPT control strategy of wind and photovoltaic in the wind-solar hybrid power generation system on Matlab / Simulink.

**Guyuan Ji et.al (2020)** Maximum power point tracking (MPPT) performance is an important control target for wind energy conversion systems. There is an optimal generator speed that allows the system to capture maximum wind energy at a certain wind velocity. This paper proposes a variable speed wind power generation system (VSWPGS) using a switched reluctance generator (SRG) and AC-AC converter. For the theoretical verification of the proposed system, the mathematical formulas that including the wind turbine, SRG, the AC-AC converter, and the control system were constructed. The MPPT control strategy of the optimal tip speed ratio method is adopted to the whole system. It was a simulation with changing wind velocities in Matlab/Simulink.

**Khoulood Bedoud et.al (2020)** This paper presents the description, modeling, and control of an electrical energy production system based on a wind power system operating at variable speed. Such energy production systems are inevitably called upon for randomly varying wind speeds. Moreover, MPPT control using fuzzy logic observer (FLO) for rotational speed estimation without using wind speed data is adopted. To improve and verify this approach's effectiveness, a quantitative and qualitative analysis of the energy generation system with a power of 1.5 MW is investigated by numerical simulation using Matlab/Simulink software. Thus, simulation tests validate the technique and improve the dynamic behavior of the system.

**Krunalkumar R. Prajapati et.al (2019)** In this paper, application of fuzzy logic in the function of artificial intelligence technology is applied for the tracking down the point of maximum power in a stand-alone wind power system having PMSG as a generating machine. With the purpose of tracking the maximum power that can be extracted from wind energy with wind alteration, the hill climb search (HCS) algorithm is implemented using fuzzy

logic control (FLC) method. In a stand-alone wind energy conversion system along with a predetermined load, a battery as an electrical energy storage device is used for the storage of excessive power. This proposed scheme has been simulated in Matlab/Simulink and obtained results for the same.

**Hayat Elaissaoui et.al (2020)** In this paper we have studied a hybrid system that combines two photovoltaic and wind energy system. For the purpose of improving the performance of this system, we have proposed a new Maximum Power point tracking MPPT. The proposed algorithm is based on fuzzy logic (FL) and ANN artificial neural network. For the photovoltaic system (PV), ANN is used to estimate the maximum output voltage of the photovoltaic generator (PVG) under different environmental conditions (Temperature and Solar irradiance). The fuzzy logic is used to control the DC-DC boost converter. For the wind turbine system (WT), the ANN is employed to estimate the maximum output voltage for different wind speed values and the Fuzzy Logic Controller (FLC) is used to control the DC-DC boost converter. To verify the effectiveness of the proposed MPPT, the simulation is done under MATLAB/SIMULINK.

**Jyotismita Mishra et.al (2018)** This paper proposes a load voltage based maximum power point tracking (MPPT) algorithm for a standalone wind generation system (WGS). The algorithm uses the slope of change in load voltage to duty cycle for extracting the optimum power. The MPPT performance at steady-state and during wind speed change condition is verified through experiment. The proposed algorithm uses only one voltage sensor which makes the system less costly, simple to implement and robust. Moreover, it neither requires the knowledge of any system parameter nor the speed sensor. The controller is implemented in DS1103 digital platform with the developed laboratory setup.

**Tomas Syskakis et.al (2019)** To increase the adoption of micro- and pico-grid systems, easy to use and commercially viable distributed generation solutions are required. The proliferation of distributed generation systems has accelerated the research and implementation of small wind turbines (SWTs) as viable renewable energy solutions. Sophisticated Maximum Power Point Tracking (MPPT) algorithms, used for large wind turbine installations, are not implemented with SWTs as they require turbine parameterization and costly sensors such as anemometers.

Due to financial considerations, traditional SWTs implement either no MPPT or very simple algorithms such as an Incremental Conductance (InCond) or Perturb and Observe (P&O). In this work, a novel and computationally efficient SWT MPPT algorithm, derived from the InCond method, is proposed. A control-oriented model of the

SWT system is also presented which facilitates fast simulations using conventional power electronics software. The proposed MPPT algorithm offers 3 key advantages: 1) elimination of algorithm confusion due to change in wind velocity, 2) fast and accurate tracking of the maximum power point (MPP) and 3) improved steady state efficiency. The behavior of the proposed algorithm is presented and corroborated in simulations and experimental validation, using a custom-built Turbine Emulation Platform (TEP), is also included.

**Shefali Jagwani et.al (2018)** For utilizing the wind energy to its full potential and to ensure the reliable power across critical loads, a Switched Reluctance Generator (SRG) with grid interactive inverter is presented for wind energy conversion systems (WECS). A wind turbine is emulated using Maximum Point Power Tracking (MPPT) algorithm in which tip speed ratio is controlled to obtain the reference speed for SRG. In order to control the SRG, the reference current, turn-on angle and turn-off angle are controlled. A single-phase grid interactive inverter is used which operates in both grid connected (current control) and off-grid (voltage control) modes. Robust power flow control for various cases in on-grid and off-grid modes are presented which depends upon the state of charge (SOC) of generation bus battery.

**Chenghao Fu et.al (2018)** Wind energy is a promising renewable energy resource which is cheap, eco-friendly and inexhaustible. A wind energy generating system with wind turbine, generator and converters is established to capture and integrate wind energy and transfer it to the grid. This paper discusses the modeling of the wind energy generating system, including wind speed, wind turbine, generator, generator side converter, grid side converter. After the introduction of the three traditional MPPT methods (TSR, PSF, HCS), a fuzzy slope HCS method is proposed to ensure the rapidity and accuracy of the system. Finally, simulation in Simulink shows that the method is feasible and able to capture most wind energy.

### Summary

Various maximum power point tracking techniques are discussed for solar PV energy conversion systems in this chapter. Many types of a control algorithm for wind energy conversion system is discussed. The advantages and disadvantages of the MPPT techniques are explained. The objective of the proposed research work is to find a suitable method for MPPT tracking.

## II. SOLAR-WIND HYBRID POWER SYSTEM

The electric system that combines solar energy and wind energy is named as hybrid power system, which offers several advantages over either single system. In much of the areas, wind speeds are low in the summer when the sun shine brightest and longest. In winters less sunlight is

available and wind is stronger. Hybrid systems produce power when it will be needed. The peak operating time for wind and solar occurs at different times of day and year. Many hybrid power systems are stand alone systems which are not connected to an electricity distribution system. When neither the wind nor the solar system is generating power, the hybrid system provides power through batteries. The engine generator can provide power and recharge batteries, when batteries run low. Modern electronic controllers can operate hybrid systems automatically, by adding engine generator which makes the system complex. Other components needed for the system should be small in size due to engine generator. During non charging period the storage capacity must be large enough to supply electrical need. The solar energy system output and wind energy system output are added together in parallel because if one source is absent the other one can compensate for it. Solar energy system and wind energy system can work separately and together. However by combining these two intermittent sources and by incorporating maximum power point tracking (MPPT) algorithms, the system power transfer efficiency and reliability can be improved significantly. MPPT is specifically used to extract the maximum available power from the PV array.

Maximum power can be achieved by tracking the Maximum Power Point (MPP) using specialized algorithms such as Perturb and Observe (P&O) and Incremental Conductance (INC). These algorithms are the most commonly used due to their simplicity in implementation compared to other algorithms. In addition, it illustrates the theory of operation of both P&O and INC algorithms. The simulation work (using Matlab/Simulink) evaluated the algorithms under different operating conditions (temperature and solar irradiance) and showed that each algorithm has advantages over the other. P&O is the fastest to reach the MPP and charge the battery, but it can't retain the MPP as the INC algorithm can do. Meanwhile, INC can reach the MPP with lower perturbations, lower switching rate, higher efficiency, and higher lifetime for the used components. The proposed configuration is simulated in MATLAB/SIMULINK. Both simulation and experimental results match the theoretical expectations closely.

**Wind Power**-the existing wind speed as well as the generator speed, either measured or estimated, in order to calculate the necessary information for the controller unit (30). In order for the PSF control to work the generators maximum power curve has to be acquired in advance, either through simulations or empirical testing. Through measuring the frequency and comparing it to the expected values, attained previously, in a look up table the MPPT can be obtained (30). The HCS method uses an algorithm that continuously searches for the maximum power. By changing the load by a small increment and comparing if the change reduced or increased the power output. The

load is thereafter adjusted accordingly (30). Though, problems in tracking rapid changes in wind are a known issue for wind turbines with a large inertia (31). However, the use of MPP tracker in smaller wind power systems is not always needed. Depending on how the system is built the ability, or need to adjust or load the generator, are sometimes abundant. For example a wind power system connected to the grid using a PMSG, fixed pitch and variable speed will always run on optimal TSR, i.e. operating at the MPP, due to the fact that the grid has a fixed frequency. Though, the MPPT equipment could still be useful. For example it can be used instead of a gear box. Smaller wind power systems usually do not have gearboxes. Consequently there is no way for control. The implementation of control equipment for controlling smaller wind turbines is therefore in order of priority.

**Modeling of Hybrid Solar - Wind System** -A hybrid solar-wind system consists of PV array, wind turbine, battery bank, inverter, controller and cables. The PV array and wind turbine work together to satisfy the load demand. When energy sources (solar-wind) are abundant, the generated power from the solar, in the day time will continue to charge the battery until it is fully charged. On contrary the when energy sources are poor, the battery will release energy to assist the PV array and wind turbine to cover the load requirements until the storage is depleted. The hybrid solar-wind system modeling is mainly dependent on the performance of individual components. In order to predict the system performance, both sources of power generation should be modeled separately and will be combined to meet the demand reliability. If the power output prediction from these individual sources is accurate enough, the resultant combination will deliver power effectively. A hybrid system could be designed to operate either in isolated mode or in grid connected mode, through power electronic interface.

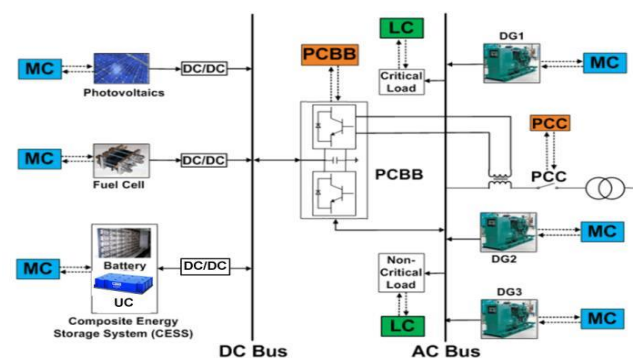


Figure 2 architecture diagram.

**Maximum Power Point Tracking** -Most of the MPPT algorithms residential in recent years have been discussed in the preceding sections. Some of them are related, using the same rules, but in different ways, like the last three algorithms listed in Hill Climbing Technique. According to the number of releases, the most popular MPPT



algorithms are P&O, InCond, and Fuzzy Logic. However, they have a few disadvantages, as mentioned earlier. In the next chapter, we will examine the effectiveness of these three algorithms. They were chosen for their plainness or reputation. In the case of P&O and InCond, a few suggestions are offered, which overcome the limitations of the original method of tracking MPP below the water's edge. The FLC was designed according to reference, and its active efficacy was tested and compared with the MPPT scaling method. As explained previously there is a significant gain in efficiency to be achieved if the solar cell is operating near its MPP. MPP tracking methods can be applied for both wind and solar power. Though, the methods utilised for wind and solar differs slightly.

The next section intends to give an introduction to the most common methods used for both resources, which aims to illustrate their differences. The P&O method, also known as the trial and error method, operates through changing the terminal voltage of the solar array by a small step,  $V$ . It then compares if the power output of the array increases or decreases. Depending on the outcome, the  $V$  of the next perturbation cycle is either deducted or added. Furthermore since the step size  $V$  is a fixed value. Assigning a small value for the step size results in slow tracking but good accuracy, and vice versa if the step size is too large. Moreover, the P&O method will never achieve the exact MPP since it continuously checks for a better power output, i.e. raises and lower the terminal voltage. Instead it will oscillate around the MPP. The overall performance of the P&O method is good. Though, the tracking and accuracy ability varies depending on step size. More so, erratic behavior has been observed when tracking rapid changes, resulting in the MPP searching in the wrong direction [10].

The incremental conductance method achieves the MPP through measuring the power and voltage output of the photovoltaic cell. It then calculates the derivative of power with respect to voltage. With the knowledge on how power varies as a function of voltage for a photovoltaic cell, i.e. the PV- curve. The maximum power point can be found when is set to zero. Accordingly, if the derivative is not zero, the controller changes the duty cycle so that the equation is fulfilled with the constraint of being zero. The IC method is better than the P&O in the sense that it does not oscillate around the MPP due to the fact that it measures the changes in current and voltage. For example, if the insolation is fixed the voltage and current would remain steady, resulting in the IC method eventually settling at the MPP (10).

The constant voltage and current method is based on the fact that for a given insolation the ratio between the array's  $V_{MPP}$  and  $V_{OC}$  is close to constant. Accordingly, if the value of  $V_{OC}$  is obtained the value of  $V_{MPP}$  can be calculated through equation above. The voltage level of the array is then varied until the voltage level corresponds

to the  $V_{MPP}$ . Acquiring the value of  $V_{OC}$  is done through measurements during a small period where the MPPT is briefly isolated from the array.

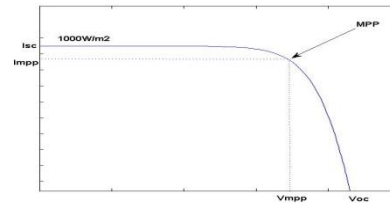


Figure 3 Voltage and current  $I_{mpp}$  &  $V_{mpp}$  at the MPP

The following methods are commonly used for finding the MPP for wind energy systems Tip Speed Ratio (TSR)

### III.CONCLUSION

A MATLAB MPPT system model for Photovoltaic's was developed in order to compare the performance of the Constant Voltage, Perturb and Observe, Power Increment, Hybrid of Constant Voltage with P&O and Hybrid of Power Increment with P&O under different weather conditions. This study was conducted in order to compare and evaluate the performance of each implemented individual MPPT technique and to demonstrate how Hybrid MPPT techniques outperform individual techniques when working on their own without any added complexity since Hybrid techniques combine the merits of each algorithm and eliminate their drawbacks.

The Hybrid of Constant Voltage with P&O achieved the higher tracking accuracy of a small step size P&O with the faster convergence speed of the Constant Voltage. Whereas, the Hybrid of Power Increment with P&O achieved better accuracy speed than the two individual algorithms along with the ability of tracking the GMPP under partial shading conditions provided by the Power Increment. Also, the performance of the Hybrid algorithms under both sudden and dynamic compared to their performance individually; as the presence of the P&O provided high performance under dynamic weather conditions. Moreover, the addition of the P&O to the Power Increment improved the speed of the latter under sudden changes in irradiance, while the convergence speed of the former under sudden irradiance changes was also boosted when hybridized with the fast Constant Voltage.

### REFERENCES

- [1] Marina Babayeva; Artur Abdullin; Nikolay Polyakov; Stanislav Aranovskiy MPPT Algorithms for Magnus Effect Wind Turbine Control System 2020 XI

- International Conference on Electrical Power Drive Systems (ICEPDS) Year: 2020
- [2] Chao Xing;Xinze Xi;Xin He;Mingqun Liu Research on the MPPT Control Simulation of Wind and Photovoltaic Complementary Power Generation System 2020 IEEE Sustainable Power and Energy Conference (iSPEC) Year: 2020
- [3] Guyuan Ji;Kazuhiro Ohyama MPPT control of Variable Speed Wind Power Generation System using Switched Reluctance Generator and AC-AC converter 2020 23rd International Conference on Electrical Machines and Systems (ICEMS) Year: 2020
- [4] Khoulood Bedoud;Hichem Merabet;Tahar Bahi;Djalel Drici Fuzzy Observer for MPPT Control of Variable Wind Energy Conversion System Associated to AC-DC Converters 2020 20th International Conference on Sciences and Techniques of Automatic Control and Computer Engineering (STA) Year: 2020
- [5] Krunalkumar R. Prajapati Application of fuzzy logic for MPPT control in stand-alone wind energy conversion system with a battery storage system 2019 IEEE International Conference on Intelligent Techniques in Control, Optimization and Signal Processing (INCOS) Year: 2019
- [6] Hayat Elaissaoui;Mohammed Zerouali;Abdelghani El Ougli;Belkassam Tidhaf MPPT Algorithm Based on Fuzzy Logic and Artificial Neural Network (ANN) for a Hybrid Solar/Wind Power Generation System 2020 Fourth International Conference On Intelligent Computing in Data Sciences (ICDS) Year: 2020
- [7] Jyotismita Mishra;Monalisa Pattnaik;Susovan Samanta Load Voltage based MPPT Algorithm for a Stand-alone Wind Generation System 2018 15th IEEE India Council International Conference (INDICON) Year: 2018
- [8] Tomas Syskakis;Martin Ordonez MPPT for Small Wind Turbines: Zero-Oscillation Sensorless Strategy 2019 IEEE 10th International Symposium on Power Electronics for Distributed Generation Systems (PEDG) Year: 2019
- [9] Shefali Jagwani;Gyanendra Kumar Sah;L. Venkatesha MPPT Based Switched Reluctance Generator Control for a Grid Interactive Wind Energy System 2018 7th International Conference on Renewable Energy Research and Applications (ICRERA) Year: 2018.
- [10] Chenghao Fu;Tinglong Pan;Hui Liu;Dinghui Wu;Yanxia Shen;Zeliang Hao MPPT Control Based Fuzzy for Wind Energy Generating System 2018 37th Chinese Control Conference (CCC) Year: 2018