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# Modelling and Analysis of Modern Micro-Grid based on Hybrid Regs

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***Abstract* -This paper presents control of modern micro-grid at remote location fed from wind and solar hybrid energy sources. Doubly fed induction generator (DFIG) is used for wind energy conversion and a battery bank is connected to a common DC bus between them. A solar photovoltaic (PV) array is used to convert solar power, which is vacated at the common DC bus of DFIG by means of a DC-DC boost converter in a cost effective way.**

***Index Terms: MICRO-GRID, DFIG, PV.***

## I. INTRODUCTION

There are several isolated locations in the world, that don't have access to electricity. Also, there are several places which are connected to the grid, however, they don't receive electricity for up to 10-12 hours within the day and as a result of it, economic activities of those people living at these remote locations suffer. In such places renewable energy (RE) sources like wind, solar and bio-mass are made available. Renewable Energy sources will greatly cut back the dependency on the grid power that is mainly produced by using fossil fuels which are Non-Renewable energy resources. Wind and solar power sources, are more favorite than bio-mass but bio-mass system is feeble to offer chain issue. However, wind and solar energy resources suffer from high level of power variability, low capacity utilization issue with unpredictable nature. Due to these factors, we can't get solid power for the independent system. Whereas the Energy storage system (ESS), stored by means of battery, also called battery energy storage system (BESS) useful for lowering power fluctuation and increasing foregone conclusion. The outcome in operation point additionally known as maximum power point tracking (MPPT) which needs regulation of the operating point of DFIG and solar PV (Photovoltaic) array in terms of speed and voltage to take out most of the current from input energy source. The MPPT is achieved by physical science, which is based on management. A hybrid energy system consisting of two or more forms of energy sources which has the ability to scale back the BES (Battery Energy Storage) demand and will increase liableness. Solar and Wind energies are natural allies for hybridizing. Each energy resource is familiar to be complementary to every alternative on daily basis moreover as yearly pattern of the behavior. Accepting blessings of these two energy resources, several authors have conferred independent wind and solar hybrid energy systems. The foremost favorite machine for tiny wind generation application is synchronous generator. It's feasible to attain gearless configuration with permanent magnet synchronous generator (PMSG), however it needs 100% rated device and converters which enhances the cost of machine. Some authors have additionally used wind & solar hybrid energy system with a cage induction generator (SCIG), Although SCIG has industrial edge concerning machine value, however, the system doesn't have speed regulation which is needed to attain maximum power point tracking (MPPT). Moreover, if the speed regulation is finished, it needs full power rated device.

## II. PROBLEM DEFINITION

Wind and solar energy resources, are more relative than bio-mass energy resource, As bio-mass energy resource is capable to supply chain issue. However, wind and solar energy sources suffer from power variability, low utilization factor with unpredictable nature, which results, firm power can't be guaranteed for independent system. Battery energy storage system (BESS) can be helpful for lowering power variation and increasing predictability. Utilization factor can be improved by operating wind and solar energy sources at optimum operating point. The optimum operating point called as maximum power point tracking (MPPT), which needs regulation of the operating point of wind energy generator and solar array in terms of speed and voltage to extract maximum electrical energy from input resource available.

## III. METHODOLOGY

This research work can adopt a research methodology that mixes the theory model with pure logic analysis and refinement of the planned theme on MATLAB simulation tool. MATLAB could be helpful in high-level development surroundings for systems that need mathematical modeling, numerical computations, information analysis, and improvement ways. A simulation model of system is developed in Matlab environment and simulation results are presented for various conditions e.g. unavailability of wind or solar energies, unbalanced and nonlinear loads.SLD of the proposed renewable energy generating sources (REGS) fed modern micro-grid is shown in the following figure. The same has been designed for site location having maximum power demand and average power demand of 15 kW and 5 kW,

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respectively. The rated capacity of both wind and solar energy block in REGS is taken as 15 kW. The capacity utilization factor of 20% is considered for both energy blocks, which is enough to provide full day energy requirement of the habitation. As shown in the schematic diagram, the wind energy source is isolated by using a 3-pole breaker from the network, when wind speed is insufficient. The DC side of both RSC and LSC along with HV side of solar converter is connected at the battery bank. RSC helps the wind energy system to run at the optimum rotational speed as required for MPPT algorithm.

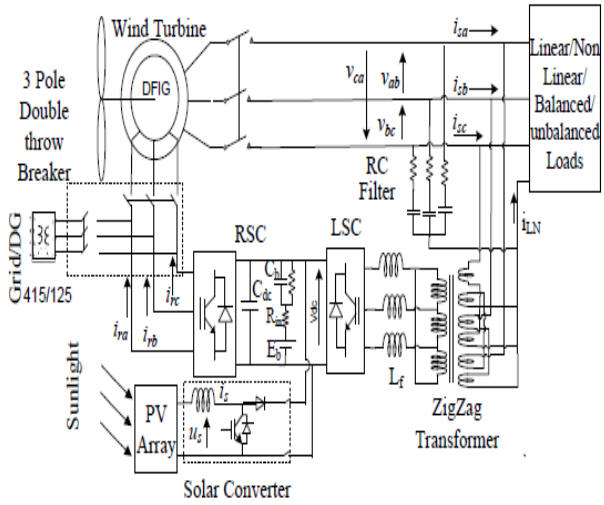


Fig.1: Schematic of isolated micro-grid network fed by renewable energy source using battery storage

## IV. RESULTS

The results are very important for research and development work to prove the problem definition practically. In my research I am using MATLAB tool to simulate the results. The results obtained are mentioned below:

SIMULATION MODEL

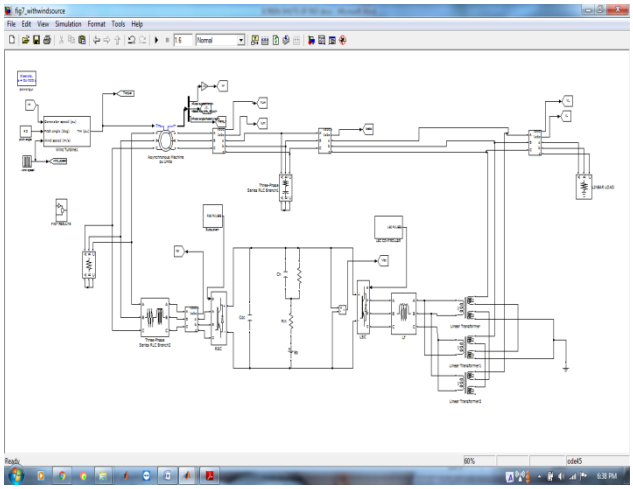

Fig. 2: Performance of REGS fed micro-grid with wind energy source

Simulation Model diagram of system showing various components, blocks and performance of Renewable Energy Generating Sources, fed to Isolated Micro-Grid; with Wind Energy Source.

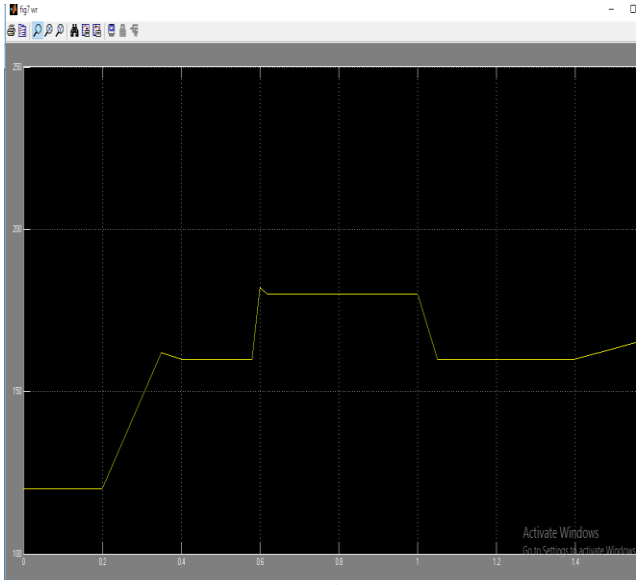

Fig.3: $W_R$ (Rotational speed of Wind Turbine) Rad. /sec

Above Figure shows graph of Rotational Speed of Wind turbine. Y-axis shows Rotational speed which is in Radians and X-Axis shows time which is in Sec.

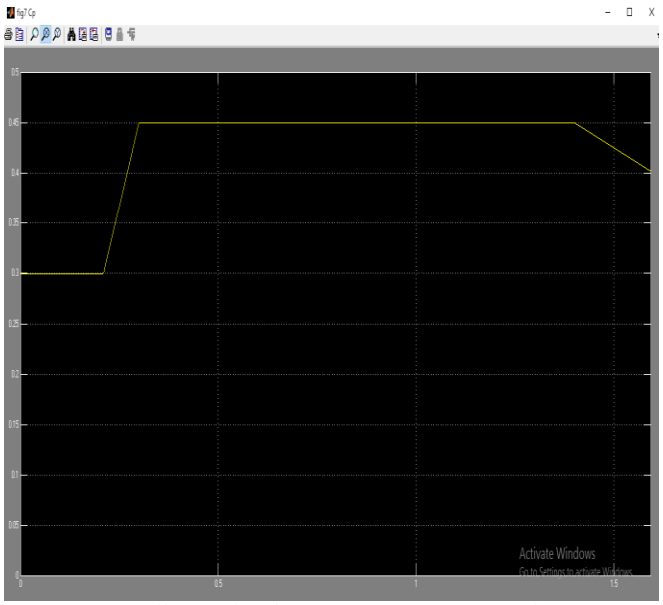

Fig.4: $C_P$, Coefficient of Performance Vs Tip Speed Ratio for wind Turbine

Figure shows variation of Coefficient of Performance also called Power Coefficient with respect to Tip speed ratio; X-axis shows Tip speed ratio and Y-Axis shows coefficient of Performance.

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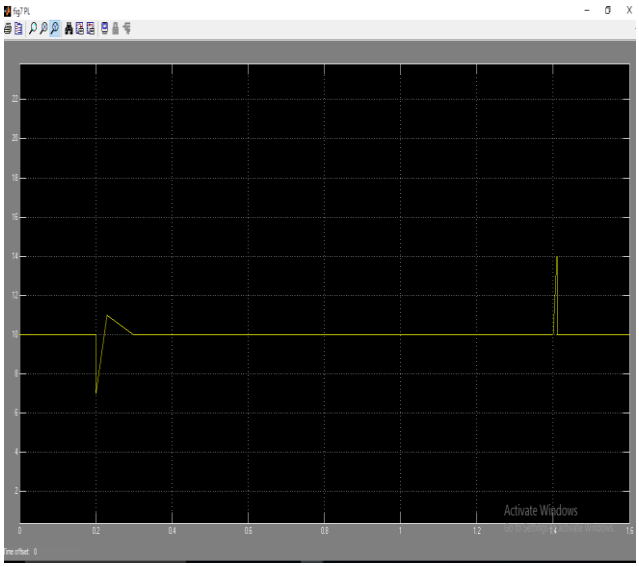

Fig .5: $P_L$ (Load Power; Watts) Power Vs Time

Above figure shows change in Power waveform with respect to time; Y-axis shows Power waveform which is in watts and X-Axis shows Time which is in Seconds.

SIMULATION MODEL

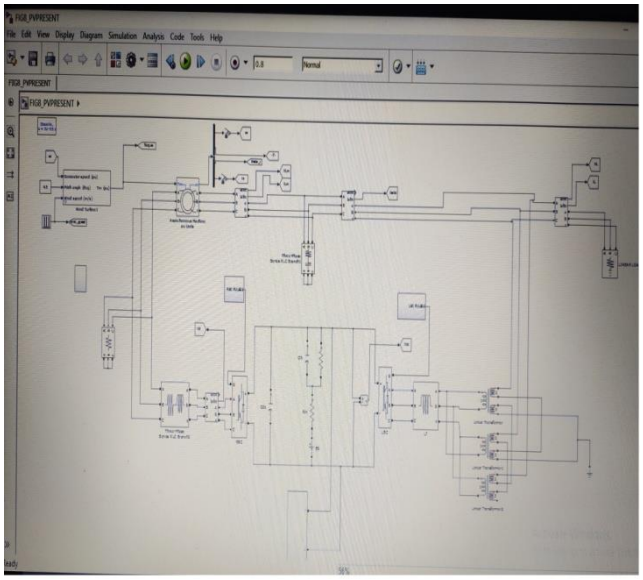

Fig.6: Performance of the system without generating source and solar system is taken in the service.

Simulation Model diagram of system showing various components, blocks and performance of Renewable Energy Generating Sources, without generating source and solar system is taken in the service.

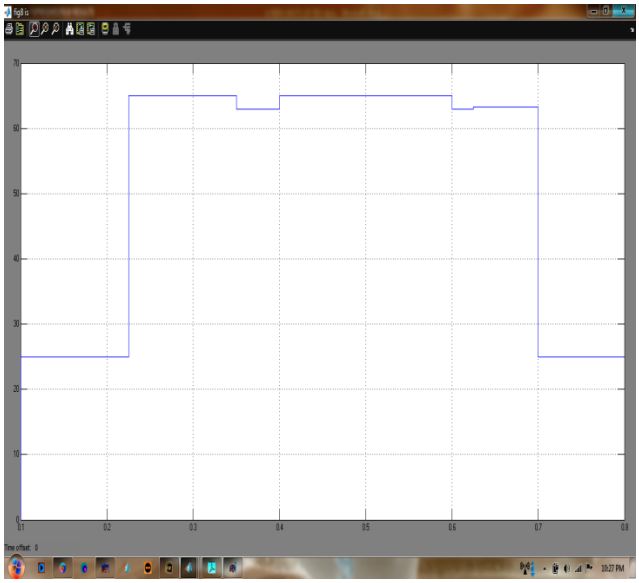

Fig.7: $I_S$ (Stator Current; Ampere) Current Vs Time

Above figure shows Performance of the system without generating source and solar system is taken in the service. Y-axis shows Current waveform which is in amps and X-Axis shows Time which is in Seconds.

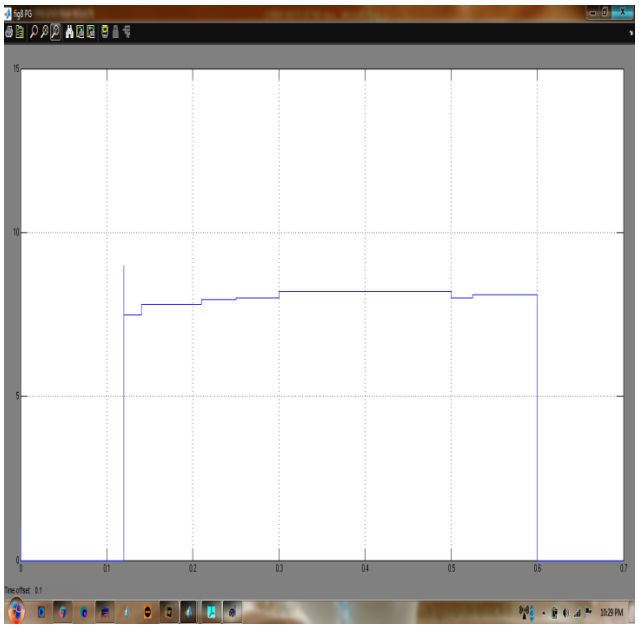

Fig.8: $P_G$ (Generated Power; Watts) Power Vs Time

Above figure shows Performance of the system without generating source and solar system is taken in the service. Y-axis shows Power waveform which is in watts and X-Axis shows Time which is in Seconds.

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SIMULATION MODEL

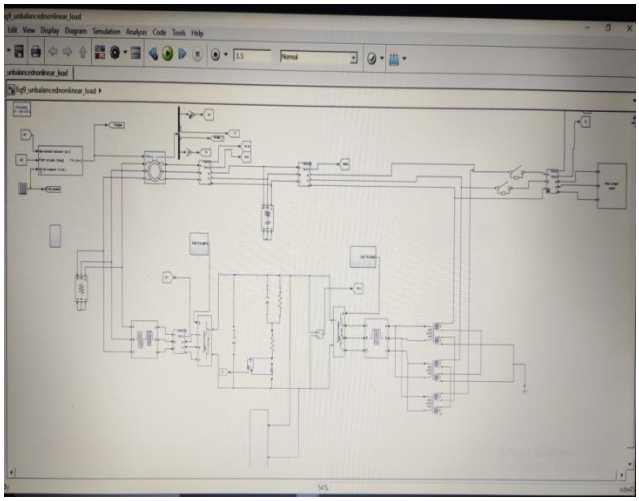

Fig.9: Performance of the system at unbalanced and non-linear load

Simulation Model diagram of system showing various components, blocks and performance of the system at unbalanced and nonlinear load

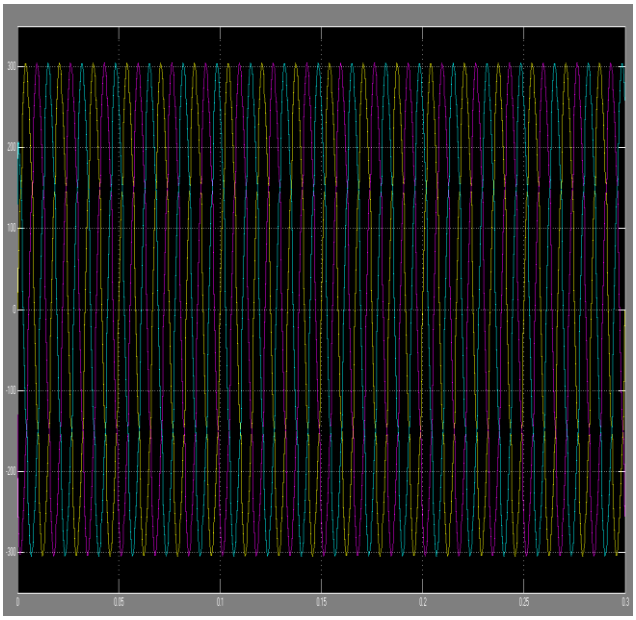

Fig.10: $V_L$ (Load Voltage; Volts) Voltage Vs Time

Above figure shows Performance of the system at unbalanced and nonlinear load. Y-axis shows voltage waveform of three phases which is in Volts and X-Axis shows Time which is in Seconds. Voltage can be measured between phases to ground and phase to phase.

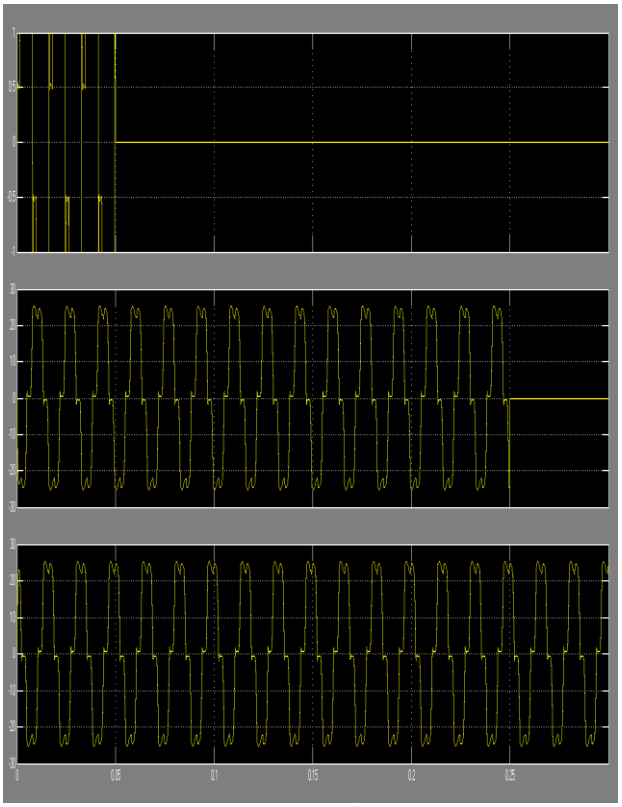

Fig.11: ILA, ILB, ILC (Load Currents of 3- Phases A, B&C; Ampere) Current Vs Time.

Above figure shows Performance of the system at unbalanced and nonlinear load. Y-axis shows Current waveform of three phases which is in Amperes and X-Axis shows Time which is in Seconds. Current can be measured between phases to ground and phase to phase.

## V. CONCLUSION

The paper presents Modern Micro-grid system fed from Renewable Energy Sources i.e., wind and solar in this case, has been found perfect for satisfying load requirements of remote located habitation comprising of few households. The system is designed, to extract the maximum energy from renewable sources and at the same time, it provides quality control power and power free from fluctuations to the consumers.Under all the conditions, the power quality at the load terminals remains stable. System has been designed for complete automatic operation. The effectiveness of system is presented with results with prototype in the laboratory.

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