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Maximum Power Point Tracking of a Hybrid PV-Wind–Diesel System for Micro Grid

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Abstract- This paper proposed a hybrid system a combination of photovoltaic source and wind energy with Diesel system. The objective of the proposed work is to implement P&O mechanism on MPPT system, to implement Fuzzy Inference System based MPPT system and to implement PID based MPPT system. The simulation of the proposed Perturb and observe (P&O) and Fuzzy Logic algorithms MPPT techniques is done in MATLAB and results are compared in terms of certain parameters. It is analyzed that fuzzy Logic MPPT approach is the most efficient approach performs well as compared to existing technique.

Keywords- ***MPPT, Perturb and observe (P&O) Technique, Photovoltaic (PV), Diesel generator (DG), DC link***.

I. INTRODUCTION

The power sectors need alternate energy resources to meet the power demand because the natural resources on Earth are decreasing with time. Because of use renewable energy sources, the carbon content in the climate can be diminished by which an Earth-wide temperature boost issue can be survived .PV systems have simpler structure and therefore, they are leading the market presently [1]. There had been discussions on the structure of PV panel systems already. Controller for maximum power and power electronic devices are used to improve the productivity of PV systems [2]. The maximum power point tracking controller is used to extract maximum power from a photovoltaic module. In this way, its efficiency can also be increased [3]. There are various algorithms for calculating the maximum power point. The already existing MPPT algorithms mostly track slowly. Because of this, the usage productivity is decreased. Different calculations for ascertaining maximum power point like Perturbation and Observation and Fuzzy logic are examined. Comfort, etc. and increasing the productivity are the major goals of energy transformations [4]. Energy supplied to the people must be affordable, secure and sustainable in order to provide future prosperity [5].

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Out of the total energy consumed, 45% is used for the purposes that use heat like drying, heating of water and cooking, 10% is used by industrial processes that need high temperature heat, 15% is used by electronic services and 30% is consumed by transport for meeting these demands, mainly fossil fuels are used and CO_2 emitted is almost 80% of the total global emissions [6].

The economic progress and energy demands are interlinked with each other. In developing countries, the demand for energy is increased tremendously over last few years [7,8]. The hybrid system can work in three unique modes, which Incorporates ordinary activity without utilization of battery, dispatch operation, and averaging operation [9,10].

Sources Of Energy

Various sources of energy on earth are coal, natural gases, petroleum etc. They are divided into two categories:

- Renewable Sources
- Non-Renewable Sources

II. LITERATURE REVIEW

Much research works have already existed in the literature which depends on the various energy sources with different algorithms. A portion of the works is inspected here.

S. Khadija et al. [2017] , have an approaches of MPPT i.e. IC (Incremental conductance) and P&O (perturbation & observatio). Thus, author dedicated a part of work to study of components comprising overall PV system i.e. photovoltaic module, DC-DC converter with MPPT controller. And other part to contrast MPPT approaches-both designed in MATLAB / SIMULINK. From the obtained results, it has been demonstrated that IC approach outperforms P & O approach.

P. Vincent et al. [2014], an innovative methodology for wind turbine having variable speed was simulated utilizing PMSG. This system consists of power conditioner that comprise of diode rectifier which was powered by phase shifting transformer and then it was cascaded with PWM voltage source inverter. The simple MPPT control approach finds the best active reference current that has been controlled via grid-side PWM inverter's active current. MPPT approach tracks wind turbines' maximum power. The major benefit of this system is that price can be minimized and the grid side MPPT control leads to enhanced performance and offers maximum power from the wind energy to load. Wind energy is unique renewable energy source which is unpolluted and inexhaustible, due to this it has gained the most attention in world.

Y. Zhu et al. [2014], explained that it is very significant to improve the efficiency and stability of wind power conversion system. For this, MPPT algorithm was proposed in this paper based on experiment data i.e. open-jet and return-flow wind tunnel was utilized for simulating natural wind and curve of optimal rotate speed versus optimal power was calculated.
The analytical procedure via utilizing proposed algorithm can be appropriate to vertical axis wind turbines, and wind power conversion system's efficiency and stability have been increased efficiently.

S. Kundu et al. [2016], given idea to implement MPPT approaches, various algorithms had been proposed. In the presented paper, work performed in solar MPPT approaches was reviewed, along with that, the benefits and drawbacks of different approaches were mentioned. This paper provides quick access to previous work done in MPPT field and therefore, suggests the future enhancements that can be done in MPPT techniques.

H. I. Cristian et al. [2014], presented the MPPT systems to extract high amount of power from PV installation. A maximum transfer among generator and receiver was attained via interconnecting the DC-DC converter that carried out load's continuous adaptation to the PV generator. This principle had represented the MPPT system's basis. The output of PV cell power majorly relies upon 2 variables i.e. ambient temperature (T) and insolation level (G). Therefore, MPP (maximum power point) relies upon these two variables for the panel orientation set. By reaching the MPP, transfer among PV generator and the receiver was done using MPPT control approaches. This paper has presented the major MPPT control approaches at operating level and contrast of performances.

Ray P. et al. [2015], dependent upon enhancement of quality of power with the hybrid power generating system consisting of PV and Wind system. The enhanced MPPT system based on fuzzy logic was implemented for hybrid system that offers highest amount of power and can obtain stable as well as reliable power from generation system for loads and utility grid therefore enhances entire generation system's steady and dynamic behaviors.

III. RESEARCH METHODOLOGY

It has gotten basic for the power and energy specialists to look 5out for the sustainable energy sources, for example, sun, wind, geothermal, sea and biomass as manageable, financially perception and condition amicable choices for conventional energy sources. However, non-accessibility of these sustainable energy source assets all the time to research in area of hybrid renewable system.

Hybrid system that connect more than one energy source can enhance the certainty of capacity demands every moment, Even higher producing capacity can be achieved by hybrid system. In stand-alone system hybrid system provide fluctuation free output to the load irrespective of climates situations. To get the energy output of the PV system converted to storage energy, and continuous power delivered by the wind turbine, for efficient energy storage a battery bank is used.

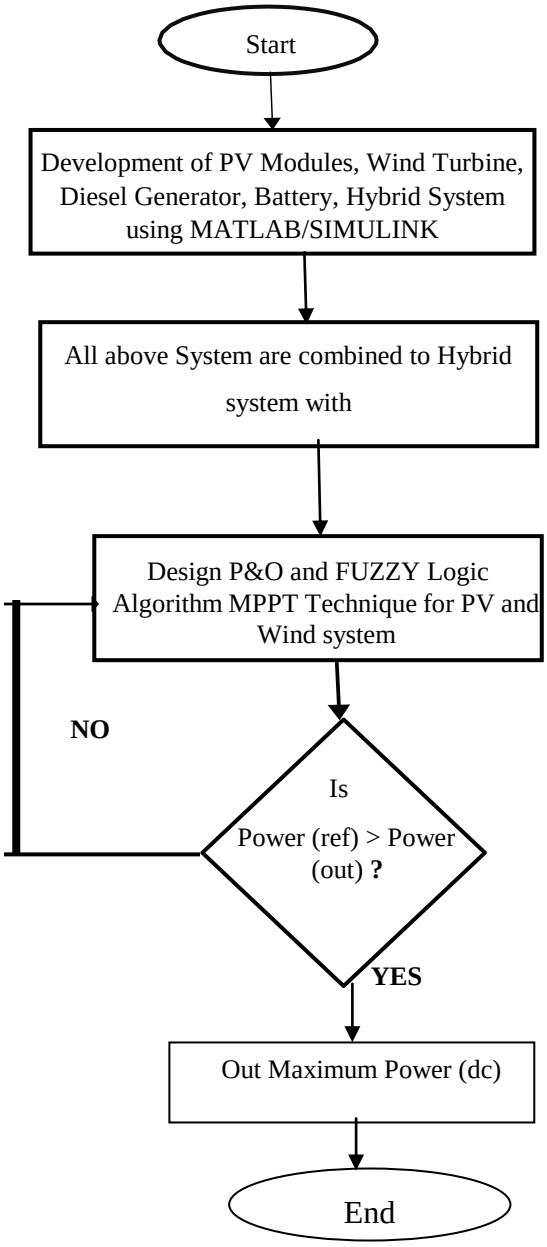

Fig. 1: Flow Chart of the Proposed Work

IV. EXPERIMENTAL WORK

The hybrid MPPT system is developed in the present work by combining the Wind system, Battery system, DG system, PV Array system.

A. Modelling of Solar MPPT using Perturb and Observe Algorithm

The simulation model of the solar MPPT is shown in Fig. 2. This model is represent the comparison between the power accomplished using an perturb and observe MPPT algorithm.

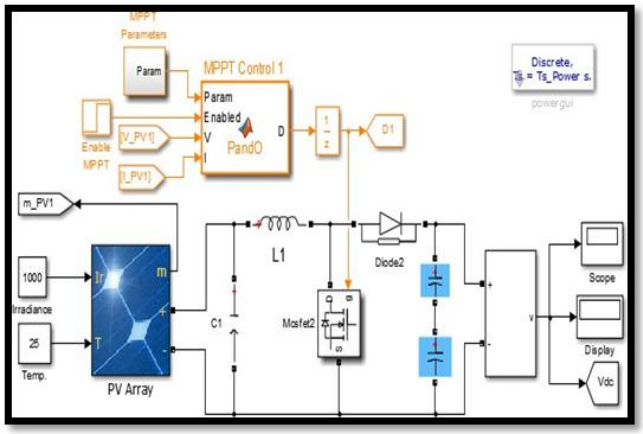

Fig. 2: Simulation Model of Solar with Perturb and Observe control

B. Modelling of Solar of MPPT using Fuzzy Logic Controller

Simulation model of solar module scheme with Fuzzy logic based MPPT control is represented in Fig.3.

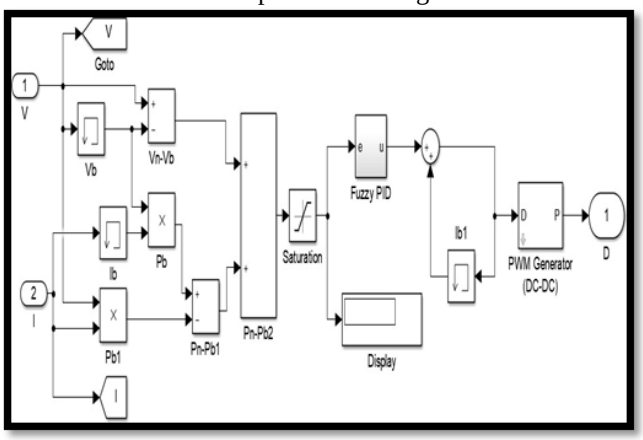

Fig. 3: SIMULINK Model of Solar with Fuzzy MPPT Control

In this section a new logical MPPT method with Fuzzy logic controller (FLC) has been proposed that can enhance the performance of solar PV system

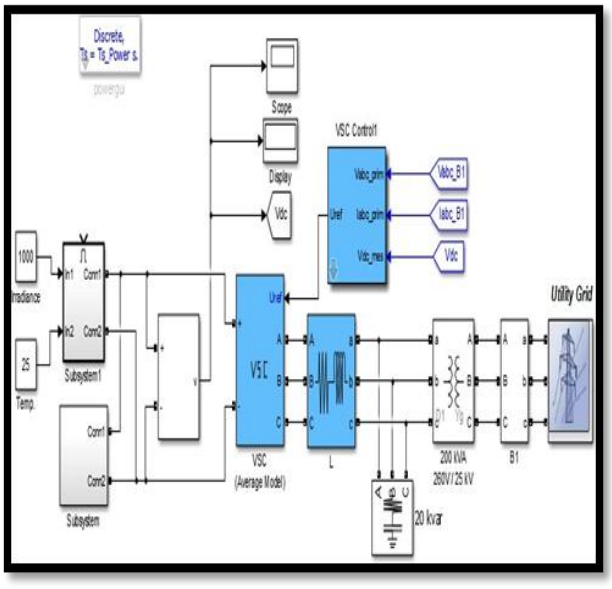

Fig. 4: SIMULINK Model showing the utilization of Irradiance and solar Modules

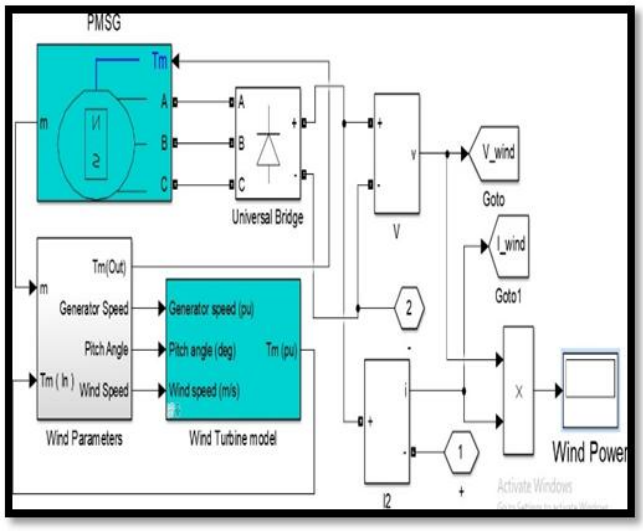

Fig. 5: Wind Turbine Linked with Synchronous Generator

C. Diesel Generator

PV wind and diesel have opposite characteristics, the capital cost of PV and wind is highly as compared to diesel; operating cost of

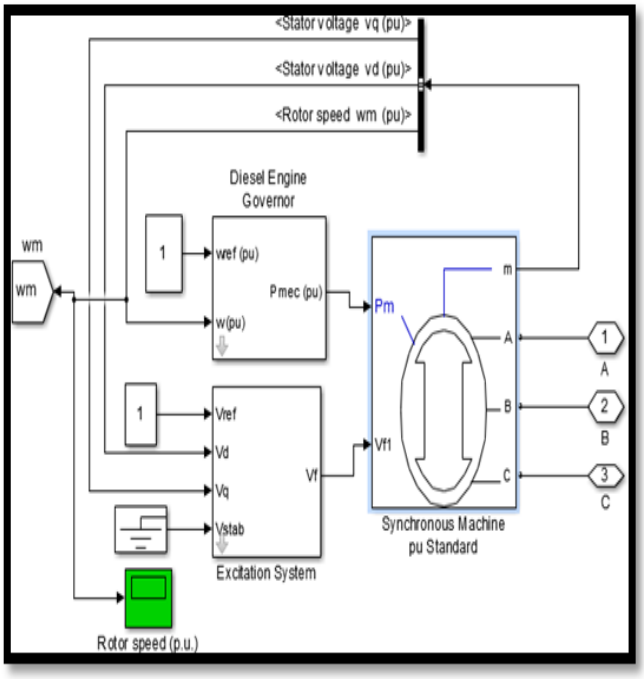

Fig. 6: SIMULINK Model of Diesel generator

The diesel backup system is activated when PV fails to fulfill the load demand and the battery storage is exhausted. The diesel generator system shown the MATLAB/SIMULINK model in the Fig.6.

V. RESULT AND DISCUSSION

In this paper, the proposed hybrid algorithm is realized in the MATLAB/Simulink. The gained outcomes are compared with different algorithms, for example P&O and Fuzzy Logic algorithm. The generated voltage, current, and power of PV array, wind system, and grid system by using the fuzzy-MPPT approach are represented in the following graphs along with its comparison with the P&O approach.

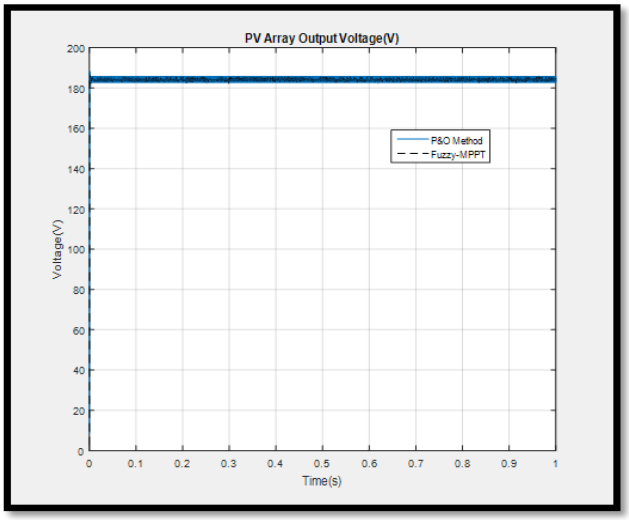

Fig. 7: Output Voltage Comparison using P&O and Fuzzy logic

It is comprehensible that both P&O approach and the Fuzzy-MPPT methods generate almost the same output voltage with less fluctuations in it.

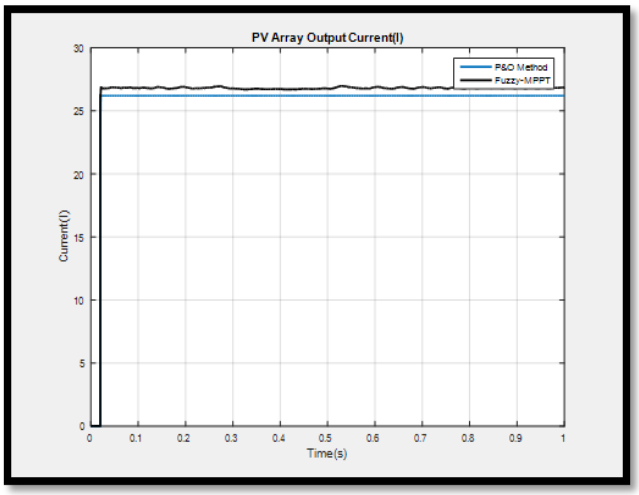

Fig. 8: Output Current Comparison using P&O and Fuzzy logic

It can be seen from the Fig. 8 , that the fuzzy-MPPT approach generates the high output current as compared to current generated by using the P&O approach.

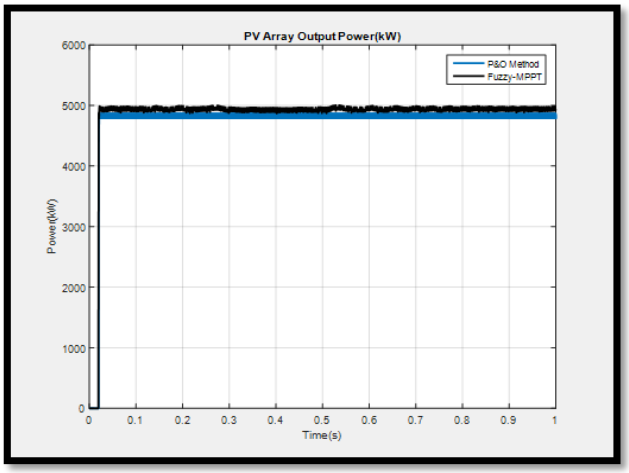

Fig. 9: Output Power Comparison using P&O and Fuzzy for PV System

The Fig.9 indicates that the fuzzy-MPPT approach generates a high output power than that generated by the P&O approach. The values of PV array output power obtained by comparing the P&O and fuzzy approaches are recorded in table 1. This table represents how much improvement is obtained by using the fuzzy-MPPT approach as compared to the P&O approach.

TABLE 1: Comparison of two different approaches in terms of PV panel output power

	Output of PV Panel Power (KW)		
Time	P&O approach	Fuzzy approach	Improvement
0.025	4788.108	4934.386	2.964458109
0.225	4788.1	4942.748	3.128785786
0.4249	4788.129	4942.905	3.131290076
0.625	4788.125	4947.818	3.22754407
0.825	4788.114	4955.918	3.385927556

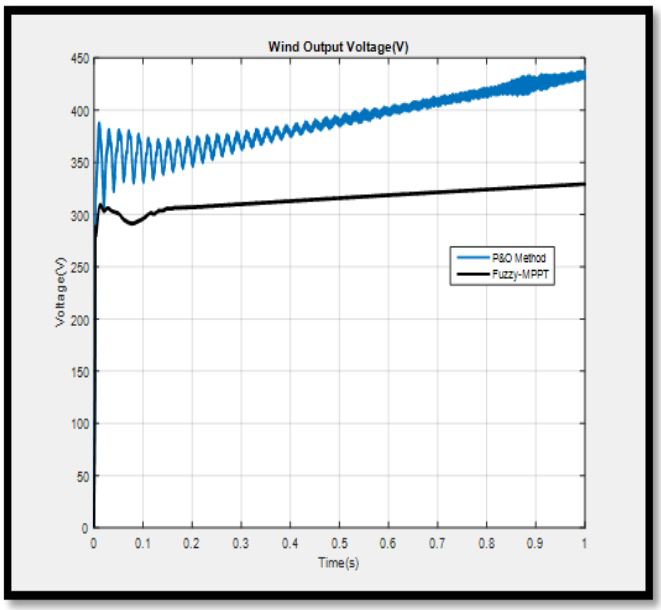

Fig. 10: Output Voltage Comparison using P&O and Fuzzy for Wind System

The obtained graph demonstrates that stable voltage is generated by using the fuzzy-MPPT approach. Whereas, the P&O approach generates high voltage with fluctuations present in this graph.

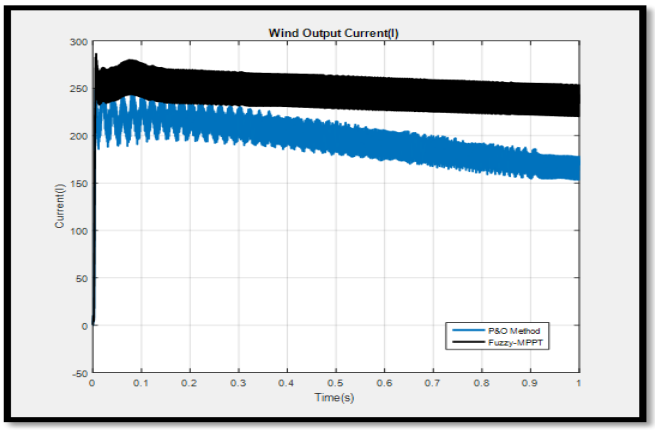

Fig. 11: Output Current Comparison using P&O and Fuzzy for Wind System

The Fig.11 represents that the fuzzy-MPPT approach generates high and stable wind output current. On the other hand, the P&O approach generates low wind output current which consists of fluctuations in it and also, it decreases with time.

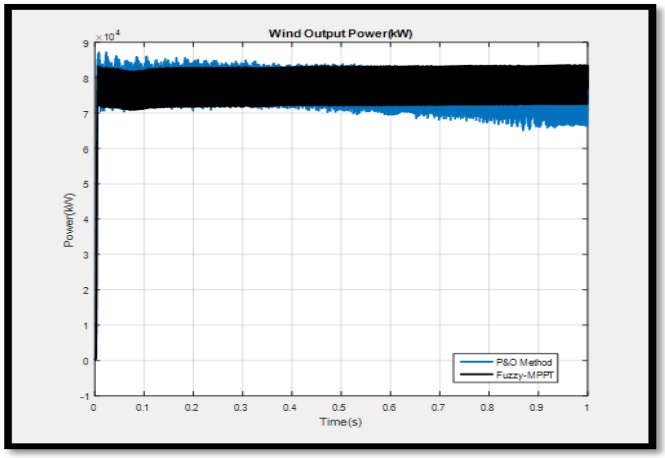

Fig. 12 Output Power Comparison using P&O and Fuzzy for Wind System

From the graph of Fig.12 , it is clearly observable that the fuzzy-MPPT approach generates the stable wind output power with no fluctuations present in it. In contrary, the P&O approach generates the fluctuating wind output power which decreases with time.

Table 2: Comparison of two different approaches in terms of wind system output power

	Output of PV Panel Power (kW)		
Time (s)	P&O approach	Fuzzy approach	Improvement
0.025	76994.22	78873.21	2.382285
0.225	77778.25	81823.11	4.943425
0.4249	81107.48	81233.59	0.155242
0.625	80218.16	80346.32	0.15951
0.825	70973.64	75984.12	6.594117

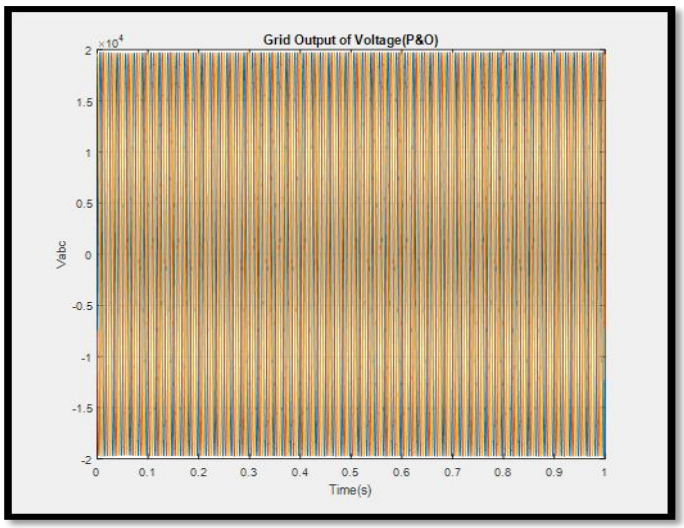

Fig. 13: Voltage Grid Output of Fuzzy MPPT

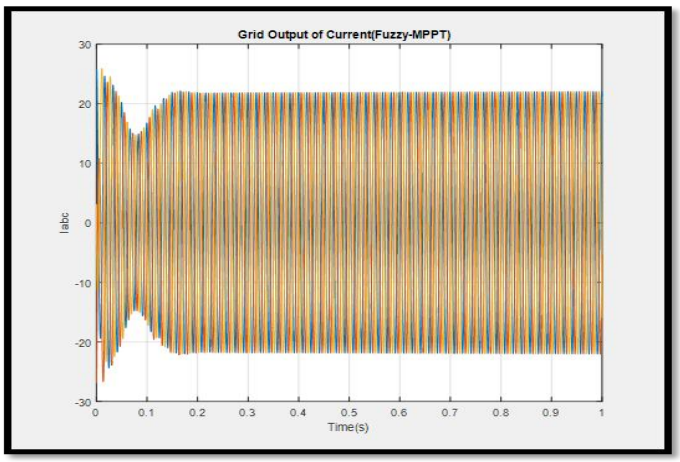

Fig. 14: Current Grid Output of fuzzy MPPT

VI. CONCLUSION

Here Wind, PV Hybrid system, implemented to produce a continous power regardless of intermittent power output from the wind and photovoltaic energy sources .Thus, all the obtained results demonstrates that fuzzy-MPPT approach is the most efficient approach which helps to achieve the high-performance, stable and efficient system.

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