A Hybrid PV-Wind-Diesel System for Optimal Performance in Microgrid

[1]Jatinder Kumar Bhagat, [2]Shekhar Verma
[1]Student, [2]Assistant Professor
[1]Electrical Engineering
[1]E-Max Group of Institutions, Haryana, India

***Abstract* - The PV-Hydro Diesel technology can be made attractive option because the features various merits like as low maintenance requirement, environmental friendliness and absence of fuel cost. The efficiency of energy conversion a PV generation system may low because sun power cell exhibits to the nonlinear voltage and current and power versus voltage characteristics. The recent advancements in the technology and the reduction of fossil fuel resources have further contributed to the cause. But still, there lies several challenges to it. The paper proposes a novel approach of hybridisation of renewable sources using Maximum Peak Power Transfer technique and optimal control. The performance of our approach is quite better than its other counterparts in terms of transient state and the magnitude of voltage obtained.**

***Keywords* - MPPT, PV- hydro-diesel, perturb and observe.**

I. INTRODUCTION

Most of the PV power generation takes place from the grid-connected installations, where facility could feed at intervals electricity network. Actually, it's the expansion of business within the developed countries like Federal Republic of Germany that in 2010 is out and away the world leader within the PV current generation which will be followed by state, USA, Japan and Italia [1]. On opposite hand, the instrumentation is required, power generation PV are often costlier than different resources. Governments unit are often promote with subsidies or feed-in tariffs, expecting the event of the technology therefore at intervals near future become competitive [2]. The Increasing efficiency in PV plants that the facility generated can increase may be a key aspect, as a result of it will increase the incomes, reduces consequently value of facility created therefore approach the worth of facility made of different sources. The efficiency of PV plant are often affected in main by three factors: efficiency of PV panel between 8-15% [3], the efficiency of converter and therefore efficiency of most electric outlet following algorithmic rule [4]. Rising efficiency of PV panel and thus the converter is not easy as a result of it depends on the technology available, it ought to want higher components that may increase drastically value of installation. Maximum Power Point Tracking, frequently referred to as MPPT, is an electronic system that operates the PV-Hydro Diesel (PV) modules in a manner that allows the modules to produce all the power they are capable of. MPPT is not a mechanical tracking system that "physically moves" the modules to make them point more directly at the sun. MPPT is a fully electronic system that varies the electrical operating point of the modules so that the modules are able to deliver maximum available power. Additional power harvested from the modules is then made available as increased battery charge current. MPPT can be used in conjunction with a mechanical tracking system, but the two systems are completely different.

MPPT is an electronic method of capturing the most power from your PV solar modules (solar panels). MPPT controllers will convert the module operating voltage to battery voltage and raise the output current (amperage or amps) in the process. The word "tracking" has nothing to do with mechanically moving the PV modules to track the sun. The MPPT process will raise the current while lowering the voltage. This can be done through a process called DC to DC conversion. The reason this works is because we can exchange current and voltage and yet have the same amount of power (Watts).MPPT circuits use this process to lower the voltage close to the battery voltage while raising the current. As long as the voltage reaching the MPPT controller is higher than the battery voltage by about 5% or more, then the MPPT output current will be higher than the input.

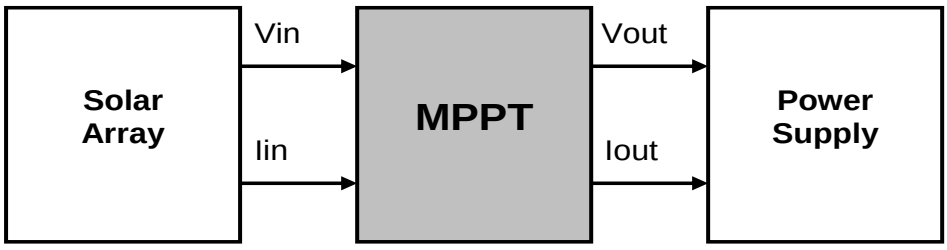


Figure 1: Basic Block Diagram

Hydro power is available mostly in hilly or mountainous regions due to owing of river tributaries. To install micro/mini hydro plants in such regions, proper modeling and simulation of hydraulic, mechanical and electrical components is required considering coupling interactions between all of them. The design of controller to maintain fixed speed, head and discharge is also dealt with. Hybrid Systems such as PV-Hydro Diesel are of utmost importance these days as they complement each other in need. Such type of electrical system which have at least one distributed energy source and the load connected to it can be called as micro grid. Further having the option of intentional islanding and transition from grid parallel mode to isolated mode is allowed.

RELATED WORK

Siddharth Joshi et al presented MPPT algorithm for wind and solar energy conversion standalone system.in this work, algorithm is implemented in PSIM 9.1.4 software. The maximum power point tracking is obtained of order of 98.32% and 80% for solar and wind respectively.

BinayakBhandariin this paper A novel off-grid hybrid power system comprised of solar photovoltaic, wind, and hydro energy sources has been presented. This paper presents a novel approach for connecting renewable energy sources to a utility mini-grid.

SweekaMeshram et al. proposed modeling of grid connected dc linked pv/hydro hybrid system. The simulation is done in Matlab/Simulink. This proposed approach is cheaper and having less complexity in comparison with AC linked hybrid system. The performance of proposed system is very efficient. A high-frequency physical phenomenon pulse for storage battery which is guided by power-increment-aided incremental-conductance most of the electric receptacle track can be projected by Hung-I Hsieh et al.

Panom Petchjatuporn et al introduced most electric receptacle track algorithmic rule exploitation an artificial meta-heuristic approach for energy system. By applying a three layers meta-heuristic approach and few easy activation functions, most electric receptacle of a electrical device is expeditiously tracked. The track algorithmic rule integrated with a star power-driven battery charging system has been successfully enforced on a low cost PIC16F876 RISC(reduced instruction set computer)-microcontroller whereas not external detector unit demand. The experimental results with poster electrical device showed the projected algorithmic rule outperforms quality controller within terms of track speed and mitigation of fluctuation output power in the steady state operation. The system efficiency may well on high of ninetieth.

S. Yuvarajan et al projected proper and fast most electric receptacle track the algorithmic rule for physical phenomenon panel uses electrical circuit voltage and so tangency current of PV-Hydro Diesel panel. The mathematical equations are described nonlinear V-I characteristics of the PV-Hydro Diesel panel can be used to develop the algorithmic rule. The MPPT algorithmic rule is valid below utterly completely different temperature, insulation, and level of degradation. The algorithmic rule can be verified exploitation MATLAB and results attained exploitation the algorithmic rule were very close to the theoretical values of temperature and illumination levels. The deviation among most power has however one.5% for the illumination levels and temperatures normally encountered by poster PV-Hydro Diesel (PV) panel. The complete derivation of MPPT algorithmic rule can be displayed. It is seen algorithmic rule which is faster than several MPPT algorithms like perturbation and observation and ton of the correct than approximate ways that use the spatial property between voltage at the most electric receptacle and open-circuit voltage.

Prof. Dr. IlhamiColak, et al. have curvy three separate farms that supply fifteen emu power for each farm exploitation Mat work Simulink amount analysis code. Energy conversion is performed with the most electric receptacle track algorithms in every device exploitation Perturb and Observe structure. These are collected in the DC bus bar with their parallel affiliation of converters over the inter-phase transformers. The voltage can be applied to bridge convertor to induce the 3- half AC voltages at output of the convertor that has controlled with flexuous pulse dimension modulation theme.

S. G. Tesfahunegn et al. designed solar/battery charge controller that mixes every MPPT and over-voltage controls as single operation. A small-signal model of the lead acid battery has derived to utilised dual-loop management configuration. The designed controller was incontrovertible to transient response with voltage overshoot.

Yuncong Jiang et al. has proposed Associate in the analogue most electric receptacle track the controller for physical phenomenon theme that utilized the load current to output power from device. Examination to prevailing MPPT controller equipment that desires multiplication of detected PV-Hydro Diesel panel voltage and current to yield panel power, worth and size of projected circuit has been reduced.

PROBLEM FORMULATION

The problem of this thesis is to implement a novel PV-Hydro Diesel hybrid system to act as standalone system. The transient stability analysis of the system needs to be done in terms of harmonics in current and voltage. The interconnection of PV-Hydro Diesel system is not an easy task as the output of PV is DC while that of hydro is AC. Thus the PV system needs to be converted to an AC by use of inverter. The problem of drawing maximum power from solar panel which is to be solved using MPPT technique and improvement algorithm needs to be formulated so better performance. A model for the above stated problem needs to be designed. The problem can be briefly summarised as follows. The basic equation can be described mathematically the IV characteristic of PV cell is

$$I_{pv} = I_g - I_S\left(\exp\left(\frac{q(V_{pv} + I_{pv} \cdot R_S)}{nkT}\right) - 1\right)$$

The major tasks addressed in this paper are as below:

To implement the Photovoltaic system for performance with variable irradiance and variable temperature.

To develop an MPPT algorithm for improved performance of the PV-system

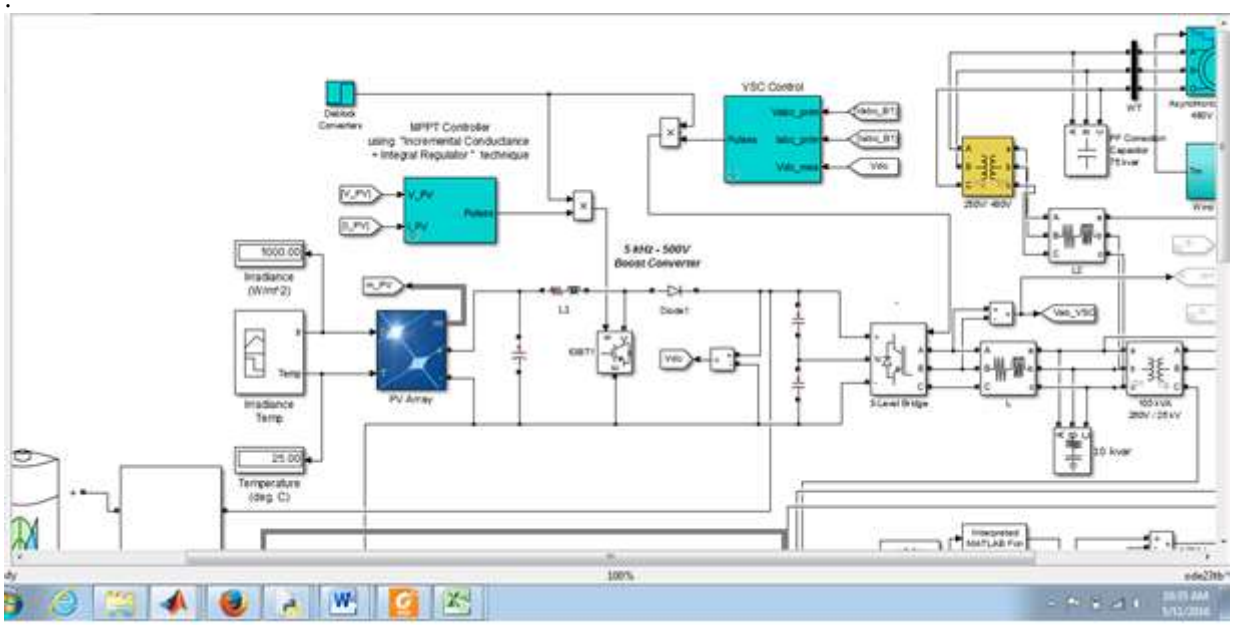
To design a 3 level inverter for conversion of PV output to AC

To create the hydro turbine and generator and implement a hybrid system
To add Diesel unit and battery unit to the hybrid system and connect the system to grid
To analyse the performance of hybrid system in terms of transient stability and harmonics in current and voltage

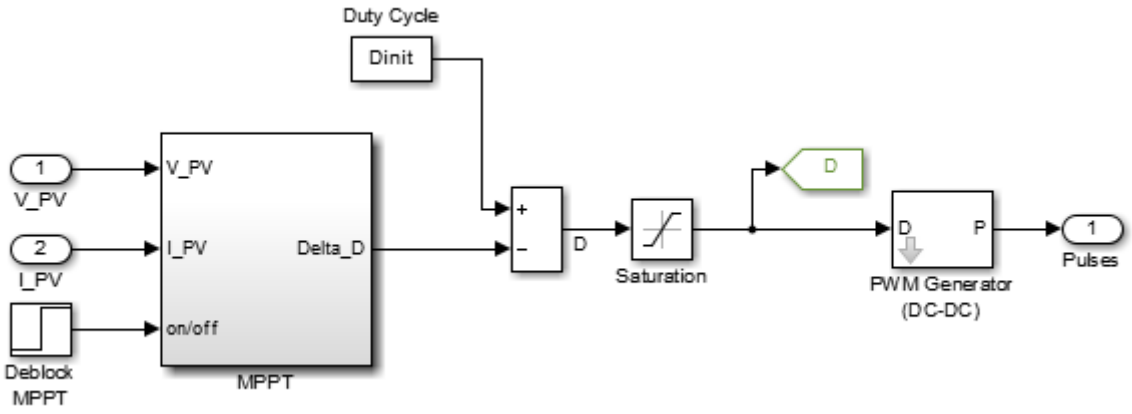
PROPOSED METHODOLOGY

It is proposed to use a New Hybrid model for improvement of the performance of micro grid. A model will be simulated in which the algorithm will be implemented and the controller will be included with the load. This thesis aims at developing a novel technique based on Meta-heuristic approach for improved performance of MPPT method for solar cells connected to a grid. The design will be made on SIMULINK of MATLAB and algorithm codes will be written in editor of MATLAB.

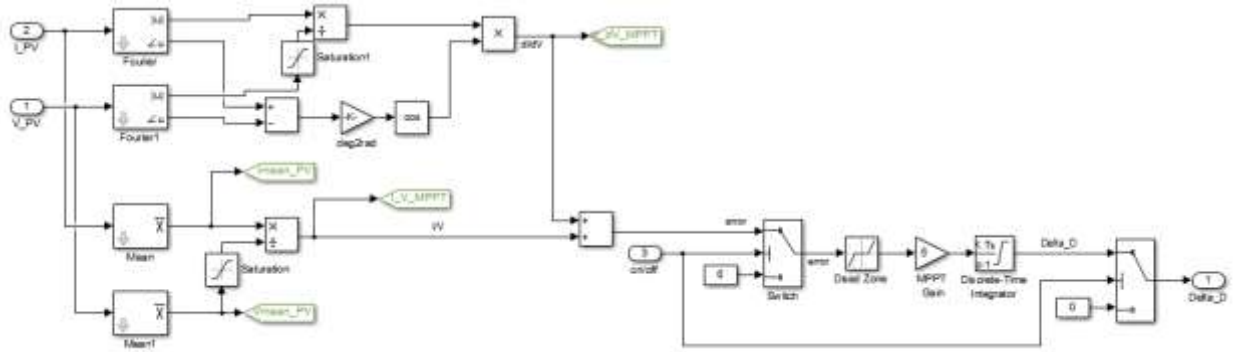
.



The solar cell is controlled using variable irradiance and temperature and is connected to a boost converter. The boost converter is given firing pulses from a MPPT algorithm as shown in figure below.



The MPPT algorithm is shown as below



The complete system is connected to an inverter to convert the dc source to ac. The ac source can be directly connected to the grid.

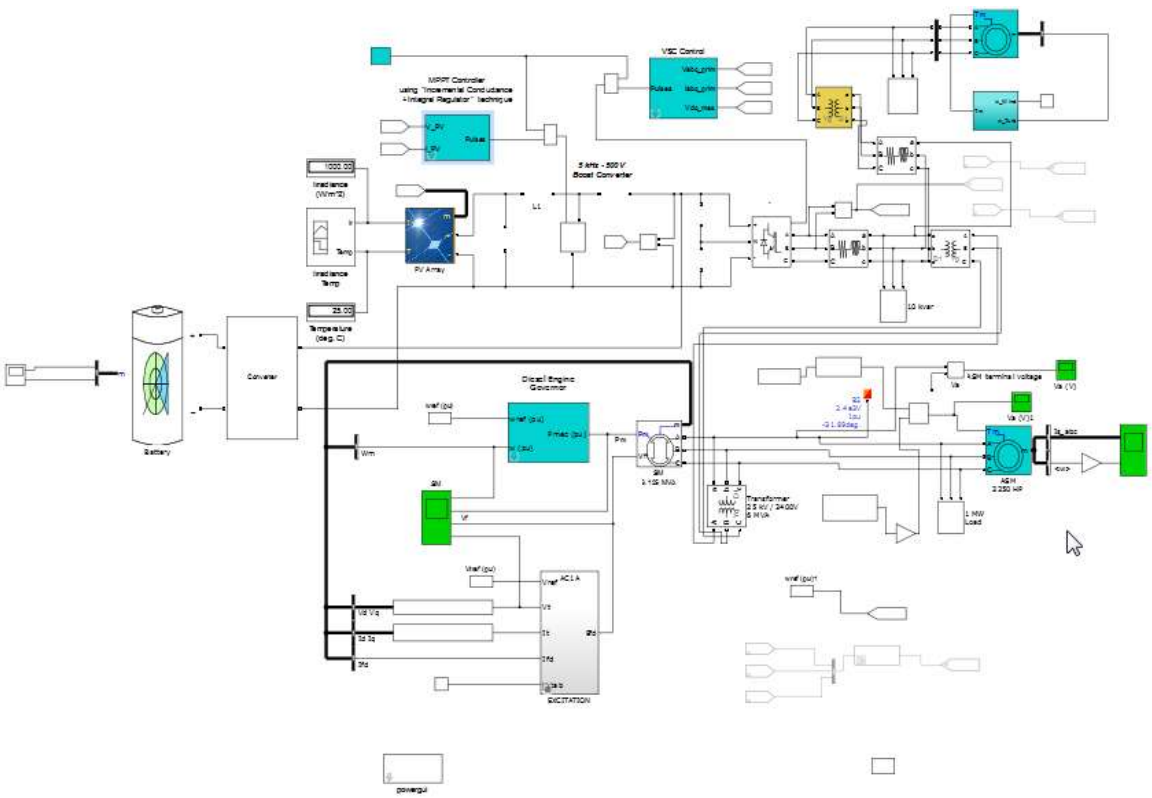
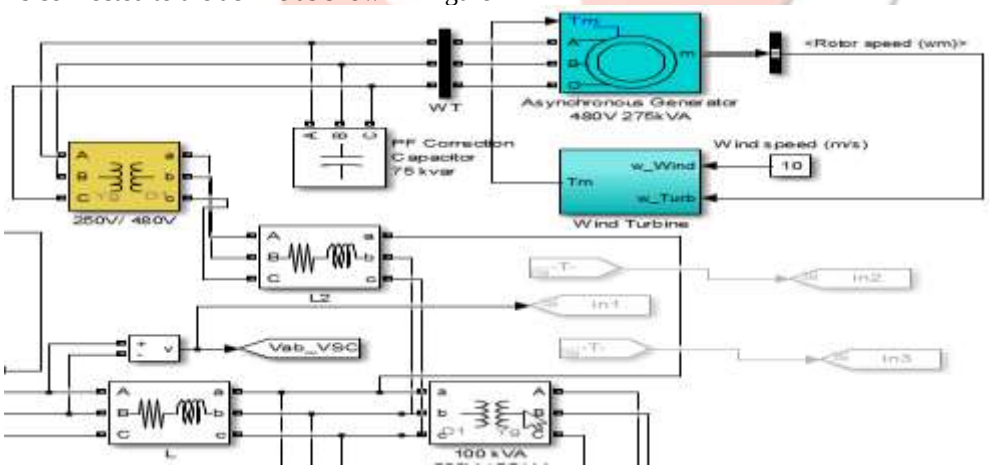
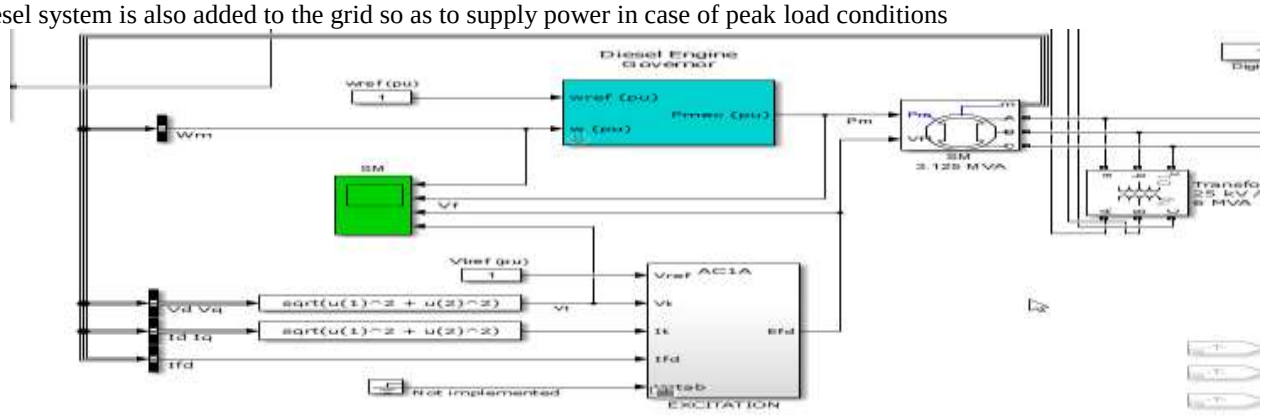


Fig. 2: Representing the overall proposed model

Figure 1 represents the complete system is connected to an inverter to convert the dc source to ac. The ac source can be directly connected to the grid.
The wind system is connected to the ac line as shown in figure

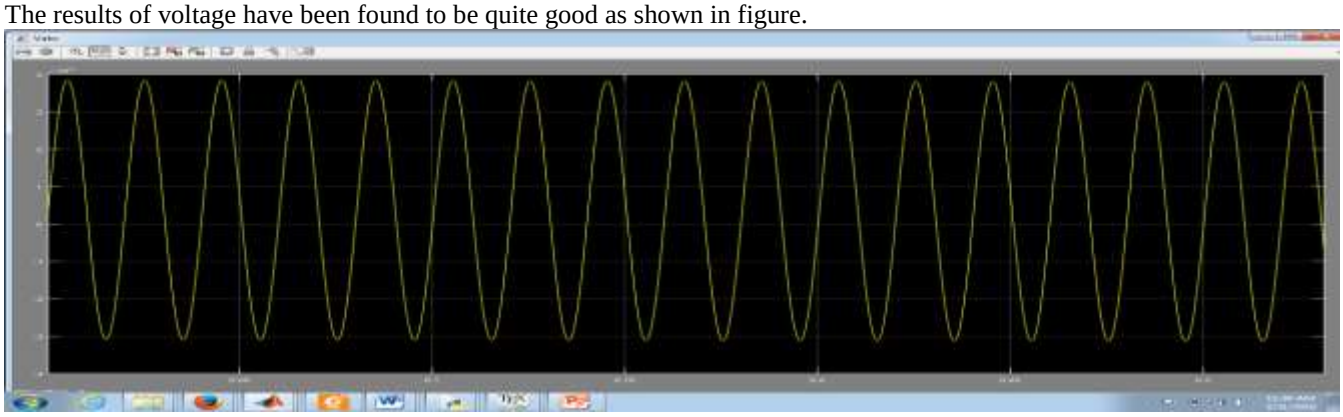


A diesel system is also added to the grid so as to supply power in case of peak load conditions



RESULTS

This section presents the various results which are obtained using the proposed methodology as given in the previous sections. The problem at hand was to develop an MPPT model using IWD for multi-junction solar cell connected to a grid. All the simulations have been done in MATLAB R =2013b in a computer having 2.7 GHz processor and 4 GB RAM.
The results of voltage have been found to be quite good as shown in figure.



The voltage at the load end is shown below

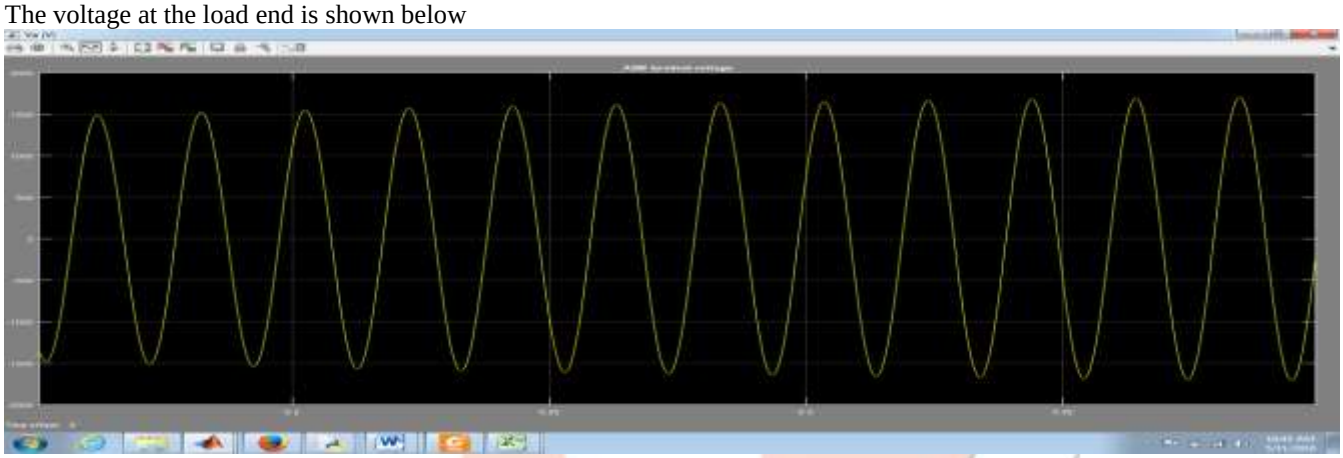


Fig. Representing The FFT analysis of the voltage waveform at the load end. when the FFT analysis of the wave form is done the THD value is found to be 0.17 %.

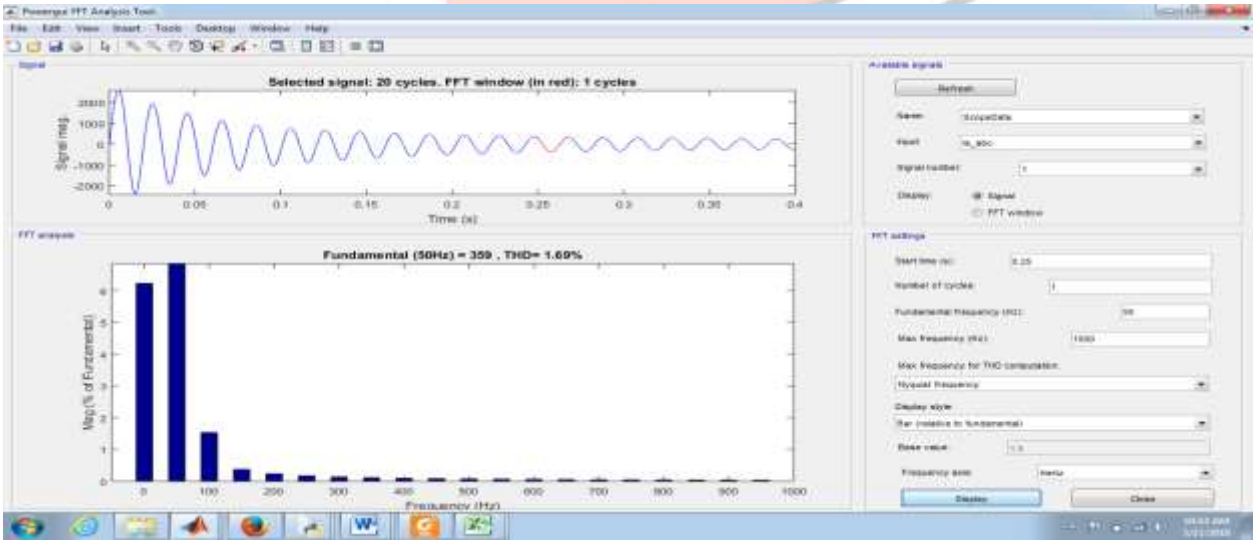


Fig.5: The THD of the output
The voltage obtained using I&C is also analysed using FFT and it is found that the THD content of I&C approach is 0.35% which is more than IWD based approach.
Table 1: Showing Comparison of THD

	Load Voltage	Stator Current
THD	2.64%	1.39%

CONCLUSION AND FUTURE SCOPE

This paper proposed a novel approach of utilising a New Hybrid Technique approach to solve the MPPT problem in microgrid consisting of PV-Hydro Diesel cell connected to a grid using three phase inverter. The solar cell model was designed and given to boost converter. The converter output was analysed. An incremental conductance technique was also implemented for comparison purpose. The result of hybrid model was found to be quite better than the incremental conductance technique in terms of output voltage magnitude and THD content. The THD content reduces using our proposed approach. Also when the current is compared, the oscillations die out very fast in case of hybrid model while in I&C approach it is more or less sustained. In future this algorithm can be improved using other techniques and approaches. Also real time implementation of the algorithms can be done and hardware testing can be done. Hybrid with other algorithms can be utilised and the performances can be compared. Also clustering and other gradient learning methods can be utilised and the model can be tested for grid connection.

REFERENCES

[1] Reddy, K. Pavankumar, and M. Venu Gopala Rao. "Modelling and Simulation of Hybrid Wind Solar Energy System using MPPT." *Indian Journal of Science and Technology* 8, no. 23 (2015).

[2] Dalala, Zakariya M., Zaka Ullah Zahid, Wensong Yu, Younghoon Cho, and Jih-Sheng Lai. "Design and analysis of an MPPT technique for small-scale wind energy conversion systems." *Energy Conversion, IEEE Transactions on* 28, no. 3 (2013): 756-767.

[3] Jain, S., Agarwal, V., 2004. A new algorithm for rapid tracking of approximate maximum power point in PV-Hydro systems. IEEE Trans. Power Electron. 2, 16–19.

[4] Bhandari, Binayak, Shiva Raj Poudel, Kyung-Tae Lee, and Sung-Hoon Ahn. "Mathematical modeling of hybrid renewable energy system: A review on small hydro-solar-wind power generation." *international journal of precision engineering and manufacturing-green* technology 1, no. 2 (2014): 157-173.

[5] S. Yuvarajan and JulineShoeb, "A Fast and Accurate Maximum Power Point Tracker for PV Systems," IEEE, 2008.

[6] Prof.Dr.IlhamiColak, Dr.ErsanKabalci and Prof.Dr.GungorBal, "Parallel DCAC Conversion System Based on Separate Solar Farms with MPPT Control," 8th International Conference on Power Electronics - ECCE Asia, The ShillaJeju, Korea, May 30-June 3, 2011.

[7] S. G. Tesfahunegn, O. Ulleberg, et al., "A simplified battery charge controller for safety and increased utilization in standalone PV applications," IEEE, 2011.

[8] Yuncong Jiang, Ahmed Hassan, EmadAbdelkarem and Mohamed Orabi, "Load Current Based Analog MPPT Controller for PV Solar Systems," IEEE, 2012.

[9] ArashShafiei, AhmadrezaMomeni and Sheldon S. Williamson, "A Novel PV-Hydro Diesel Maximum Power Point Tracker for Battery Charging Applications," IEEE, 2012.