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# Review Paper on Hybrid Power Generation Using Perturb & Observe (P&O) Algorithm

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***Abstract*: -- The sun and wind-based generation are well considered to be an alternate source of green power generation which can mitigate the today's power demand issues. The study reveals that a supervisory control unit, designed to execute Maximum Power Point Tracking (MPPT), is introduced to maximize the simultaneous energy harvesting from overall power generation under different climatic conditions. In Photovoltaic system, Perturb & observe (P&O) algorithm is used as MPPT control & Hill Climb Search (HCS) algorithm is used as MPPT control logic for wind power system in order to maximize the power generated. This research paper provides a concise yet comprehensive critical analysis of these techniques with an in-depth review of their strengths and drawbacks. This review is unique as it offers such a complete investigation of MPPT control using P&O algorithm in PV-Wind hybrid power generation. Therefore, this research paper can serve as a precise reference for the future research on MPPT for PV-Wind power generation system.**

***Keywords*— Maximum Power Point Tracking (MPPT), Perturb & Observe (P&O), Fuzzy-Logic Controller (FLC), Cuk-SEPIC converter.**

## I. INTRODUCTION

Renewable energy sources are introduced in past two decades to fulfil the ever increasing demand of world's population. Non-conventional energy sources such as sun and wind are popular and can be utilized in a better way when used togetherly i.e. as hybrid wind-PV power generation system. When these two sources are combinely used, the efficiency of generation can be increased from 15% to 50% of available energy. In this review paper, the work done about MPPT by using P&O algorithm by researchers for two decades is analysed and an even better approach is suggested so as to increase the accuracy, adaptability & efficiency of system with its economical utilization. The advancement in technology from 2004 till today which are used in P&O MPPT method are analysed and their advantages and drawbacks are recorded and a better design for this technique is suggested.

## II. OVERVIEW OF WORK DONE BY AUTHORS OVER A DECADE

**1. Weidong Xiao, William G. Dunford IEEE-2004**
They have proposed a modified adaptive hill climbing method which is used to attain maximum power point in PV systems. The advantage of this method is its simplicity. Stability to deal with non-linearity is the most fundamental requirement & is achieved successfully using this technique.

**Conclusion :-**
Due to automatic parameter tuning good dynamic as well as steady state performance is achieved. Tracking speed is also faster & this control method exhibits better overall performance.

**2. Nicola Femia, Giovanni Petrone, Giovanni Spanguolo, Massimo Vitelli IEEE-2005**
They have proposed the method that allows optimal choice of parameters for P&O method to attain MPPT. Attaining maximum power point is very crucial for power generation system to give efficient performance. There are some drawbacks of P&O such as at steady state the operating point oscillates around maximum power point which creates wastage of some available energy, moreover P&O algorithm can be confused during time intervals of rapidly changing atmospheric conditions. Thus in order to limit the drawbacks, parameters are needed to be customized for better dynamic behavior of converter adopted.
**Conclusion :-**
P&O controller can work with better efficiency only if dynamic behavior of whole system is stable or with less fluctuations. Thus for this, we need to adopt new power electronic devices or technologies for improvement of P&O method.

**3. Joanne Hui, Alireza Bakhshai, Praveen Jain IEEE-2010**
They have proposed a new system configuration of front-end rectifier stage for hybrid wind-PV energy conversion system. They have used Cuk-SEPIC converters along with multi-input rectifier stages & standard P&O method for the system.
**Conclusion :-**

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The multi-input rectifier circuit used possesses good features 1) additional input filters are not required for eliminating harmonics. 2) Output from both sources can be stepped up or down. 3) MPPT can be realized for each sources. 4) Individual & simultaneous operation is supported.

**4. Yuehua Huang, Yang Xu, Xingchen Zhou IEEE-2011**

They have proposed MPPT control method for wind-solar hybrid power generation system according to basic principle of variable step perturbation tracking MPPT algorithm. They have adopted common DC/DC charging controlling unit to simplify the control process.

**Conclusion** :-

From simulation result it was concluded that not only this control method can make full use of available energy from PV-wind but also output current of system attains stable value throughout & impact on battery is reduced.

**5. Teena Jacob, Arun S – IEEE 2012**

They have proposed DC-DC converter topology for hybrid wind-PV system. They have used fusion of Cuk-SEPIC converters so that separate or simultaneous operation can be configured as per requirement. Along with this slight perturbation algorithm is introduced in the system to attain the maximum power point.

**Conclusion :**

Cuk & Sepic converter allows two sources to operate individually or simultaneously. System has low operating cost & can be used for rural electrification.

**6. Siddharth Joshi, Dr. Vivek Pandya, Dr. Bhavesh Bhalja IEEE-2014**

They have proposed MPPT algorithm for small scale wind energy conversion system (WECS) & Photovoltaic module for power generation. The MPPT algorithms are categorized into three types

a) Tip-Speed Ratio (TSR)
b) Power-Signal Feedback (PSF)
c) Hill-Climb Search (HCS)

**Conclusion :-**

For wind turbine, dc side current is chosen as perturbing variable in the proposed algorithm & for PV module, DC power is taken as perturbing variable. Thus, if load will increase, DC reference will try to track maximum power according to changing reference value.

**7. Luigi Piegari, Renato Rizzo, Ivan Spina & Pietro Tricoli-energies journal Apr-2015**

They have proposed P&O method for PV generation. Proposal suggests a design criterion to select the parameters of P&O controller by using a 'dual input inductor push-pull converter'.

**Conclusion** :-

The conclusion of this paper is that the chosen function enables more flexibility of algorithm i.e. it shows comparable reactivity during transients even if no adjustment is operated on perturbation voltage step for different operating conditions.

**8. B. Meghni, N.K. M'Sirdi, A. Saadoun - Elsevier journal-2015**

They have proposed Permanent Magnet Synchronous Generator (PMSG) system with two controllers for generator side & grid side converters in Variable Speed Wind Turbine (VSWT). A newly designed MPPT algorithm using Variable Structure Automatic Systems (VSAS) approach was used. For controller, the technique used was Modified Enhanced Perturb & Observe (MEPO). The control strategy of proposed technique was based on setting the speed of machine when operating point moves towards maximum power point and selecting appropriate step size though larger step-size means faster response hence more oscillations resulting in less efficiency. Thus smaller step size improves efficiency but decreases convergence speed.

**Conclusion :-**

Two side control mechanism i.e. generator side & grid side balances the system parameter & gives better performance.

**9. Tanmoy Maity, Sushma Kakkar, Rajesh Kumar Ahuja IEEE-2016**

They have proposed P and O method for hybrid wind-PV generation system using Cuk-sepic converter & a 3 phase pulse width modulated inverter to convert dc to ac & supply power to ac loads.

**Conclusion :-**

From simulation results, it is found that the hybrid system is able to meet the load requirement is hybrid as well as distinct mode. THD of ac side current is found to be 3.9% in hybrid mode, 3.89% in PV mode & 3.9% in wind mode. The active & reactive power is regulated to reference values in all 3 modes of operation viz. hybrid, PV & wind.

**10. Ahmed SAIDI – IEEE 2017**

This paper introduces MPPT tracking for standalone hybrid PV-wind system. For photovoltaic system, simple P&O algorithm is used and for wind generator system P&O along with fuzzy logic control scheme is used to attain MPPT.

**Conclusion :-**

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Cost of system is reduced as it is a compact converter system. Solar PV augmentation of appropriate capacity with minimum battery storage provides solution for issues during low wind speed situation & fuzzy logic converter gives more power efficiency & is reliable compared to PI voltage regulated inverter.

## III. CONCLUSION

For better performance in wind-PV hybrid power generation system, it is very important to attain stability in steady state as well as in dynamic conditions. System can be made more stable when it gains higher adaptability towards changing atmospheric conditions. From the research analysis it can be concluded that along with modified adaptive P&O algorithm, fuzzy-logic controller (FLC) can be used to increase efficiency & reduce cost of system.

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