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Simulation and Modeling of Hybrid Electrical Energy with Combination of Microgrid

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***Abstract**: Distributed energy resource (DER) distributed storage and loads are the three combining together in microgrid. There is so many requirement of electrical energy the need can be fulfilled by renewable energy source addition with conventional source of energy. Energy management can done by using availability of electrical energy, energy source and energy storage devices. the energy management system is deal with energy combining of source and load.in this paper dc microgrid is indicated along with energy management system. The photovoltaic array, wind turbine generator, battery storage, grid and energy management building blocks are included in the simulation model. The simulation results are presented with variable load and variable generation conditions.*

***Keywords**: Sources of Renewable Energy, microgrid, energy management system, energy storage Devices.*

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I. Introduction

The ever increasing demand of electricity and crisis in conventional sources of electricity generation is leading to application of renewable energy sources for electricity generation. Also, the need to decrease pollutant gases and liberalization of electricity market has led to a large scale development and implementation of distributed renewable energy generators in electrical grids. The application of solar energy or wind generators is solutions to reduce greenhouse emissions and fuel consumption. In India, the growth in this renewable energy installation combined effect of regional energy development agencies and private sector participation. The microgrid is an electrical system that involves numerous loads and distributed energy resources such as PVS, WTGS, diesel generators, fuel cells, etc., which can be operated in parallel with broader utility grid or as an electrical island. Hence implementation of microgrids will surely help in reducing the supply-demand gap and enhance the utilization of renewable energy resources. Microgrid or distributed energy resource system is an electrical power system that have DER and load, have the ability to disconnect from and parallel with area EPS, include local EPS or may include area EPS and are intentionally planned[1]. Combining renewable resources with energy storage provides a proper solution for mitigating the intermittency and volatility of renewable energy. A cost-effective way of storing electrical energy can help make microgrid more efficient and reliable. The optimized problem includes a variety of energy resources that are likely to be found in a microgrid including PV, DG, MT, FC and WT. The problem of optimization of exchange of power between MG and distribution network of electricity utility has been represented in [5]. The objectives perform and set of constraints are conferred with formula supported evolutionary algorithms technique. An operator can be used a computer added tool in energy management system for electrical utility grid to monitor, control and optimization the performance of generation system in a microgrid. Energy management system is very important due to the presence of both the sources of energy. In literature [15], the system configuration including green power generator, energy storage element, dc appliance and equipment, and energy management system with a fuzzy controller are introduced. [17] Network for data communication and delivery of energy distribution instructions. In [18],Micrigrid can be form by a central energy management system in addition with home appliances and the conventional production of units The fig 1shows the complete block diagram of dc microgrid with energy management system. Distributed resources like PV array, WTGS and battery storage are the core components of the microgrid system. Utility grid is also taken into account whenever back up by the battery is not sufficient to supply the connected load. The EMS is the heart of the system that schedule between generation and load.

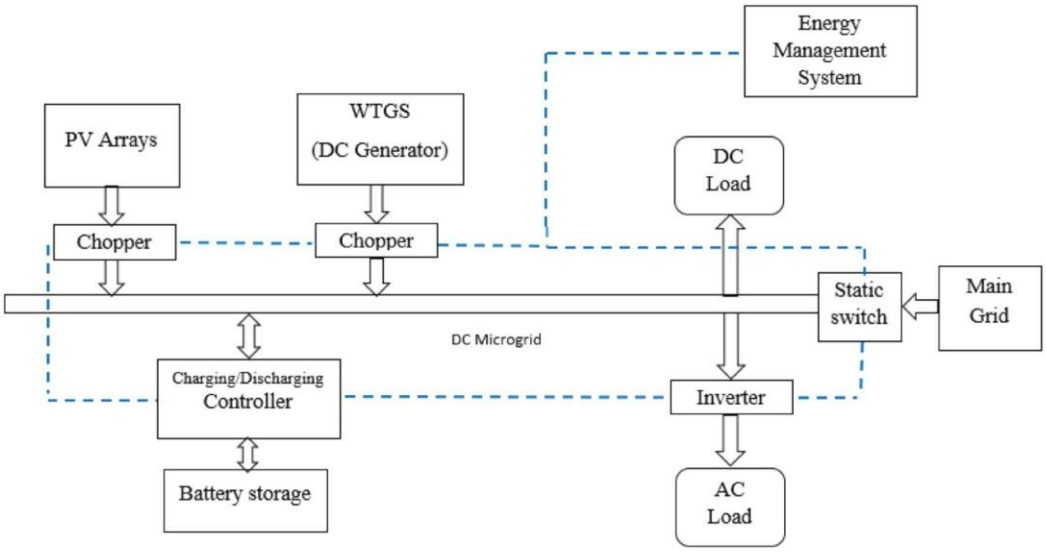

Fig.1 Dc Microgrid with Energy Management System

II. Planned Energy Management System

A. Simulation model As shown in Fig. 2.by using string of photovoltaic array, wind turbine generator, battery storage system grid and load makes the complete simulation model of dc microgrid. PV array and wind turbine generator each of 1 kW with constant voltage closed loop boost converter that step up the PV array voltage from 24V to 48V are connected to the dc bus of 48V. With charging and discharging controller for energy storage system lithium ion battery is used with rating of 180Ah, 48v.The rectified voltage of grid is connected to the dc bus through static switch to supply power whenever needed. Resistive load of 2kW is supplied from dc bus out of which 500W of critical load.

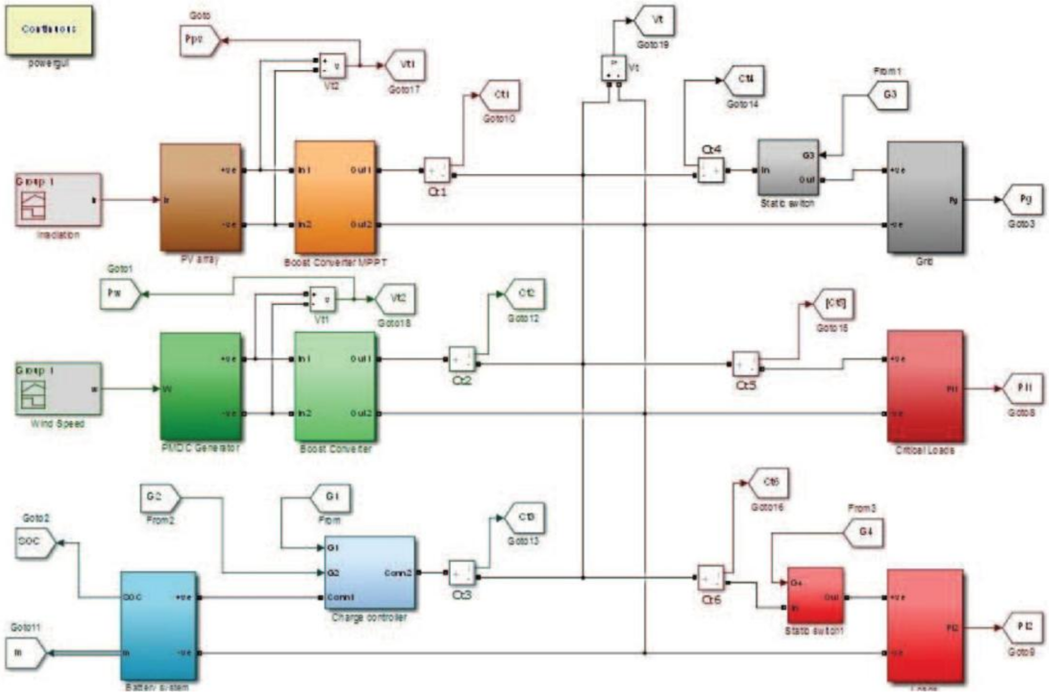

Fig.2 Simulation model of dc microgrid

On the basis Optimal scheduling of generation and load proposed energy management systems with mathematical model is based. The input signals are generated power of PV array, wind turbine generated power, SOC of battery and load. The signal G1 for battery charging, G2 for battery discharging, G3 for grid on/off and G4 for load on/off.

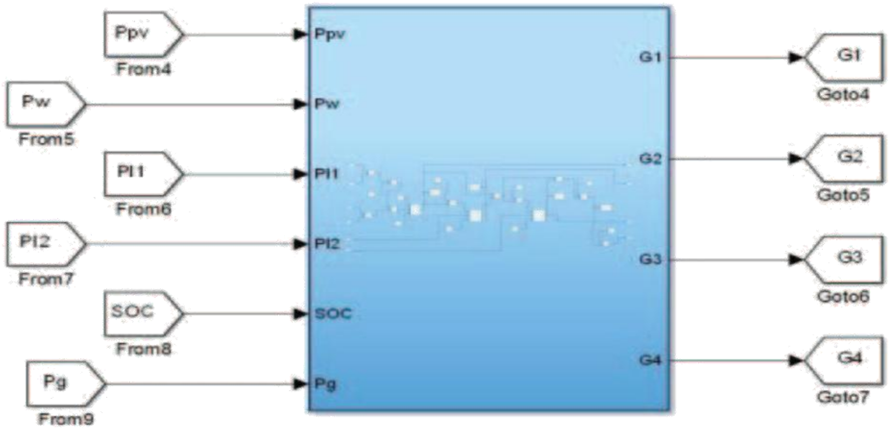

Fig.3 Ems Mathematical Model

B. Formulation of Energy management System

The total energy generated from renewables is,

PPV + PW = PE

(1)

Where, PPV is generated power by PV array and PW is generated power by WTGS and that of the total load is
PL1 + PL2 = PL
(2)
Where, PL1 is critical load and PL2 is manageable load.

After comparing PE and PL,

if PE > PLin this condition through renewable energy source the battery charge by triggering charging controller that is giving signal G1 = 1,

Otherwise G1 = 0,

If PE < PL in this condition the battery is discharge to supply extra load that is not available to renewables,

By triggering discharging controller that is giving signal G2 = 1

If SOC of battery is greater than 0.5,

Otherwise G2 = 0, if SOC < 0.5 then check PG to supply extra load

If PG > 0 in this condition give signal G3 = 1 otherwise G3 = 0,

Switch off some manageable load by giving G4 = 0 otherwise G4 = 1.When PG don’t have enough power to supply.

III. Simulation Results

Results of simulation are illustrated for variable generation and load, in which the forecasting data of solar irradiation and wind are assumed to be variable for the day. The power generated from PV and WTGS are plotted on the same axis, in addition to that radiation of solar energy from 0 to 1000W/m2 and speed of wind varies between 30 to 60 rad/sec. The simulation is run for 0.1 different conditions are considered for illustration as shown in table I, condition 1, is for battery charging in which the SOC of battery is assumed to be 0.3 (30 percent) and variable load connected to the system is between 400W to 1.2kW. Whenever the load is less than generation battery will charge by triggering static switch of charge controller, extra generated power by the renewable sources will charge the battery. Fig.4 shows generated power and load and Fig.5 shows battery parameters that is SOC, battery voltage and current. From 0.05 s battery will start charging because required voltage will develop at this point.

TABLE I DIFFERENT CONDITIONS OF SCHEDULING GENERATION AND LOAD

Conditions	Generated power	Connected Load	Battery state	Grid state
Condition 1	700-1600W	400-1200W	Charging	Off
Condition 2	300-1200W	500-1700W	Discharging	Off
Condition 3	400-1500W	500-1700W	No action	On

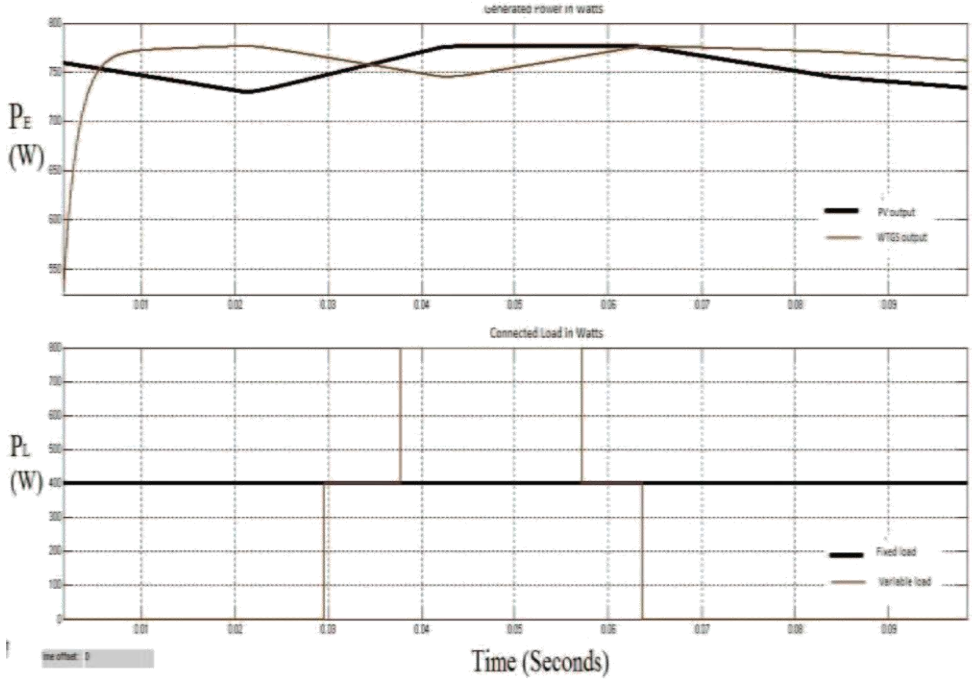

Fig.4 Condition 1 Generated power and load while battery charging

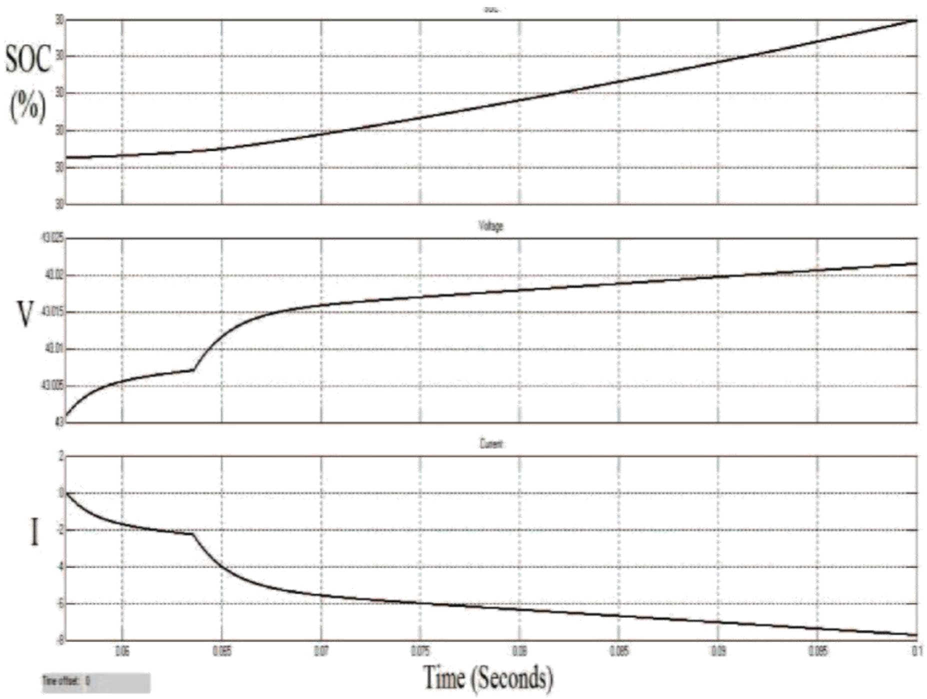

Fig.5 Condition1 battery parameters while charging

Condition 2, is for battery discharging in which the SOC of battery is assumed to be above 0.5 (50 percent). Whenever load exceeds the generation needs an extra power to fulfill the load, That extra power is taken from the battery. Fig.6 shows the graph of generated power and load and Fig.7 shows Battery parameters. From 0.01 s the load exceeds the generation then battery supplies extra power.

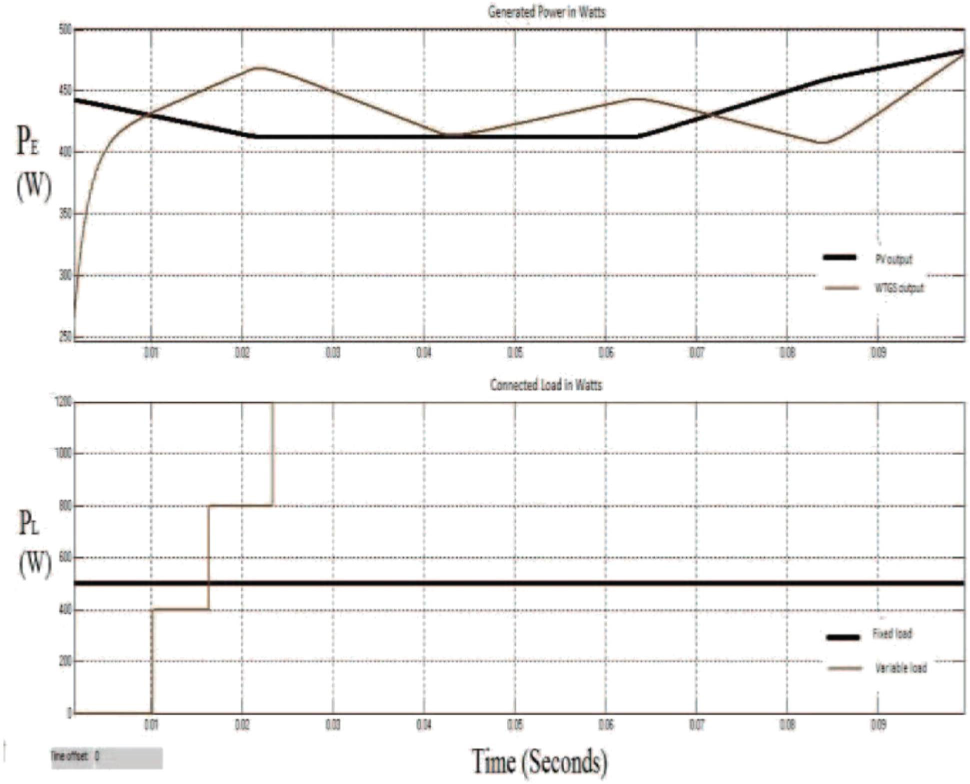

Fig.6 Condition 2 generated power and load while battery discharging

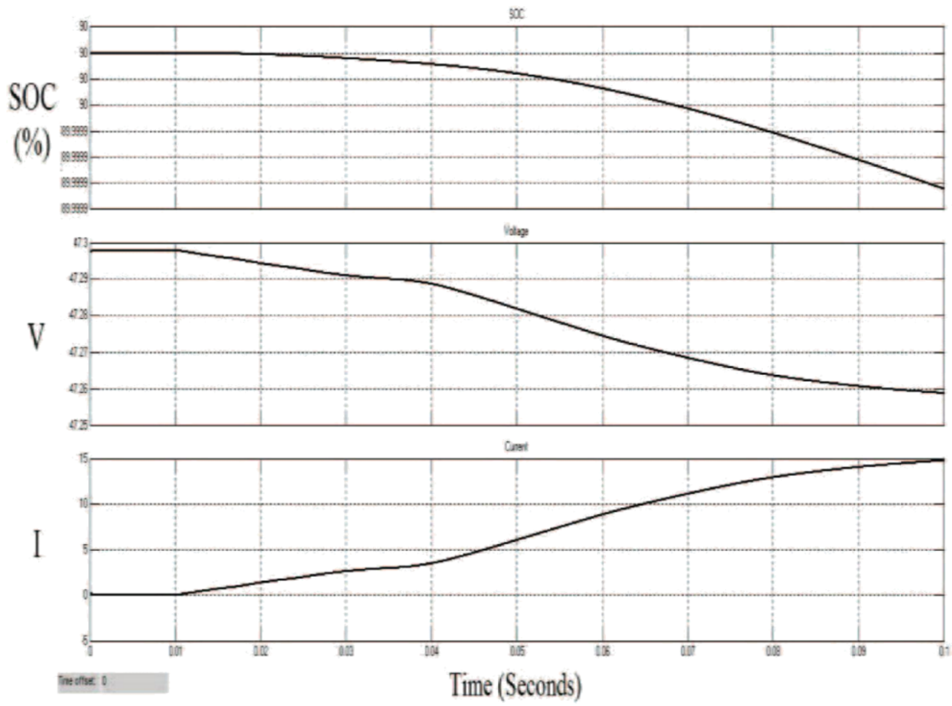

Fig.7 Condition 2 battery parameters while discharging

In condition 3, load is more than generation and battery SOC is less than 0.5 (50 percent), then to supply load power is taken from grid by triggering static switch connected between dc bus and utility grid. Fig.

8 shows generated power and load and power taken by the utility grid is shown in Fig.9.

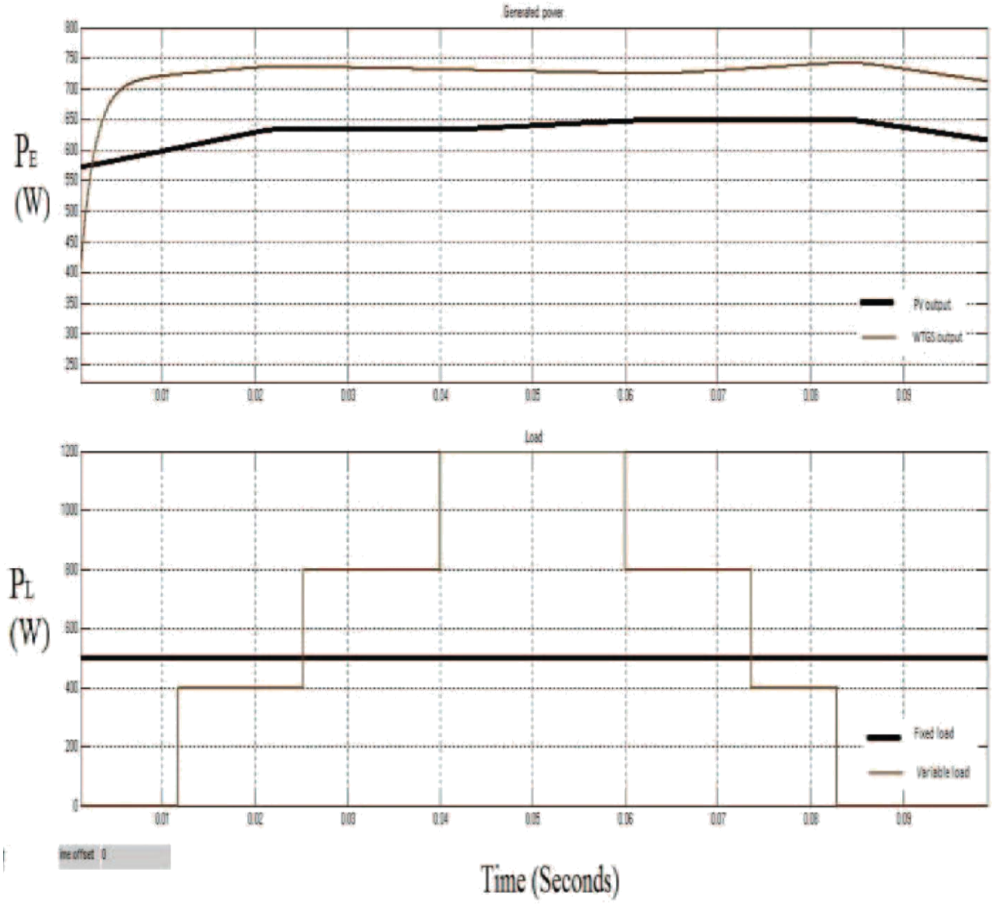

Fig.8 Condition 3 generated power and load while supply taken fromgrid

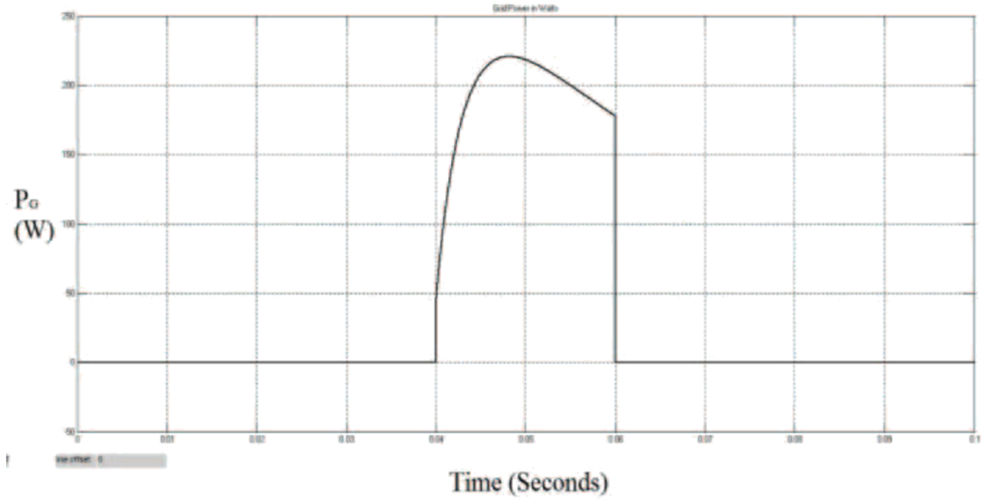

Fig.9 Condition 3 power taken from grid

IV. Conclusion

Energy management system plays an important role for development of an generation and load of an system. Generation among various energy sources and connected load are not constant static switches are used for every source or load to controlled by gate pulse signals generated by energy managements system. In future there is very much scope for bidirectional power flow with the utility grid.

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