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Optimum Power Control And Quality Improvement In Hybrid Power System

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Abstract : *Renewable energy systems are the most important as being modular, energy should be nature-friendly and domestic. Where as among all renewable energy systems, a lot research have been conducted especially on photovoltaic effect, fuel cell and wind energy in these recent years. This paper shows study analysis of modelling and simulation results of a small wind-fuel cell- photovoltaic hybrid energy system. The hybrid system consists of a photovoltaic system with incremental conductance method, a wind turbine of rating 500 W, 3 sets of proton exchange membrane fuel cell (PEMFC), a boost converter, power controller using MATLAB solver. This kind of hybrid system is completely stand-alone, reliable and has high efficiency.Results showed that the liability of the system for adapting sudden changes and new conditions. These combination of PV fuel cell and wind renewable sources give the advantage of using this system which have higher wind speeds and in the seasons where we suffers from less sunny days.*

Keywords: *Wind Energy; Photovoltaic; Fuel-Cell; Hybrid Energy Systems*

I. INTRODUCTION

The gradual depletion of fossil fuel resources in a world- wide basis has cause the urgent search of alternative energy sources to meet present day demands. Alternative energy resources, like solar and wind energies these are clean, inexhaustible and are environment friendly. It is prudent that neither a wind energy system nor standalone solar can provide a continuous supply of energy, it is due to seasonal& periodical variations.To supply power directly to a utility grid Wind turbine converts kinetic energy of the wind into the mechanical energy and further converted into electrical energy by generator. Where as Solar is an non – linear power source, its radiation changes frequently and cause the output power of the panel varies with temperature & isolation. A single solar cell produce very low voltage therefore numbers of solar cells are combined to form modules to get desired voltage . Advantages of wind and PV energy technologies has the main reason for using hybrid Wind&PV configurations. Fuel cells can be work in parallel with Wind& PV system as a device which cangenerate electrical energy where it is necessary. In addition the excess heat produce from a fuel-cell can also be used for space heating or for the residential hot water.

It is a system which is designed for a Wind-PV-Fuel cell hybrid energy system to control the power flow between the system components to satisfy the load requirements. In a simple and economic control with DC-DC converter is used for (mppt) maximum power point tracking and hence get maximum power extraction from the wind turbine and photovoltaic arrays. In order to get continuous power flow, a fuel cell is also proposed in this hybrid system. It is necessary to analyse this hybrid system in all aspects such as: cost, reliability, efficiency, dynamic response to load demand. Since, these kinds of hybrid systems have to operate under variable conditions like sudden variations in wind speed or load demand. Therefore in this paper Wind- PV-Fuel cell hybrid energy system are analysed under some critical operating conditions. It is assumed that the output power of PV- wind turbine-fuel cell which can supply the nominal load demand, in the case of low wind or low of ambient irradiation , power can be supplied from the fuel cell. The system description, modelling and a study of system dynamics are presented below.

II.SYSTEM DESCRIPTION

A. Wind Power Generating System

A hybrid system consists of 2 or more renewable energy sources to enhance thesystem efficiency as well as increase balance in energy supply. Wind turbine is a device that converts kinetic energy of the wind into mechanical energy and this energy again converted into electrical power. The power from the wind depends upon speed and design of blades and its rotor construction . The power in the wind is givenby the kinetic energy of the flowing air mass per unit time and is expressed as,

$$P_{air} = ½(\text{air mass per unit volume})2 \quad (2.1)$$
$$= (\rho A V\infty)(V\infty)2 \quad (2.2)$$
$$= \rho A V\infty^{3} \quad (2.3)$$

P-(air - power contained in wind) (in watts)

A - swept area in (square meter)
$V\infty$ - wind velocity without rotor interference

In equation (2.1) gives the power available in the wind, the power transferred to the wind turbine rotor is reduced by the power coefficient, Cp

$Cp = (wind\ turbine)/ Pair$ (2.4)
$Pwind\ turbine = Cp*Pair$
$S = \rho AV\infty$ (2.5)

A maximum value of Cp is defined by the Betz limit,which states that a turbine can never extract morethan 59.3% of the power from an air stream. Inreality, wind turbine rotors have maximum Cp valuesin the range 25-45%.

B PHOTOVOLTAIC

A photovoltaic (PV) system directly converts sunlight into electricity. The basic mechanism of a PV system is the photovoltaic cell. The photovoltaic module is the result of associating a group of PV cells in series and parallel and it represents the conversion unit in this generation system. The basic block of PV arrays is the solar cell
The figure shows the equivalent circuit of a PV array with a load.

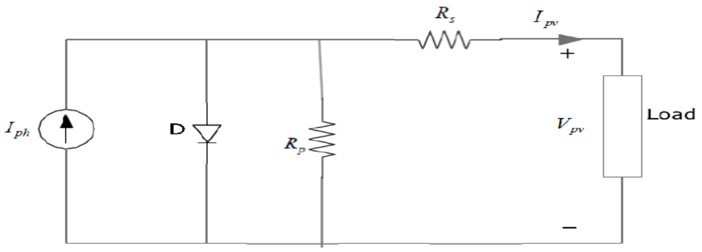

Figure 1 Equivalent circuit of a solar cell

The current output of the panel is modeled using three following three equation.
$Ipv = Iph – Is \{ \exp (q(Vph +IphRs) / K\ Tc\ A) -1]- (Vph + IphRs) / Rp$ ...(1)
The photocurrent depend on the cells and its working temperature and solar irradiation , which is explained as
$Iph= [Isc + Ki (Tc – Tref)]\lambda / 1000$ …(2)
The saturation current of the cell varies with the cell temperature , which is explained as
$Is = Irs(Tc / Tref)$ ^3exp $[qEg(1/Tref – 1/Tc) / KA]$ …(3)
Where :
Iph = Photo current (A)
Is = Diode reverse saturation current (A)
q= Electron charge – 1.38X10^-23(j/k)
T = cell temprature (k)
The power output of a solar cell is given by
P(pv) = V(pv) *I(pv)
Where :
I (PV)= Output current of solar cell (A)
V (PV) = Solar cell operating voltage (v)
P(PV)=Output power of solar cell (W)

As the outputs of PV system are dependent on the temperature irradiation, and the load characteristic MPPT cannot deliver the output voltage perfectly. For this reason MPPT is required to be implementing in the PV system to maximize the PV array output voltage.
Classification of MPPT method :

I. Perturb and observe
II. Incremental conductance
III. Current sweep
IV. Constant voltage

Hill climbing is perturbation work in the duty ratio of the power converter, and the P&O method work in perturbation of operating voltage of the PV array. However, the P&O algorithm is not be able to compare the array terminal voltage with respect to the actual MPP voltage, since the change in power can only considered to be a result of the array terminal voltage perturbation. As a result, they P&O method are not accurate enough as they perform steady-state oscillations, which will consequently waste the energy. By minimizing the perturbation step size the oscillation occurring in the system can be reduce, but a smaller perturbation size result in slows down of speed of tracking MPPs. Hence there are some disadvantages with these methods, where they fail under rapidly changing atmospheric conditions.

Where as some MPPTs methods are more rapid and accurate, thus they are more impressive. These systems need special design it can be complicated and familiarity with specific subjects such as fuzzylogic or neural network methods. In this method, the array terminal voltage is always adjusted according to the MPP voltage. It is based on the incremental and instantaneous conductance of the PV module.

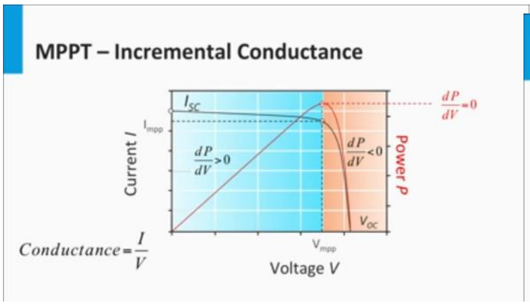

Figure 1: PV array power curve

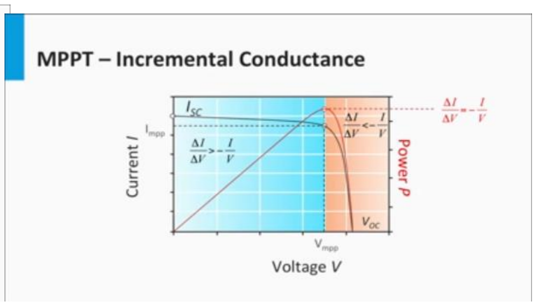

Figure 2: curve voltage vs current

Fig 1 : shows that the slope of the PV array power curve is zero at the MPP, its increasing on left of MPP and decrease on right-hand side of the MPP.

Fig 2: showing incremental curve voltage vs current
There are three conditions:

1. $dI/dV = (-I/V)$............$atMPP$
2. $dI/dV > (-I/V)$.........$leftofMPP$
3. $dI/dV < (-I/V)$.........$rightofMPP$

In other words, by comparing the conductance at each sampling time, the MPPT will track the maximum power of the PV module.

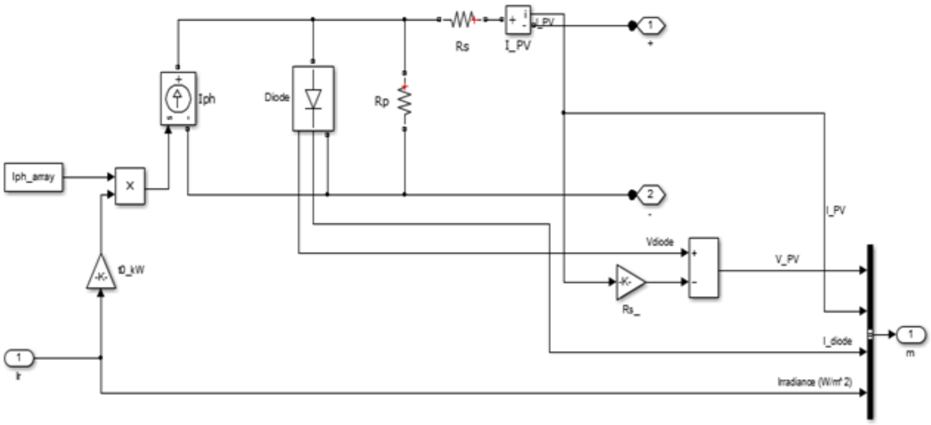

Figure 3. PV ARRAY

System Name	Rating value
No of cell per module	96
No of parallel string	66
No of series connected module per string	05
Module specification under STC [Voc, Isc,Vmp, Imp]	[64.2V, 5.96A, 54.7V, 5.58A]
Model parameter for one module [Rs , Rp, Isat , Iph , Qd]	[0.38Ω , 993.5 Ω , 3.1949*10-8A , 5.9602A, 1.3

C Fuel cell

Fuel cells are also used in distributed generation, and it can be described as batteries, it never become discharged as long as hydrogen and oxygen are continuously provided. Hydrogen can supplied directly - indirectly produced from fuels such as natural gas, alcohols etc. Each unit ranges from size 1-250 kW or even bigger size. They offer high efficiency and low emissions but today's costs are high. Phosphoric acid fuel cell are commercially available in range of 200 kW.

Fuel cells may operate continuously as long as it is necessary to overcome the power demand. These Fuel cells are differ from electrochemical cell batteriesin that they can consume reactant and complete the power demand for an external source. There are mainly 3 types of segments which are combined together: i).the anode ii). the electrolyte, and ii).the cathode. Inside the cell Two chemical reactions occur in cell. The result of these two chemical reactions is that : it produce water or carbon dioxide, and the main thing electrical current is created, At the anode a catalyst oxidizes the fuel, usually hydrogen, turning the fuel into a positively charged ion and a negatively charged electron. The electrolyte is a substance specifically designed so ions can pass through it, but the electrons cannot. The freed electrons travel through a wire creating the electrical current.These ions travel through the electrolyte to the cathode. Once reaching the cathode, the ions are reunited with the electrons and the two react with a third chemical, usually oxygen, to create water or carbon dioxide. Main block diagram fuel connected to grid is

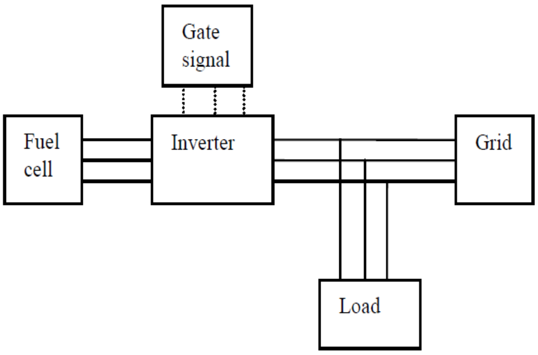

Figure 4: Block diagram of fuel cell with grid

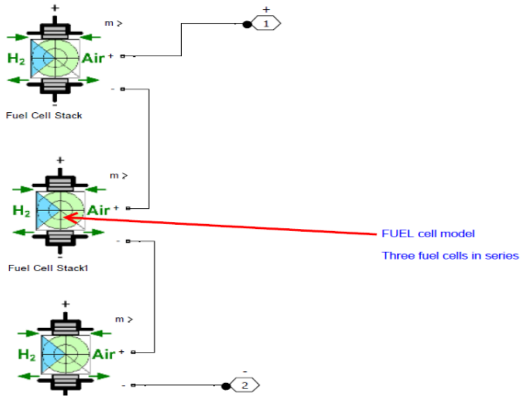

Figure 5: simulation model of fuel cell

IV STRUCTURE OF HYBRID POWER SYSTEM

The proposed hybrid system consists of a wind and a photovoltaic system as shown in Fig 6: Wind , PVand solar systems are connected to the grid through inverter which serves as a dual purpose.The system supplies the load and when there is excess generation, the power is delivered to the grid.

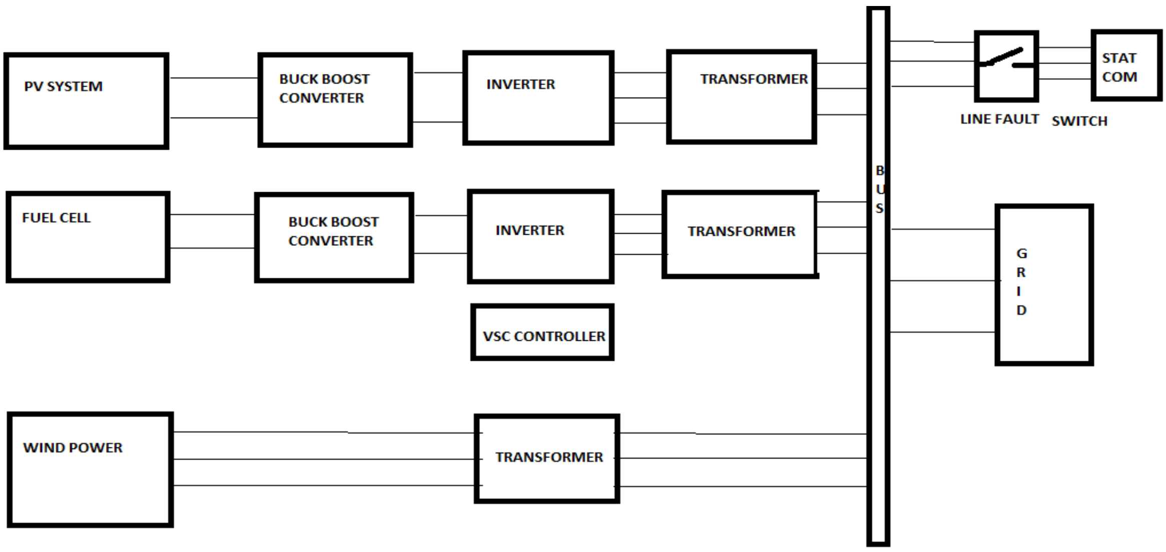

Figure6: Basic diagram of grid synchronization

This is the basic block diagram showing that PV system – wind farm – fuel cell is connected in parallel. The output of fuel cell and PV array will be DC supply hence to convert DC into AC , set of converter and inverter is connected with the grid system.The buck boost converter is used to get the constant voltage as the voltage very with temp and radiant. To reduce the fluctuation of voltage converter is used. The inverter can control the AC supply with VSC controller which contain 6 pulse IGBT.

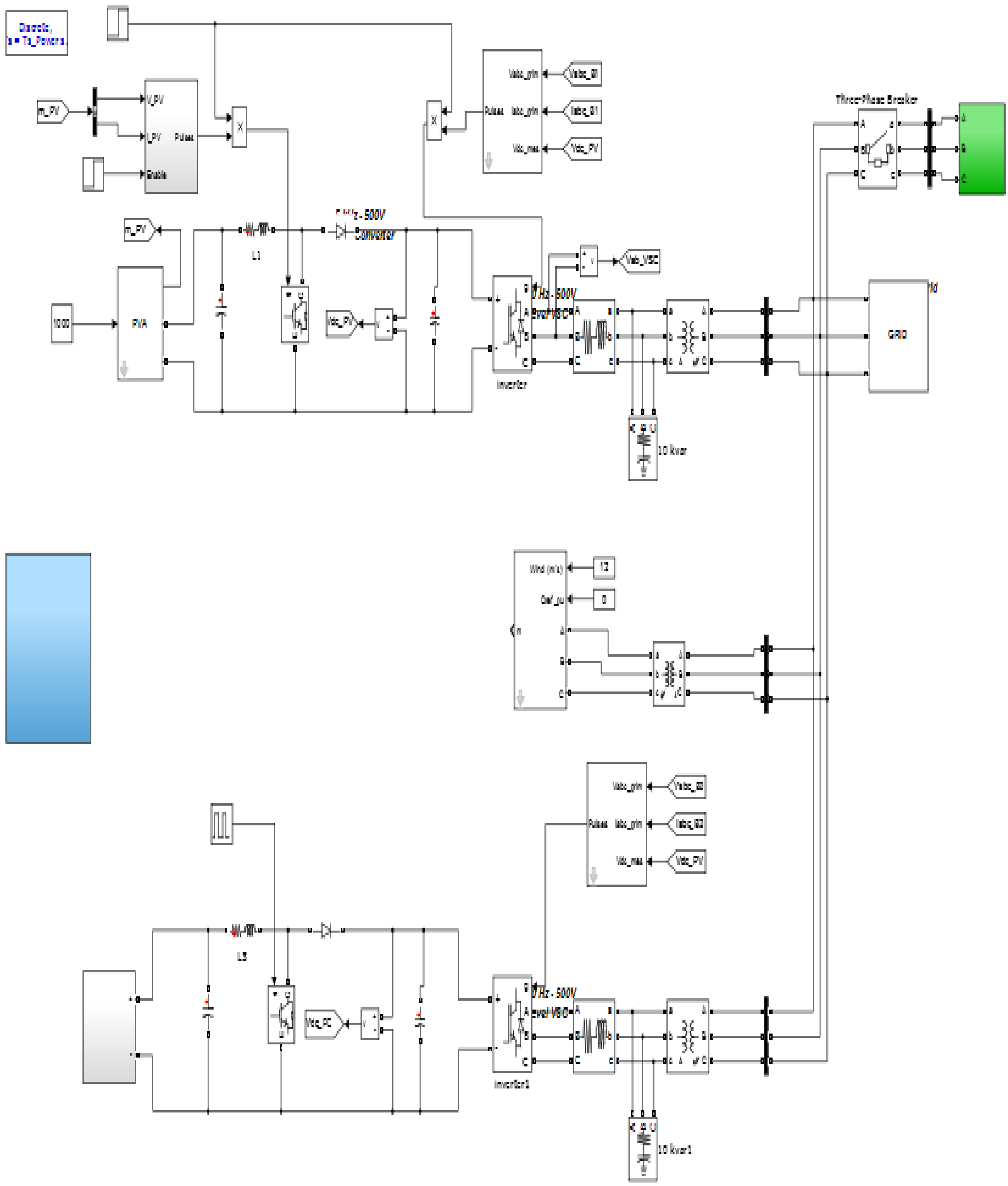

Fig 7 Basic diagram of grid synchronization

V.SIMULATION RESULT

P- V Characteristic

PV power at MPPT 10.3 KWPV current at MPPT 390A

PV voltage at MPPT 278VPV voltage at MPPT 278V

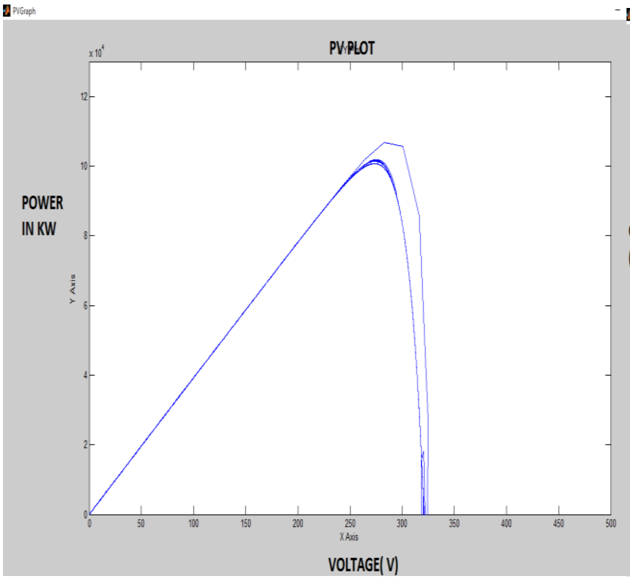

Figure 8. PV characteristic

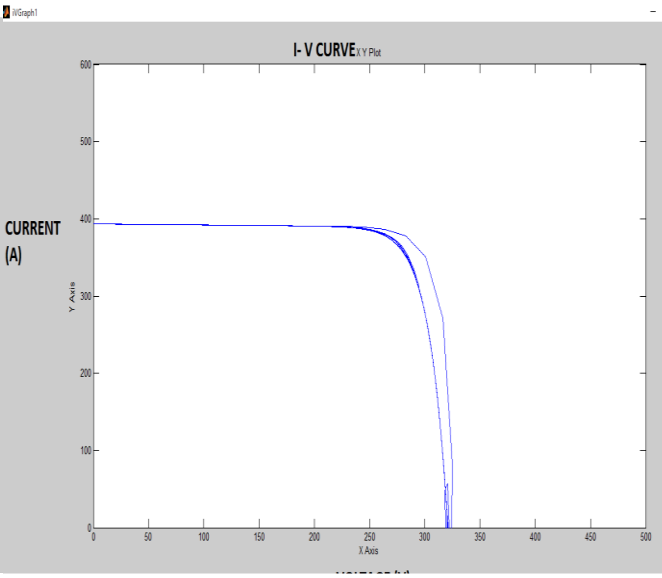

Figure 9 I-V Characteristic:

Maximum power (Pmax)	1050w[1000W/m^2]
No of cell connected in parallel	66
Open circuit voltage (Voc)	64.2 v
Short circuit currant (Isc)	5.96A
Voltage at maximum power (Vmax)	54.7V
Current at maximum power (Imax)	5.58 A

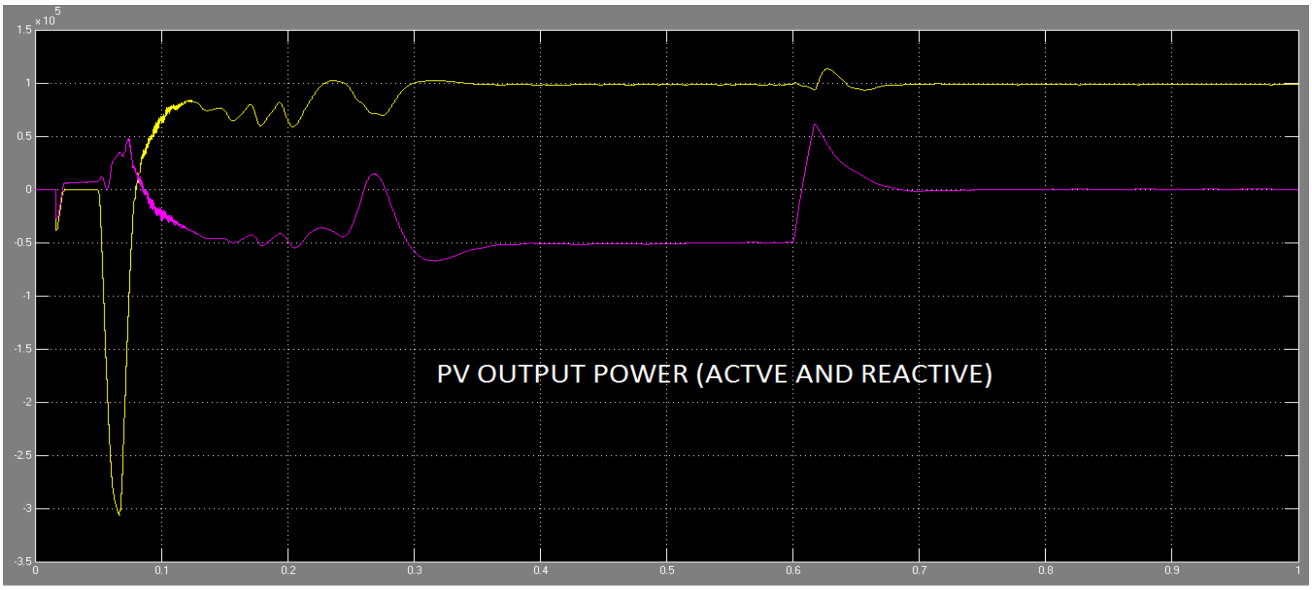

Figure 10. simulation output power(Active and Reactive) of PV array

V-I and P-I characteristic of fuel cell:

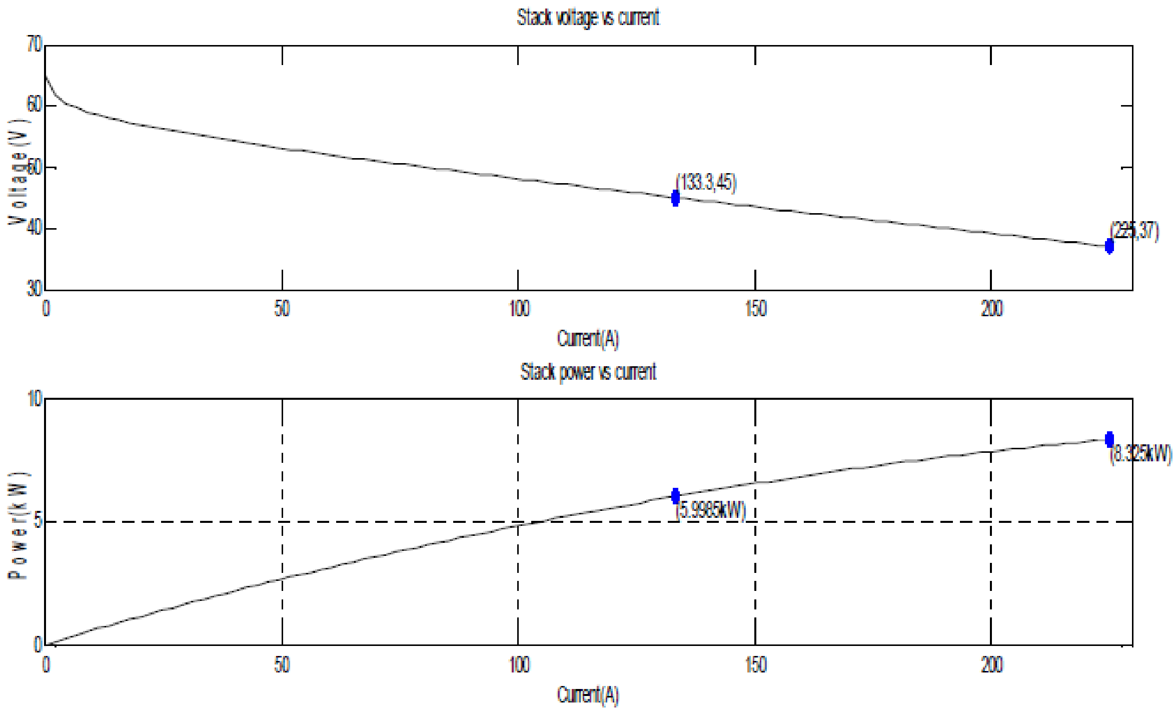

Figure 5.5 characteristic of fuel cell

Output voltage of fuel cell with load connection :

Output Voltage	498.8V
Output current	44.91A
Output Power	3.5 KW
O.C. Voltage	65V
Normal Operating Point : [Vnom , Inom]	[45V,133.3A]
Max operating point :Vmax, Imax]	[37V , 225A]
O.C. Voltage	65V

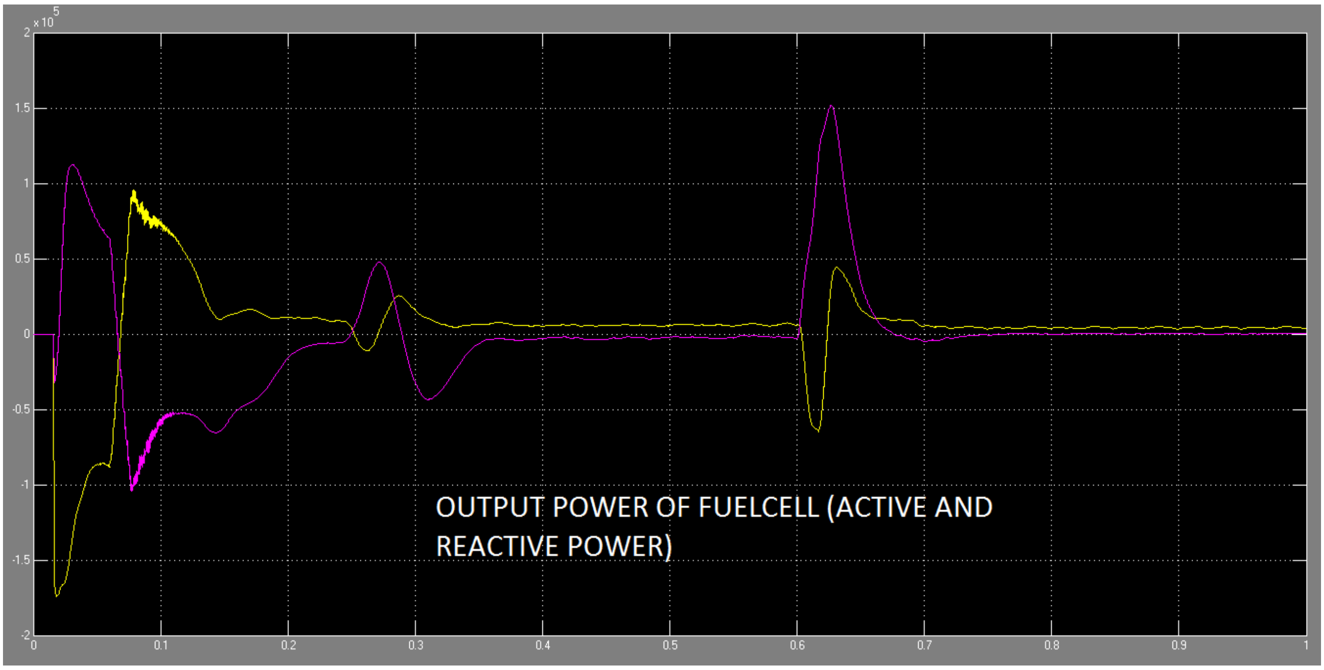

Figure11. Output power of fuel cell

Out power of wind farm with load connection :

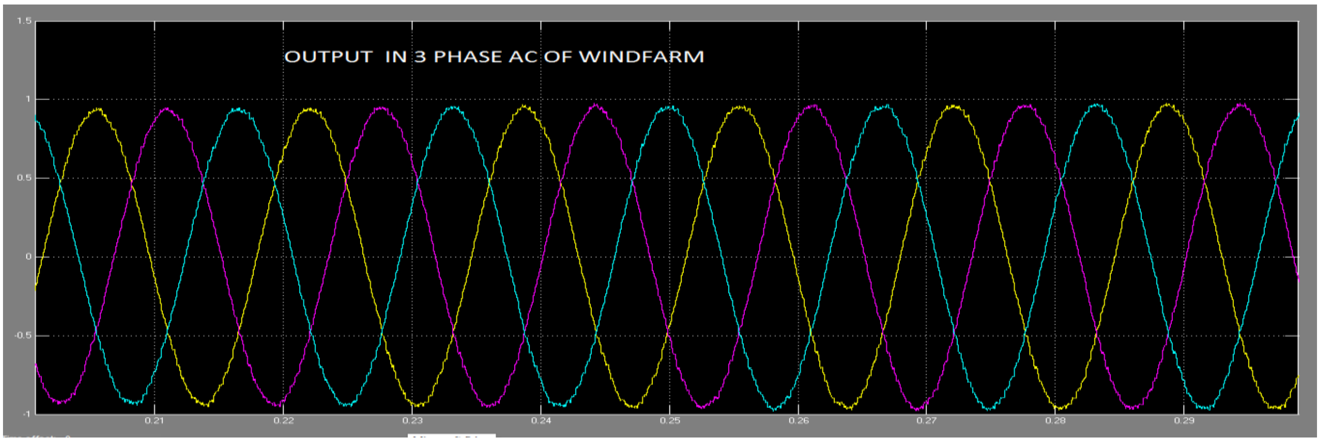

Figure 12. Output Voltage of wind farm

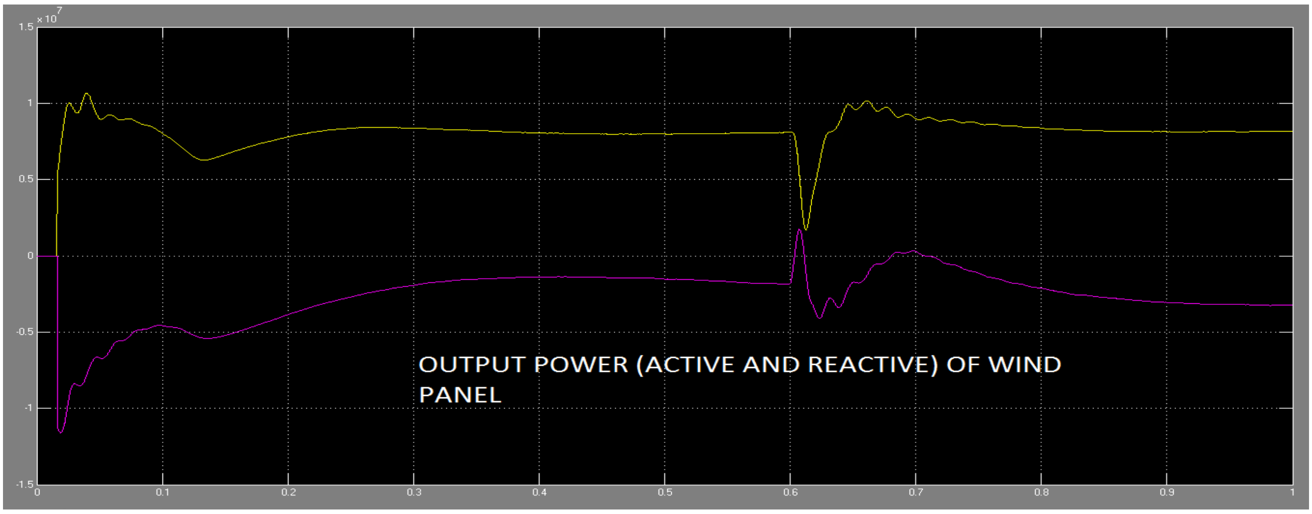

Figure 13. Output Voltage of wind farm

Power output Hybrid system of with Load connection :

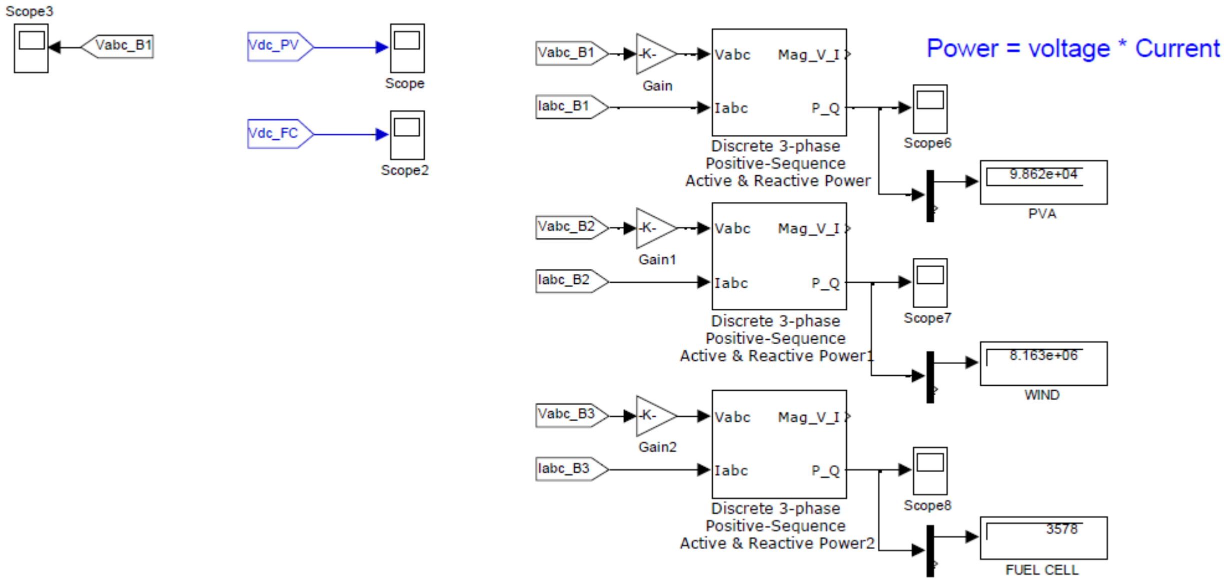

Figure 14. Simulation result obtained at display block of PVA, wind block and Fuel cell block with grid connection.

Harmonic Analysis :

In this hybrid system PV array, wind farm & fuel cell are connected in parallel with bus and grid. These grid are connected with circuit breaker, from which temporary line fault is made simultaneously at that time switch in the STATCOM. Statcom is use to compensate Reactive and active power at load. **Its**showing that after 0.6 sec a fault occurs due to(circuit breaker)line fault to control that statcom is switched on at time 0.6 sec. Hence active power and reactive power is controlled by statcom .

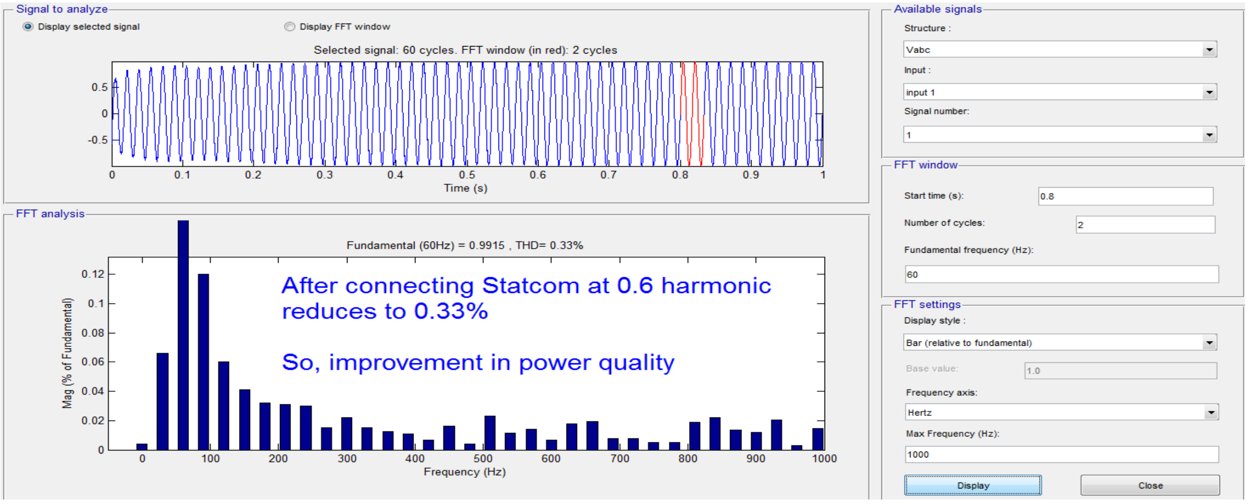

Figure 5.11 FTT analysis of showing Harmonics reduction

VI CONCLUSION

The paper shows the result of grid connected with solar,PV and wind hybridpower system which was developed inMATLAB/SIMULINK software. Converters, inverters, circuit breaker and transformer are modelled for solar PV and wind energysystem. These hybrid system are connected with the loadand also to the grid through a manual switch. Dualpurpose inverter was designed with an unified controlstrategy in order to improve the power qualityproblem and to integrate hybrid power generatingsystem to grid. The THD analysis shows that thecontroller very well improves the power quality aswell as connects the renewable sources to the grid

VII. REFERENCES

[1] Go¨kay Bayrak, Mehmet Cebeci "Grid connected fuel cell and PV hybrid power generating system design with Matlab Simulink" Elsevier, November 2013.
[2] Zeng Liu, Student Member, IEEE, Jinjun Liu, Senior Member, "A Unified Control Strategy for Three-Phase Inverter in Distributed Generation", IEEE Trans . Power Electronics, March 2014.
[3] Zhilei Yao and Lan Xiao, Member "Control of Single-Phase Grid-Connected Inverter With Non-linear Loads", IEEE Trans Industrial Electronics, April 2013.
[4] Henk Polinder, Senior Member, IEEE, Ferreira, and Richard A, McMahon, " Trends in Wind Turbine Generator Systems", IEEE Trans. Power Electronics,Vol.1, No. 3, September 2013.
[5] Frede Blaabjerg, Fellow, IEEE, and Ke Ma, Member IEEE "Future of Power Electronics for Wind Turbine," IEEE Trans. Power Electronics, vol. 1, No. 3, September 2013
[6] Enslin, J. H. R., "Maximum Power Point Tracking: A Cost Saving Necessity In Solar Energy Systems", 16th IEEE Annual Industrial Electronics Society Conference, Pacific Grove, USA, 1990, pp.1073- 1077.

