Integration of D.G in Micro-Grid

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ABSTRACT : *In this Paper solar and wind plant is design for use of the common purposes and as we can utilize maximum power according to the gio-graphical situation and can generate power and make a micro grid for the local use in Islanding and Grid connection mode of Micro-grid as per criteria and requirement of the system. In addition, Micro-grid can play very important role in small-scale distributed energy source utilization, so that wheeling cost of energy reduces. Also by use of renewable energy distribution generation, reduces cost so able to provide economical rate of energy for tribal villages.*

KEYWORDS - *PV, Wind, DC-DC Converter, P/Q Control, V/F Control, Coordination of breaker signal, Islands Mode, and Grid Mode*

I. INTRODUCTION

In this paper, solar and wind plant is design for use of the common purposes and as one can utilize maximum power according to the Geo-graphical, situation and can generate power and make a micro grid for the local use for remote area like hill or tribal villages. The need of the energy is going to increases drastically in future years for which Micro-grid is a good solution for providing energy gap, which is not carried out by current fossil sources. Power generation community require to control it and use it optimally when required, check islanding and grid connection mode of micro-grid as per criteria and requirement of the system. Micro-grid can play very important role in small-scale distributed energy source utilization [1], so that wheeling cost of energy reduces. By use of renewable energy distribution generation, we can reduce cost for providing economical rate of energy for consumer.

II. SOLAR PLANT AND WIND PLANT

In solar & wind plant, focus is generation of electrical energy, for that solar & Wind plant is simulated and modeled from equation. In simulation model Solar and wind are combined in common dc bus and the Common dc output is for the input of AC convertion of DGs.. (from grid connection to islanded or islanded mode to grid connection) is easy.
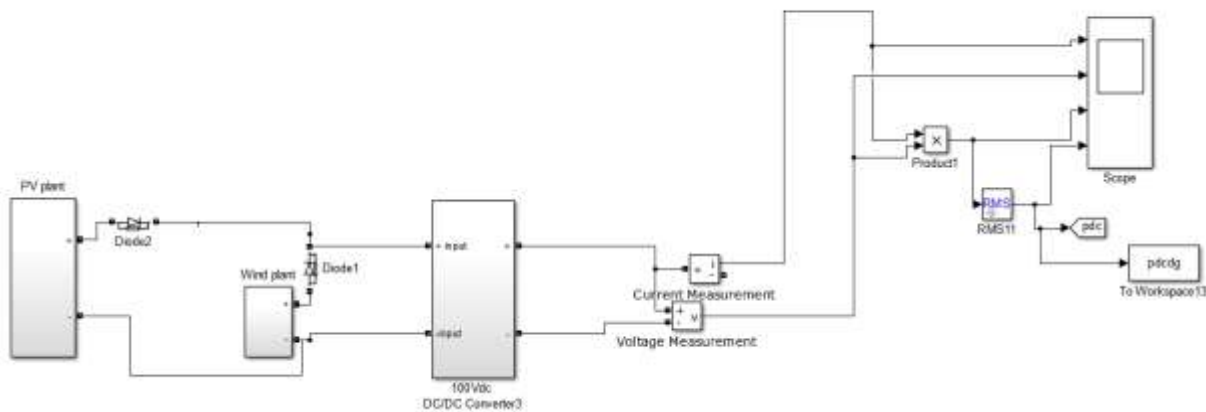
A. **Solar** *and wind Plant*

figure 1 Solar & Wind with DC/DC converter

Two or more power supplies can be connected to supply higher voltages or current. The simplest method to create higher current is to connect the power supplies in parallel and leave only one supply in constant voltage mode. The combine output of   8kw solar & 2kw wind is shows in below wave form.
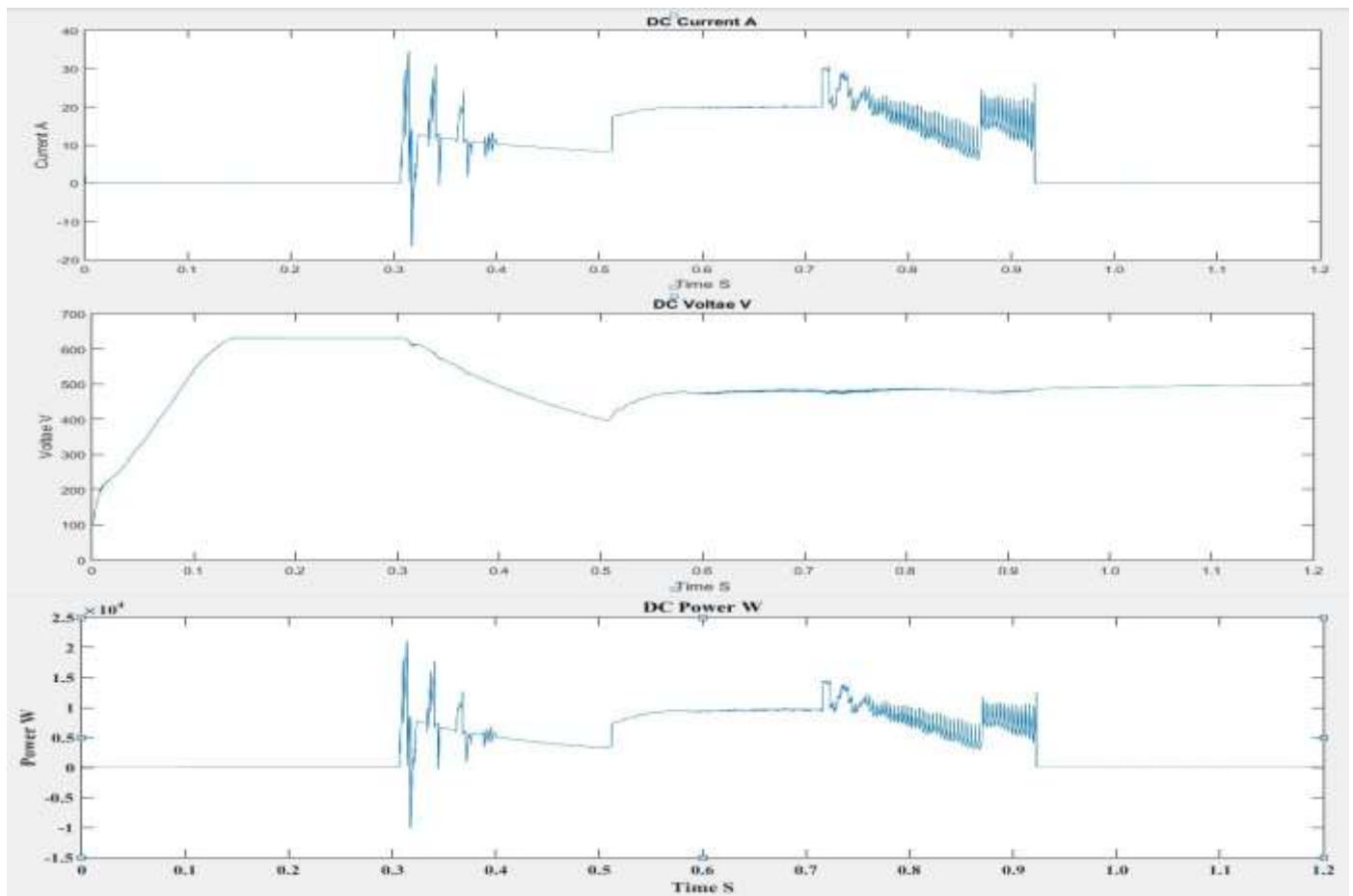
figure 2 Solar & Wind with DC/DC converter Output wave form a.Current(A), b.Voltage(V), c.Power(W)
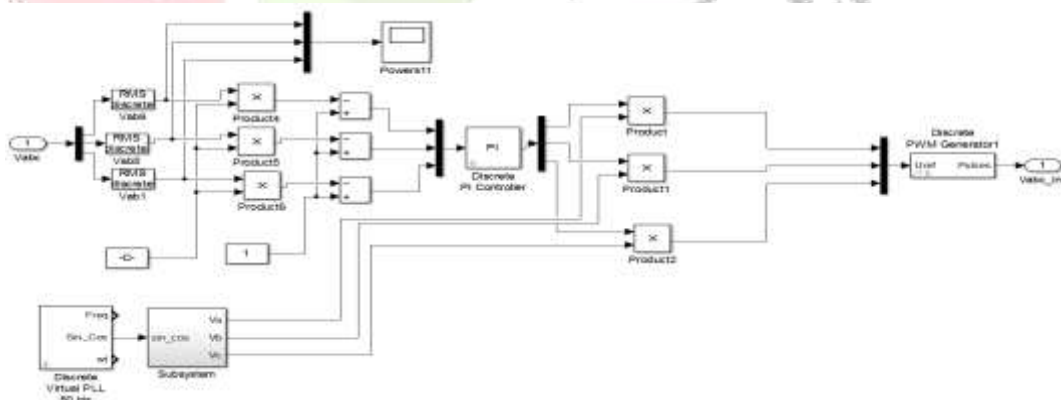
III. CONTROL SCHEME

1) V/F control diagram

Figure3 V/F control Method

Here Vabc is load voltage taken as input and for error detection voltage is divided by Vrms , that gives voltage error signal that signal is given to PI controller to remove unnecessary distortion now this signal is multiplied by 120 degree deference and with magnitude and given to the PWM generator that will generates triggering signal for the inverter here limitation is that as load increases load voltage will decreases at bus level, after increase in certain value of load voltage starts decreasing. Due to limited DG generation capacity.[4]

2) P/Q Control diagram

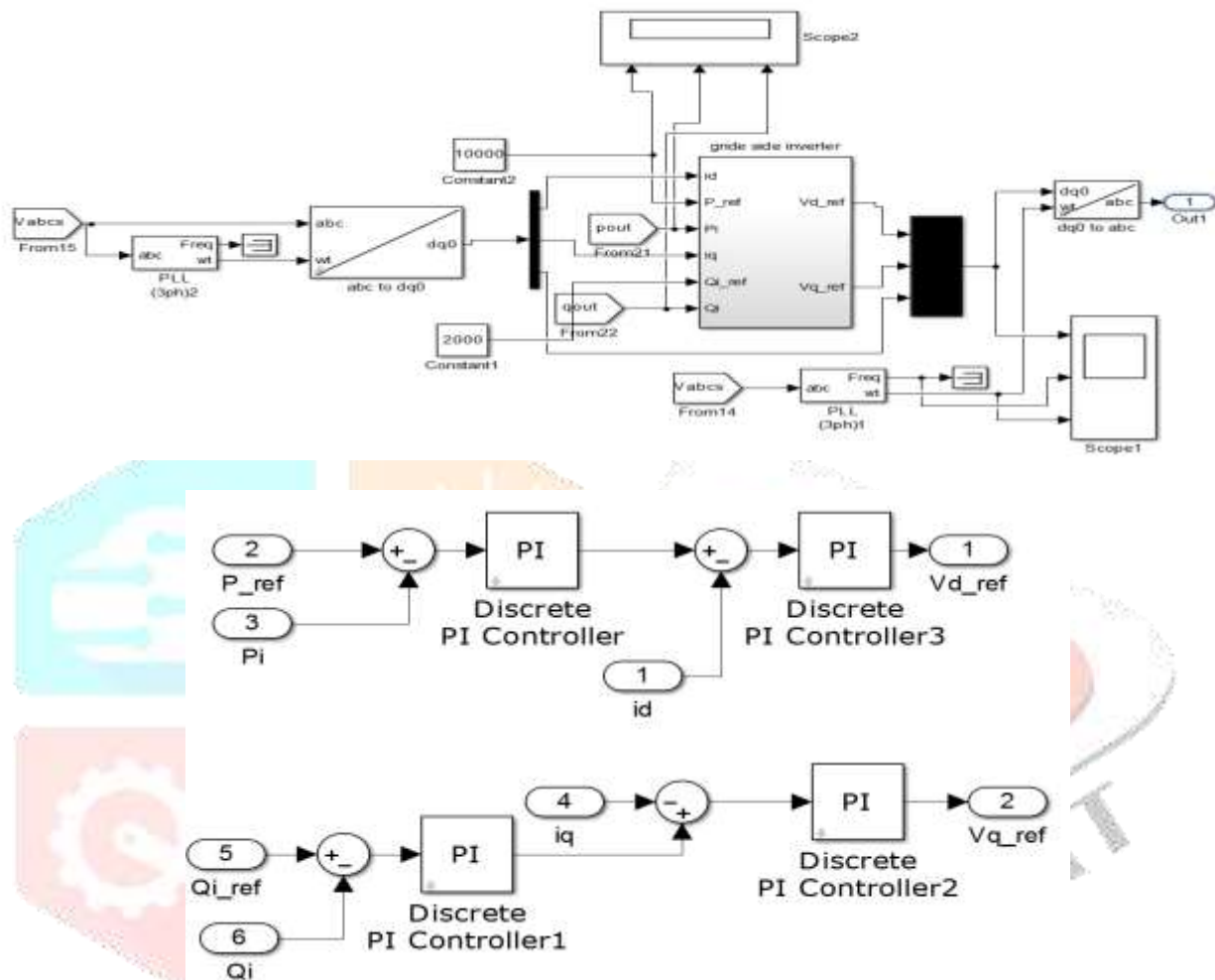*Figure 4 P/Q control scheme (Grid connected mode)*

Figure 5 Current and voltage control loop

- In figure 4 P/Q scheme is shown, in which Vabc is taken from load side grid connected mode is difficult to perform as it require synchronism with grid and DGs. For Economical point priority is given to DG and extra power requirement is provided by Grid. for that grid and DG voltage magnitude and phase should be same. PLL provide phase angle of Grid and give signal to inverter for synchronism. For this work ABC-dq0 transformation is require, that provide Vd ref and Vq ref signals and according to fig 4 signal is converted into dqo form. By using dq0-ABC conversion error signal is generated which give Signal to DG for synchronism and also requirement from grid.[4]

- Figure 5 is sub system of block grid side inverter in fig.4.

Figure 5 is simulation diagram of the figure 3. Here Vd_ref signal is used to control current of the MG during Grid connected mode. for that it is take active power difference error signal and that signal is given to id for making vd_ref. same way for controlling current signal reactive power is used.

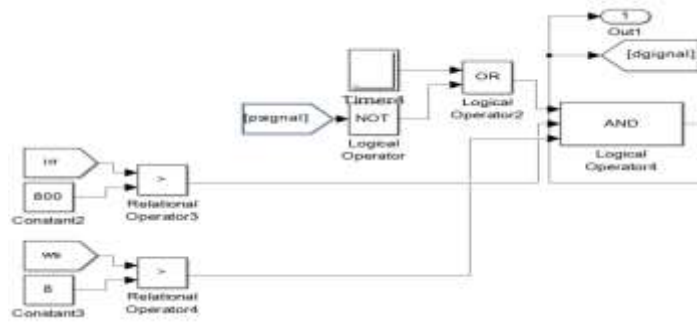## IV. COORDINATION SIGNAL OF BREAKER B1 AND B2

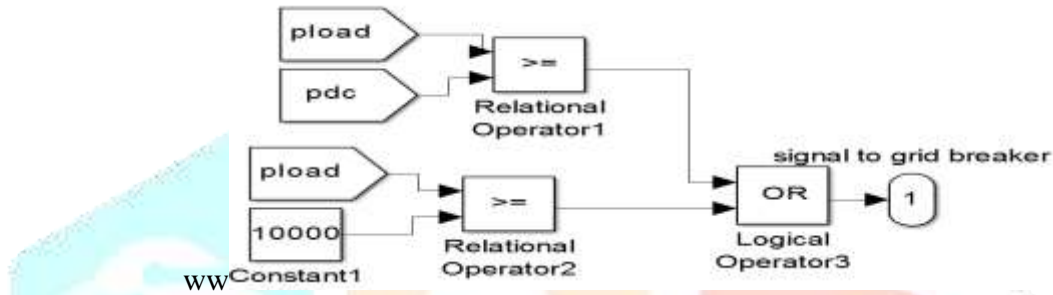

Figure 6 DG switching logic

Figure 7 Grid switching logic

Figure 7 is signal diagram of DG breaker,
1. In that first input of the DG is check. If solar irradiance is more than 800 W/M^2 and wind speed more than 8 M/s then it will conduct
2. Grid is disconnected.

Figure 8 is signal diagram for Grid switching. Which has two condition
1. P_{load} (load) is less than generation of DGs
2. P_{load} is more than Reference load (10000)

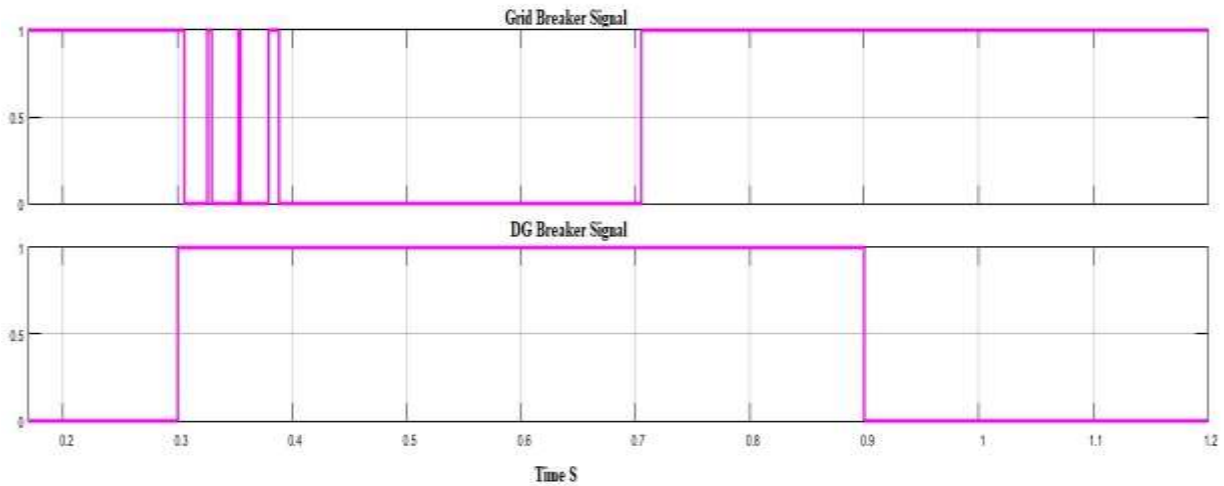This both modes help to provide continuous power to critical load.

Figure 8 Grid & DG Breaker Signal
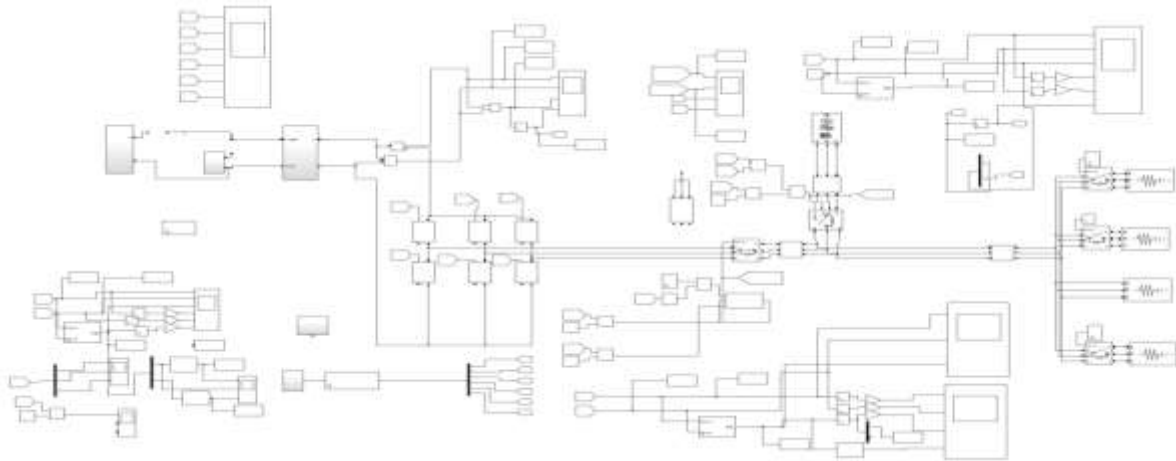
V. SIMULATION AND WAVE FORM

Figure 9 Complete Simulation diagram

A. PV Plant:

By modeling Photovoltaic cell simulation is carried out in this PV array, 9 rows and 4 columns to get 270V and 27 A to full fill 8000 W power as (9*29.6)V and (7.61*4) A = 8109.216 Watts =8000 Watts Apprx..

B. Wind plant:

Here PMSG is used as generator as type 2 model. Here at wind speed 12 m/s it generates 4KW after generation of 3 phase power, for making common DC bus this 3 phase power is converted into 200V DC. It is simulated for 2000 watts generation.

C. Breaker B1 and B2:

Two breakers are used for coordination of DG and Grid their control logic and signals are shown in section IV.

D. Inverter and control:

For working in islanding and grid connected mode, control of inverter in two V/F and P/Q methods is shown in section III with controlling diagram in detail.

E. Grid:

For simulating grid, 3 phase source is used which has 400 V as RMS and detail value is as below:

F. Load:

For simulation only R load is taken and every of 5000 watts, for variation at various time load switching is taken which is as below:

Time	Load added	Total Load
0	5000 Watts	5000 Watts
0.5	5000 Watts	10000 Watts
0.7	5000 Watts	15000 Watts
0.85	5000 Watts	20000 Watts
0.9	-5000 Watts	15000 Watts

Figure 8 shows trigging signal of grid breaker and DG breaker here at starting time grid breaker is on which is shown in figure 8. at time T=0.3 sec tripping signal is given to grid, that means power to load is start decrementing. This give signal to DG breaker to start as shown in figure 8. and at time T= 0.7 sec load power requirement is more than DG generation so grid breaker give signal to start grid in parallel with DG. Which is shown in figure 8. at T= 0.9 sec DG generation become zero. So DG breaker trip.
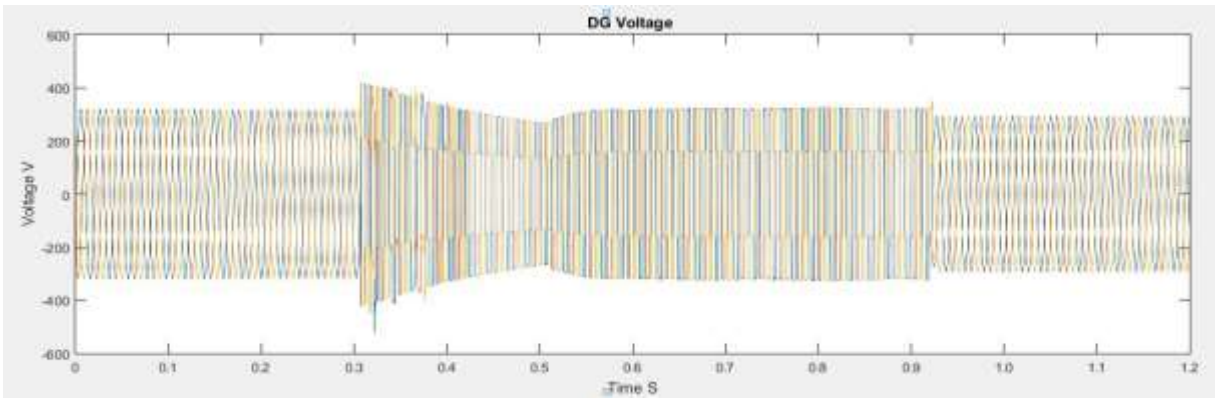
Figure 10 DG Voltage Wave Form

DG voltage wave form shows that up to time T= 0.3 sec no voltage variation is there, after T= 0.3 sec V/F control method is implemented. Due to that as load incremented voltage is decremented. Now at time T= 0.7 sec P/Q mode is on that's why voltage is incremented and integration of DG and Grid is implemented. At T= 0.9 sec DG is Disconnected. And voltage level is maintain at 325V.

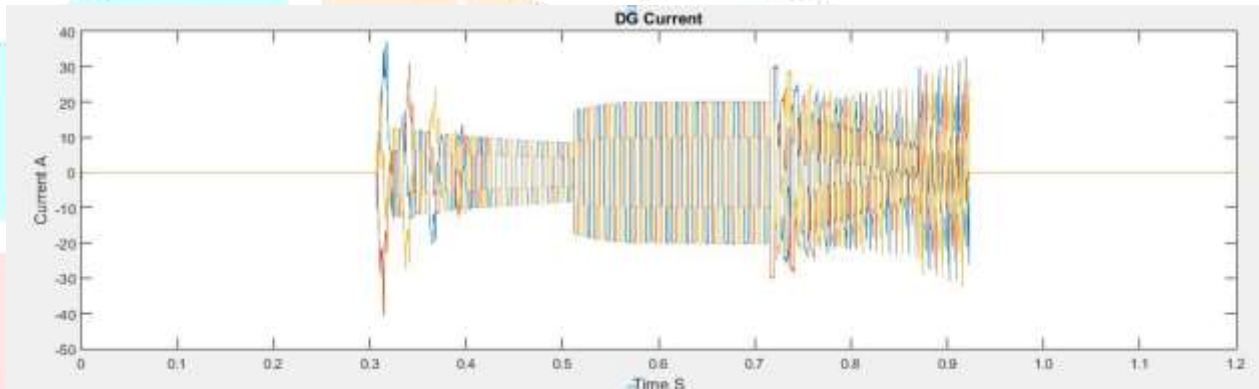- DG current value Zero shows that DG is not supplying any power.
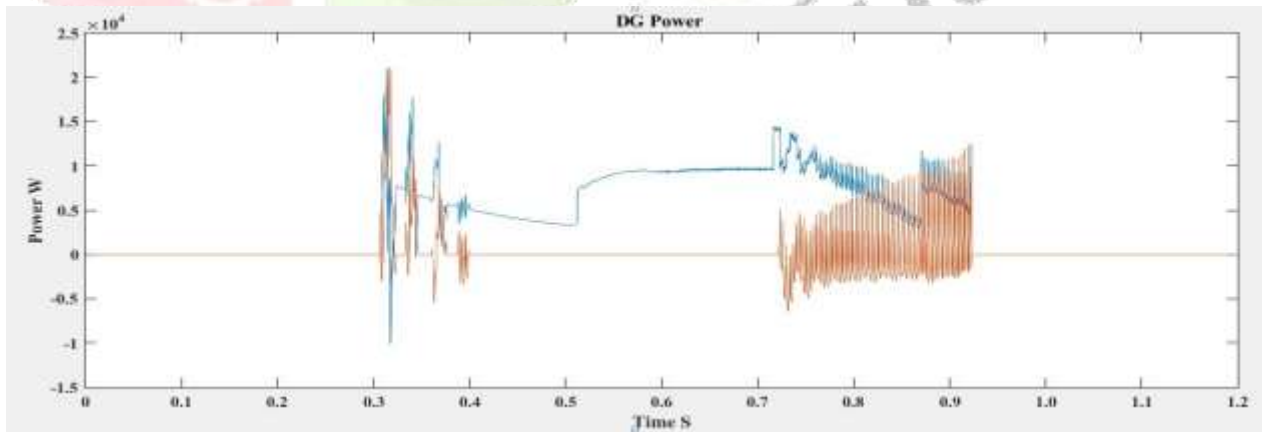

Figure 11 DG Current Wave

Figure 12 DG Power Wave Form

DG power shows that at T=0.3 sec load is 5KW, which is supplied by DG. At T= 0.5 sec load is incremented to 10KW which increment is shown in figure 35. now at T=0.7 sec P/Q control method is start which first use DG power and then surplus power is taken from the grid.
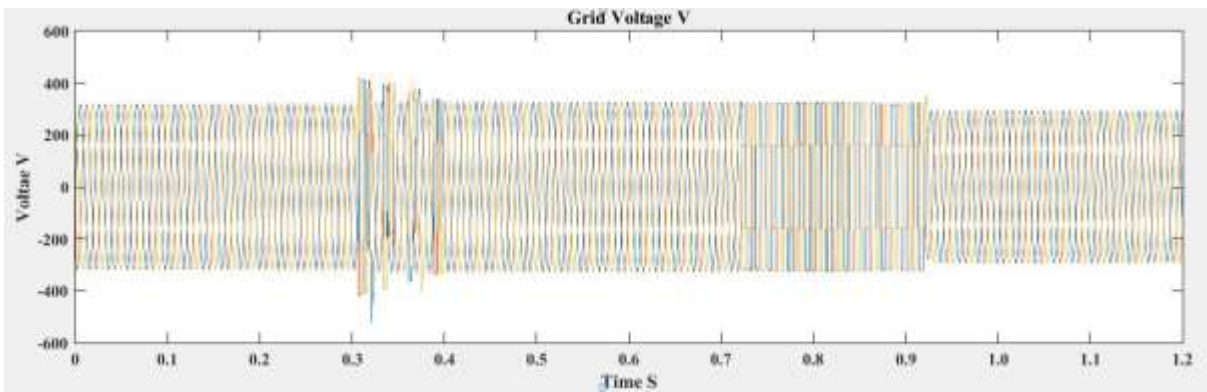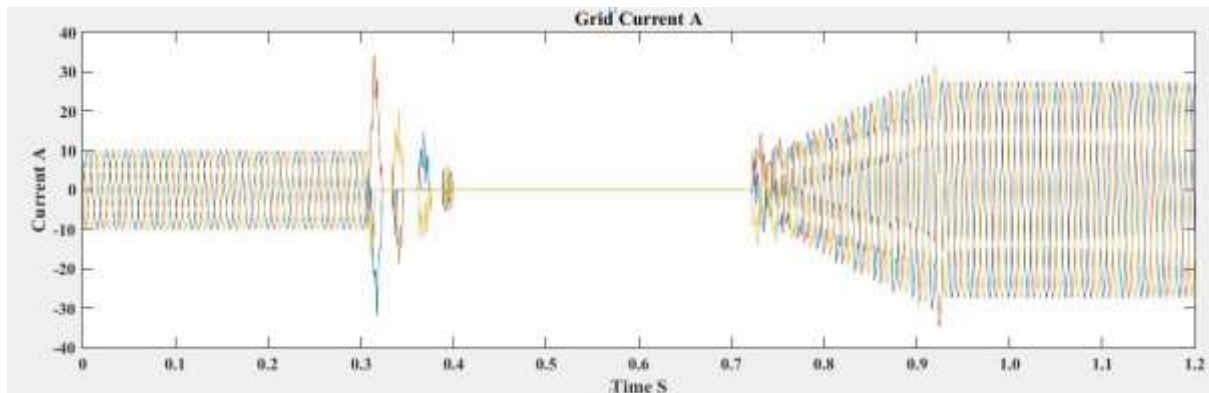
Figure 13 Grid Voltage Wave Form

Figure 14 Grid Current Wave Form

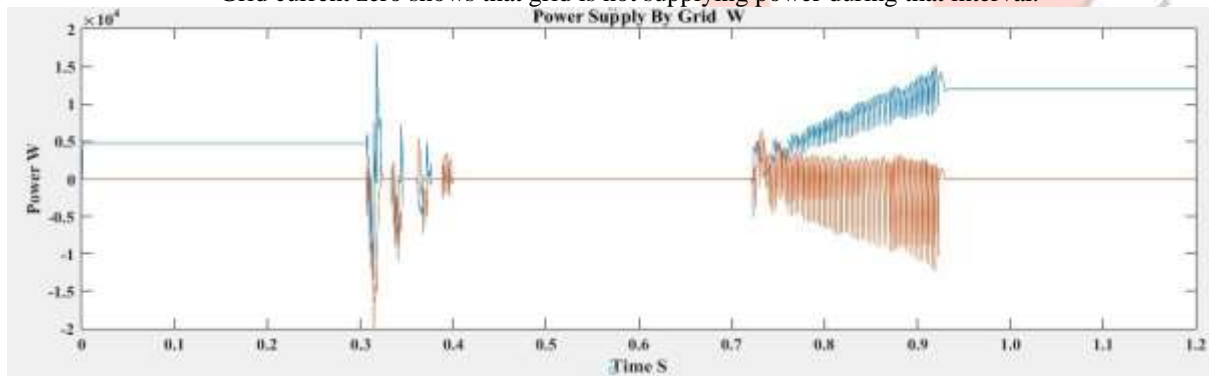- Grid current zero shows that grid is not supplying power during that interval.

Figure 15 Grid Power Wave Form

Here figure shows power is supplying by grid is 5KW provided by grid up to T=0.3 sec. and again it start at T=0.7 sec. after T=0.7 sec DG and grid are parallel so both is supplying power to load. But due to use of PLL logic in P/Q control method, surplus power is taken from the grid. and also synchronism is maintain due to that variation in the grid power is clearly visible.
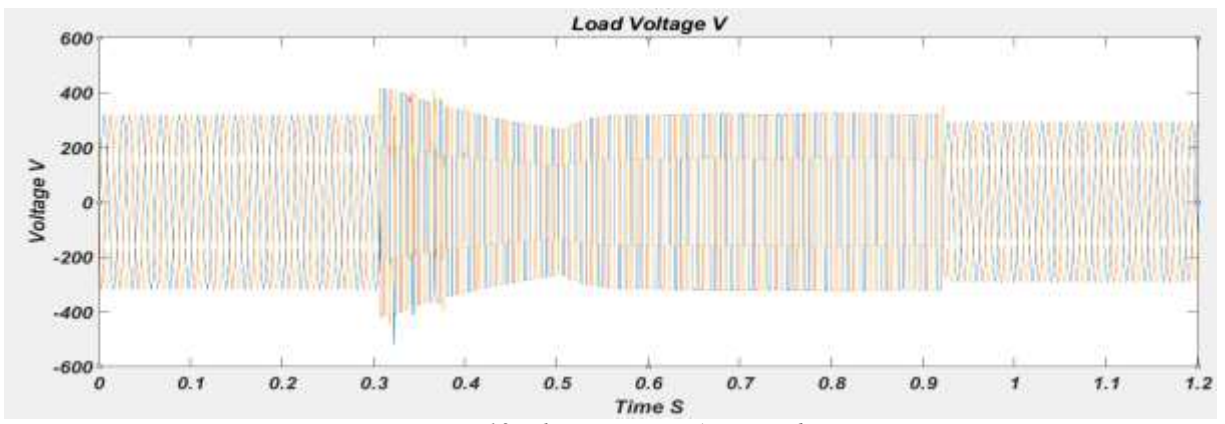
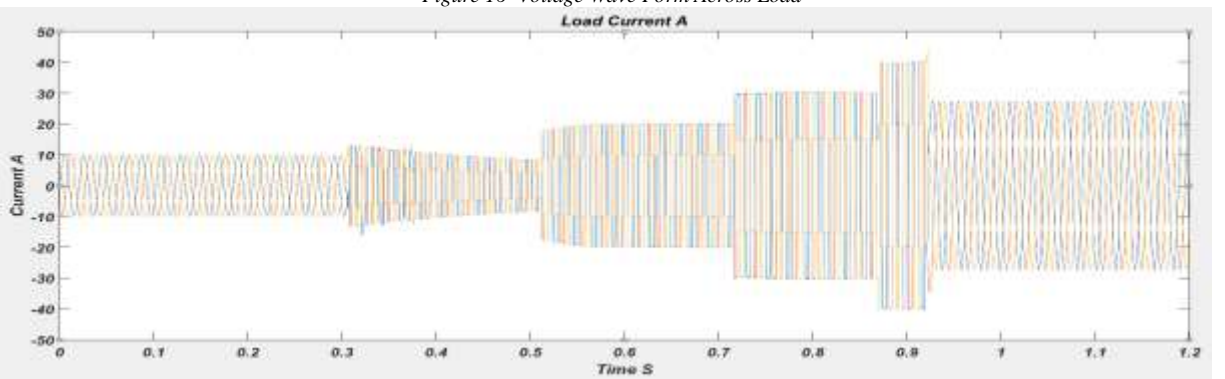*Figure 16 Voltage Wave Form Across Load*
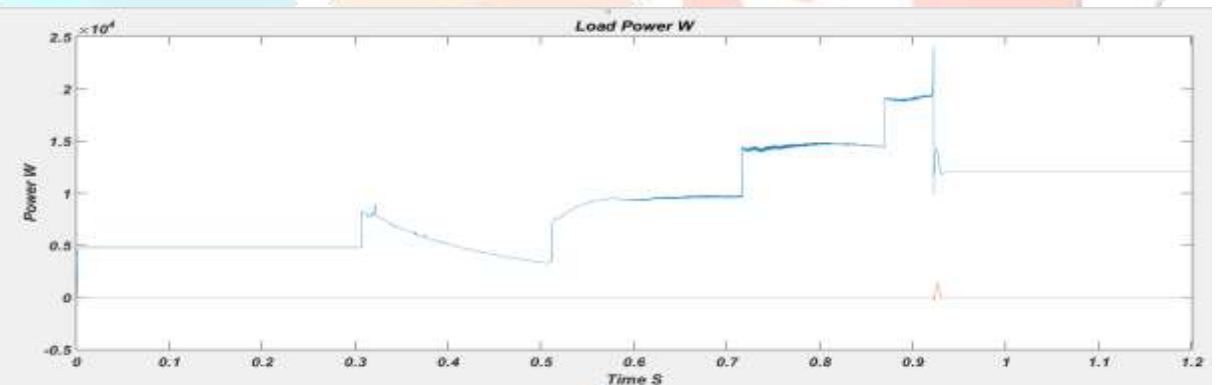

Figure 17 Current Wave Form Across

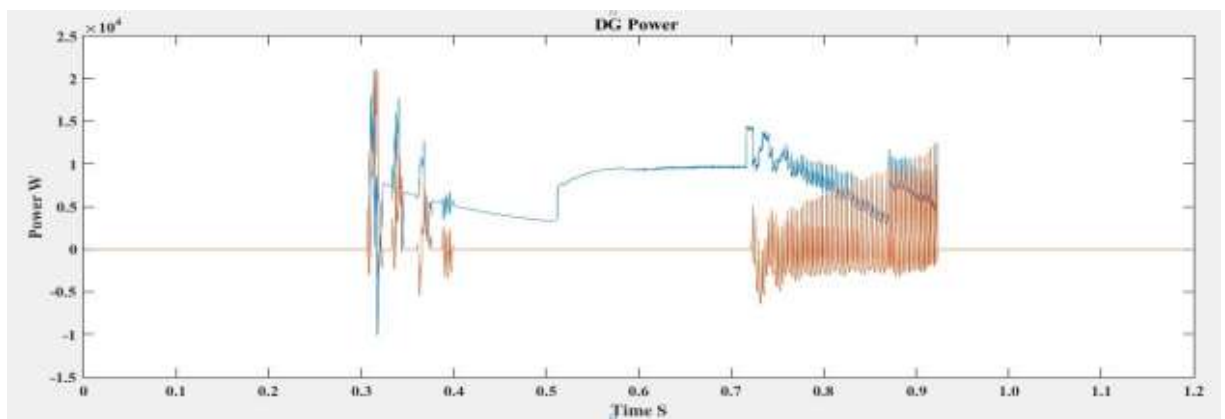*Figure 18 Power Supply by Grid*

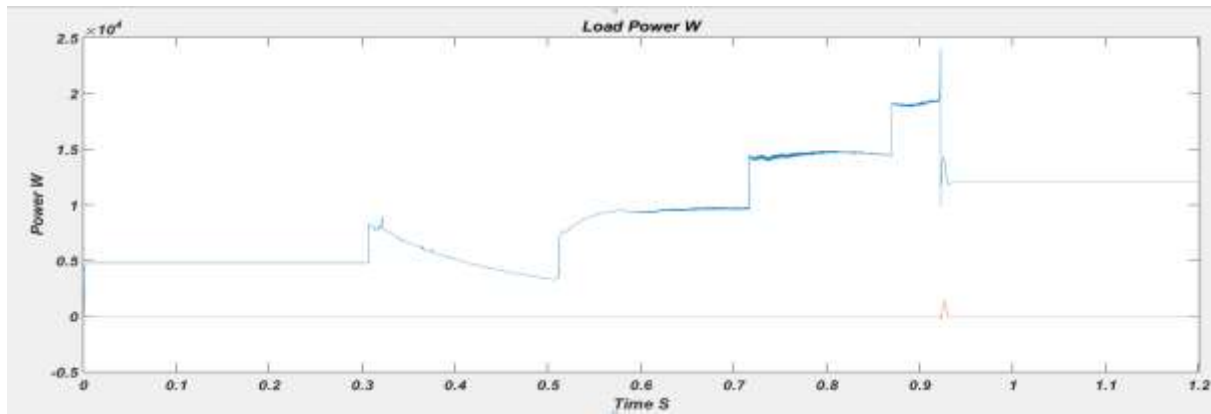
Figure 19 DG Power supply to load

Figure 20 Output Power across Load

VI. RESULT DISCUSSION

Here critical load (like hospital) should be continuously supplying by use of MG. In simulation as described at T=0.3 second grid is disconnected and DG is come picture as DG start supplying power through inverter it supply power in distorted paten, Which is shown in above results. Simulation has three major part as Grid, DG and load so variation at all these point is important. To check variation measurement of voltage, current and power are important. Here voltage up to T= 0.3 is pure sine wave but after that is fluctuates as DG start supply to load. In figure 10 shows the DG voltage in which after T=0.3 sec minor fluctuates starts. When load is added more 5000 watts this voltage is dips to maintain power flow as it is working of V/F condition voltage regulation is take place by DG. Which is properly shown in figure. And fig. 11 shows current supply from DG that shows load increment at T=0.5sec.

Now at T=0.7 sec load is incremented 5000watts now total load is 15000 watts that is more than full generation capacity of DG. For full-fill load Grid has to come in picture. 5000Watts surplus power is now start supplying by grid which is shown in figure 15.

Now here as DG and Grid both working in parallel so communication and perfect synchronism is required between them. This work is done by use of PLL and ABC-dq0 transformation which is shown in P/F control method. From this point onwards DG and Grid is Supply power parallel to full-fill load condition.

In islanded mode only by measuring phase and magnitude of voltage and current signal is generated that give inverter signal for switching. But in grid connected mode continuous measurement of phase and magnitude of voltage is require and that makes it more complicated to control. Here as shown first priority is given to the DG power, and after that surplus power is supply by Grid that is clearly shown in Figure 18;19;20. According to load condition Breaker signal will give signal to DG and Grid unit to supply power. And according to load condition inverter switching method is changes to perform Grid connected or islanded mode. Main advantage of Micro-Grid is intentional tripping of Grid for maximum use of renewable energy use for connected load. From this discussion conclusion can be explain as, working of micro-grid has two main mode as explain in theory portion

1. Islanding mode(T= 0.3 sec to T= 0.7 sec)
2. Grid connection mode(T= 0.7 sec to T= 0.9 sec)

1) Islanding mode

In Islanding mode of operation figure 3 shows control logic for inverter due to that control logic inverter start signaling at exact magnitude and phase which is shown in result figure . here inverter is triggering for supplying power in V/F mode that means as load increase inverter has to provide power with voltage regulation, means some degree of voltage dip is allowable. But when power demand increases more than signal is given to grid beaker to start supply from the grid as well DG. When two sources are working in parallel then synchronizing should be perfect. V/F logic made for Micro-grid is not performing synchronizing task because this takes PLL logic and transformation from one form to other form.

2) Grid connected mode

In grid connected mode P/Q control mode is implemented due to that at T=0.7 sec DG and grid are working in parallel. here inverter is triggering for supplying power constantly to grid that will supply power at constant voltage here variation in wave form is due to economical condition, means utilizing DG power first. Here problem for implementation in this method voltage variation is increases then allowable limit. Which is shown in figure 11;14;17 for time interval T= 0.7 to 0.9 sec. in this method for filtering active filter can be implemented to get smooth voltage, current.

- Here at T= 0 sec to T= 0.3 sec and after T= 0.9 sec load is supplied by the grid.
- Main aim to provide power to critical load (5KW) is satisfying.

Here changing in current with respect to load is shown in table below

Time (Sec.)	LOAD			DG			Grid		
	Current	Voltage	Power	Current	Voltage	Power	Current	Voltage	Power
0	11	330	5000	0	330	0	10	320	5000

0.3	11	335	5000	11	335	5000	0	330	0
0.5	21	328	10000	21	328	10000	0	330	0
0.7	32	330	15000	22	330	10300	10.5	320	4700
0.85	43	320	20000	11.5	320	5200	32	320	14800
0.9	33	320	15000	0	320	0	33	310	15000

VII. CONCLUSION

- In load incremental condition Micro-grid is able to switch Isolated mode to Gird connection mode, at T=0.7 sec as load increment 15KW that is more than DG generation in this condition coordination control auto switching take place that increases load reliability.
- Smooth switching between grid connected and isolated mode by using P/Q control.
- Voltage is constant at grid connection, isolated mode and changing mode condition.

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