SIMULATION AND ANALYSIS OF SOLAR-WIND HYBRID SYSTEM WITH GRID INTEGRATION USING MATLAB SIMULUNK

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Abstract: Rapid depletion of fossil fuel resources on a worldwide basis has necessitated an urgent search for alternative energy sources to cater to the present days' demand. The electric power generation system, which consists of renewable energy and fossil fuel generators together with an energy storage system and power conditioning system, is known as a hybrid power system. A hybrid power system has the ability to provide 24-hour grid quality electricity to the load. This system offers a better efficiency, flexibility of planning and environmental benefits compared to the diesel generator stand-alone system. This Paper focuses on the combination of solar wind systems for sustainable power generation. The solar energy also varies with the hourly, daily and seasonal variation of solar irradiation. The wind turbine output power varies with the wind speed at different conditions. However, a drawback, common to solar irradiation and wind speed options, is their unpredictable nature and dependence on weather and climatic changes, and the variations of solar and wind energy may not match with the time distribution of load demand. This shortcoming not only affects the system's energy performance, but also results in batteries being discarded too early.

I. INTRODUCTION

Rapid depletion of fossil fuel resources on a worldwide basis has necessitated an urgent search for alternative energy sources to cater to the present days' demand. Therefore, it is imperative to find alternative energy sources to cover the continuously increasing demand of energy while minimize the negative environmental impacts Recent research and development of alternative energy sources have shown excellent potential as a form of contribution to conventional power generation systems. There is a huge potential for utilizing renewable energy sources, for example solar energy, wind energy, or micro-hydropower to provide a quality power supply to remote areas. The abundant energy available in nature can be harnessed and converted to electricity in a sustainable way to supply the necessary power demand and thus to elevate the living standards of the people without access to the electricity grid.The advantages of using renewable energy sources for generating power in remote islands are obvious such as the cost of transported fuel are often prohibitive fossil fuel and that there is increasing concern on the issues of climate change and global warming.

II. SOLAR PV WORKING

There are several types of solar cells. However, more than 90 % of the solar cells currently made worldwide consist of wafer-based silicon cells. They are either cut from a single crystal rod or from a block composed of many crystals and are correspondingly called mono-crystalline or multi-crystalline silicon solar cells. Wafer-based silicon solar cells are approximately 200 μm thick. Another important family of solar cells is based on thin-films, which are approximately 1-2 μm thick and therefore require significantly less active, semiconducting material. Thin-film solar cells can be manufactured at lower cost in large production quantities; hence their market share will likely increase in the future. However, they indicate lower efficiencies than wafer-based silicon solar cells, which mean that more exposure surface and material for the installation is required for a similar performance. A number of solar cells electrically connected to each other and mounted in a single support structure or frame is called a 'photovoltaic module'. Modules are designed to supply electricity at a certain voltage, such as a common 12-volt system. The current produced is directly dependent on the intensity of light reaching the module. Several modules can be wired together to form an array. Photovoltaic modules and arrays produce direct-current electricity. They can be connected in both series and parallel electrical arrangements to produce any required voltage and current combination.

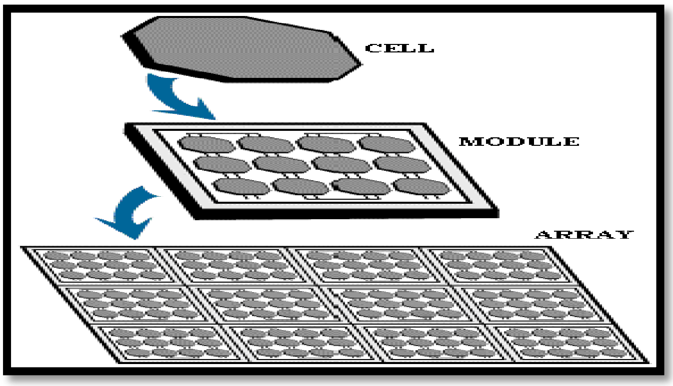


Figure -1 Electrical Connection of the cells

III. WIND POWER

Wind is abundant almost in any part of the world. Its existence in nature caused by uneven heating on the surface of the earth as well as the earth's rotation means that the wind resources will always be available. The main components of a wind turbine for electricity generation are the rotor, the transmission system, and the generator, and the yaw and control system. The following figures show the general layout of a typical horizontal-axis wind turbine, different parts of the typical grid-connected wind turbine, and cross-section view of a nacelle of a wind turbine.

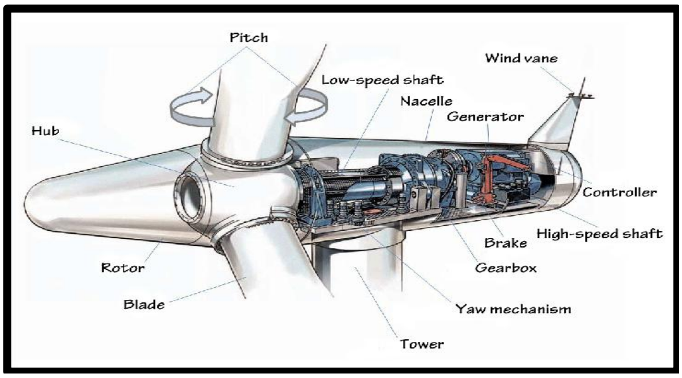


Figure 2Major Component of Wind Turbine

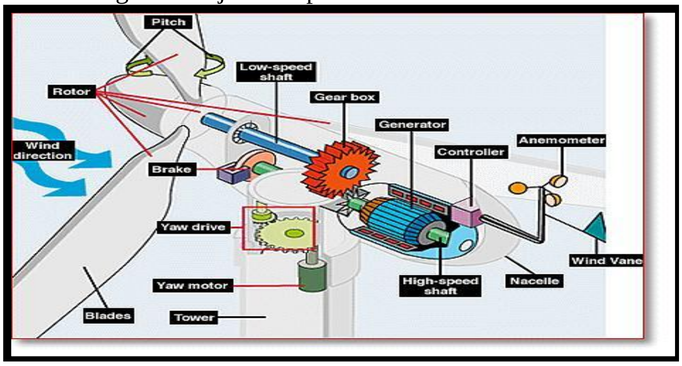


Figure 3 The Main component of a Wind Turbine can be classified as i) Tower ii)RotorSystem iii)Generator iv) Yaw v) Control System vi) Breaking and Transmission System

IV. HYBRID OPERATION AND SMART GRID

Hybrid Power Generation System

Our proposed hybrid system is designed for both on grid and off grid operation to reduce dependency on the national grid for electrical supply. The "fig." shows the block diagram of a typical hybrid grid connected power system. The system consists of PV generators, wind generator, biogas, biomass (rice husk), micro-hydro, battery bank, battery charge controller and the dump load.

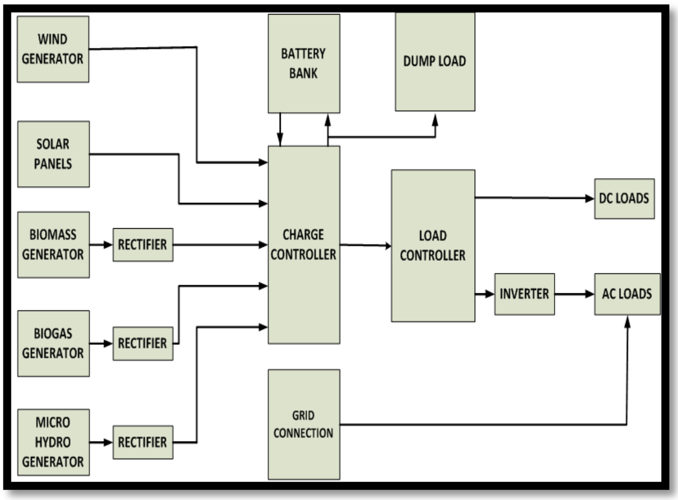
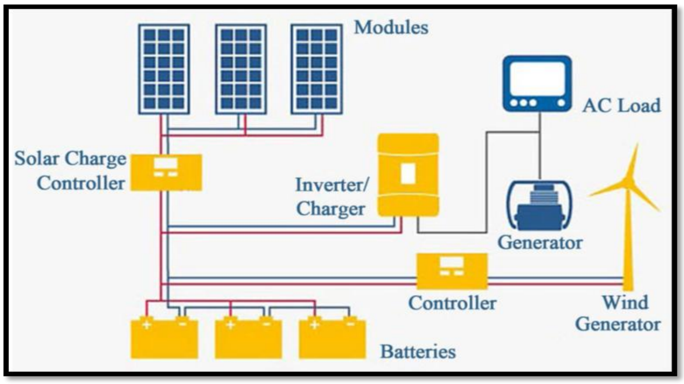


Figure 4 Basic Diagram of Hybrid System

In this project a hybrid system of solar-wind is considered. Here, we have different power generating units. Some of them generate AC and others DC power directly.

(a)



(b)

Figure 5(a),(b) Solar-Wind Hybrid System

Grid Tie PV/ Wind Hybrid System

These systems can be classified in terms of their connection to the power system grid into the following:

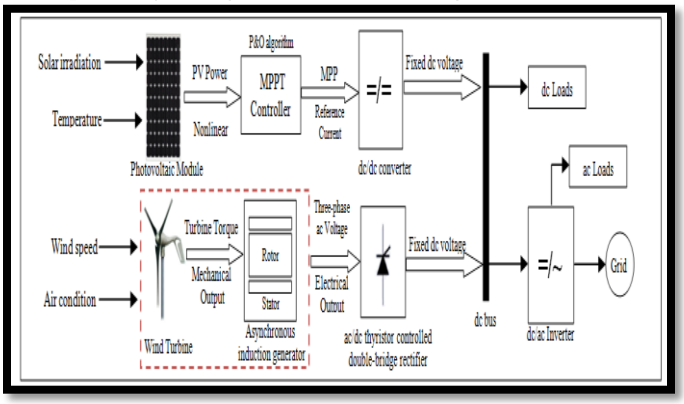


Figure 6Block diagram of the proposed system

Smart grid is a system consists of three layers: the physical power layer, the control layer and the application layer. And smart grid has to be dynamic and have constant two way communication as shown in fig.-7

Solar PV Simulation with MPPT

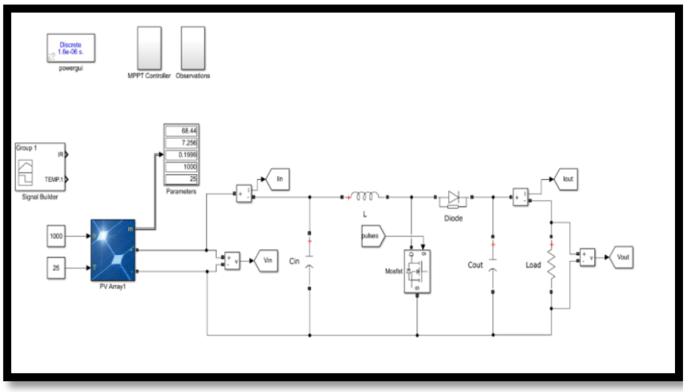


Fig 7- Solar PV Array Simulation with MPPT& Boost Converter

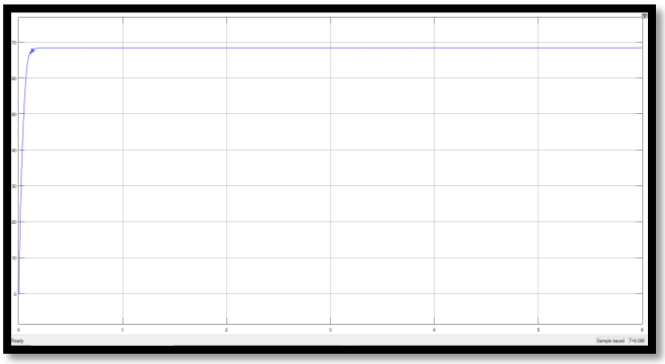


Fig 8- Solar Input Voltage to Boost converter

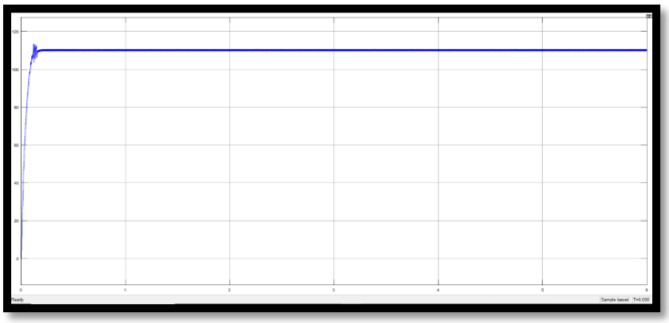


Fig 9- Solar Output voltage from Boost converter

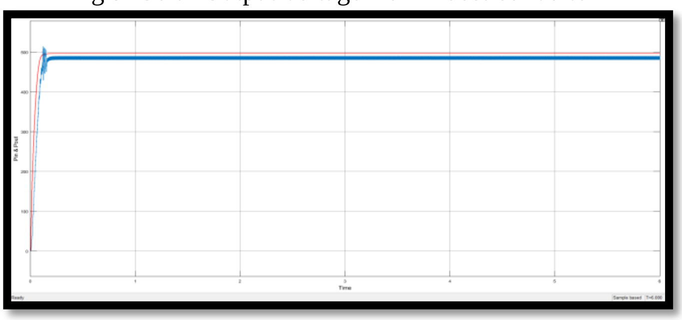


Fig 10- Solar PV array Maximum power tracking using MPPT

V. WIND SIMULATION

The Matlab modelling of Induction Generator type wind power plant is shown in the fig 6.20 below. The simulation results show the output voltage of wind turbine and also shows the different parameters output like Active and Reactive Power and other mechanical parameters also.

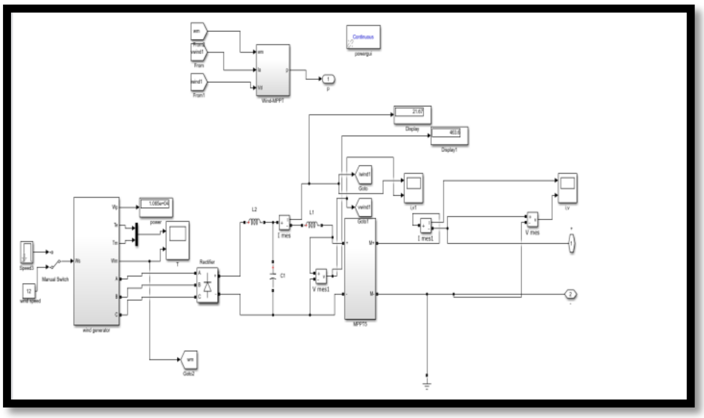


Fig 11Wind Simulation with MPPT

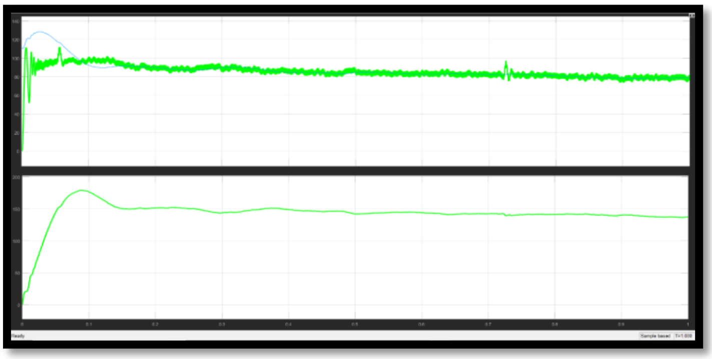


Fig 12wind Output variation in Mechanical Torque and electrical Power and Constant d.c Voltage

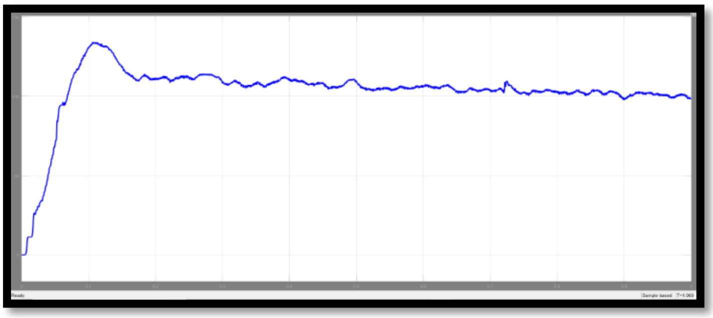


Fig 13 Wind Output Constant D.C Voltage

Hybrid of Solar-Wind Using VSC control method

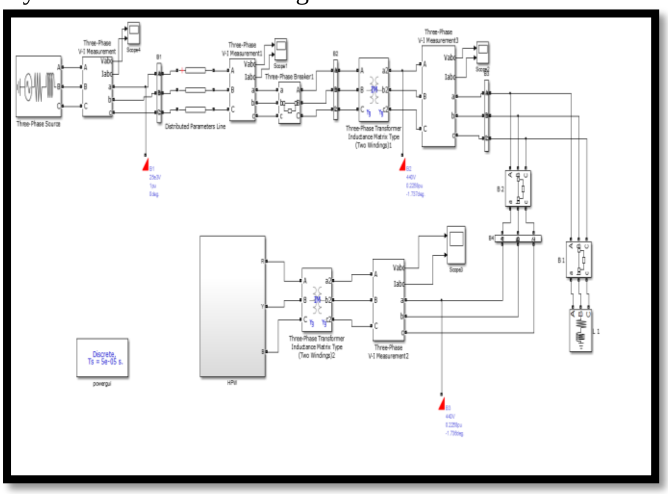


Figure 14 Solar & Wind Hybrid System

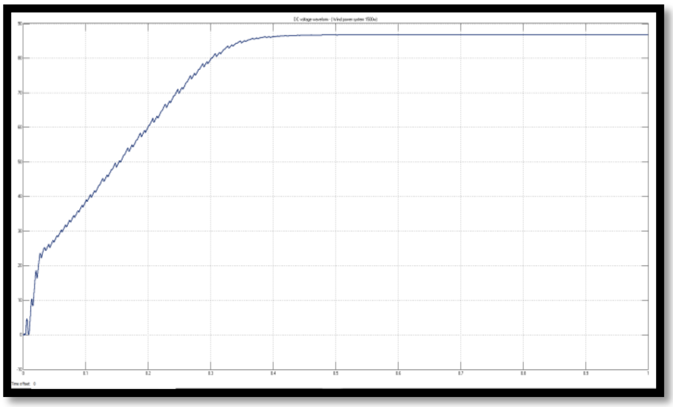


Figure 15 Regulated Hybrid D.C voltage

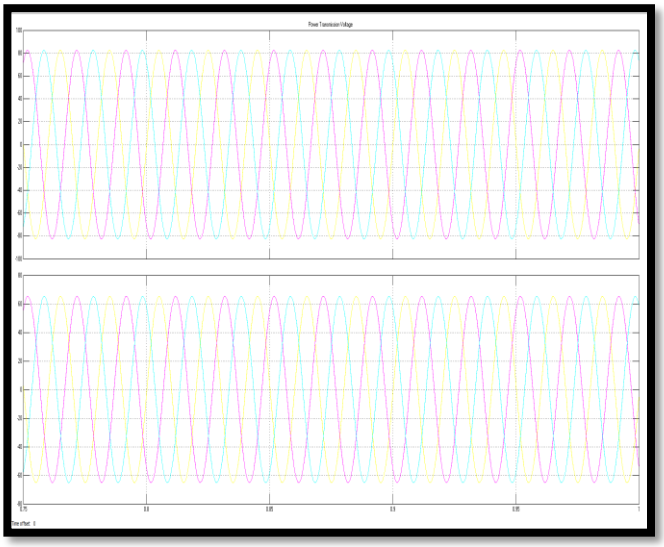


Figure 16 Grid Integration Output Voltage & Current

Hybrid of Solar-Wind Using V_L-V_P Control Method

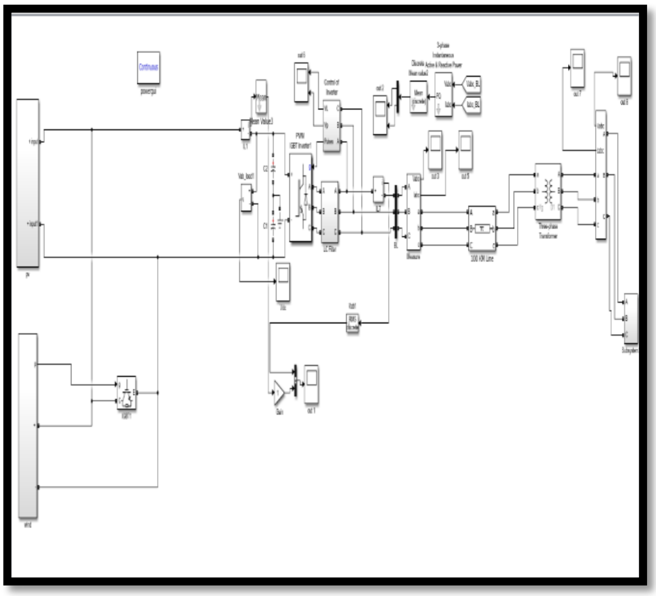


Fig 17 Hybrid of Proposed Solar PV and Wind with Line and Phase voltage control method

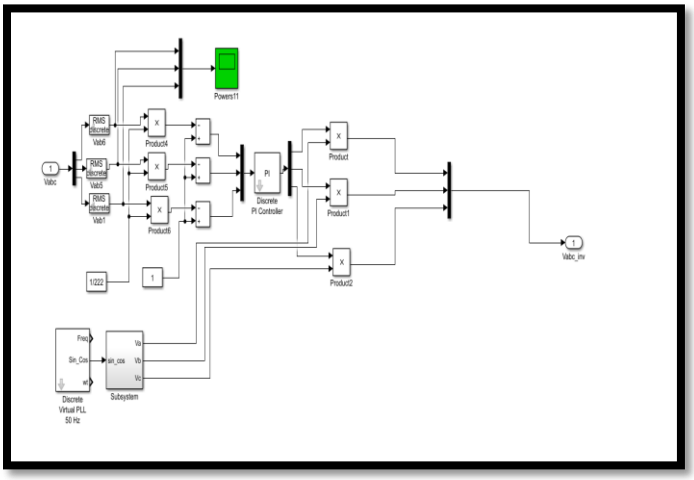


Fig 18 PI Controller Subsystem

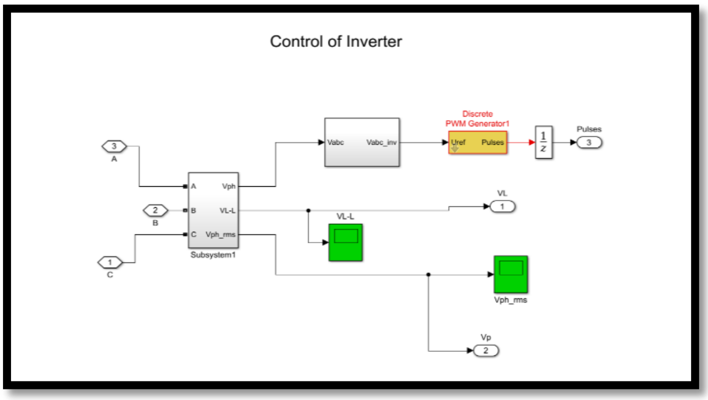


Fig 19 Inverter Control Subsystem

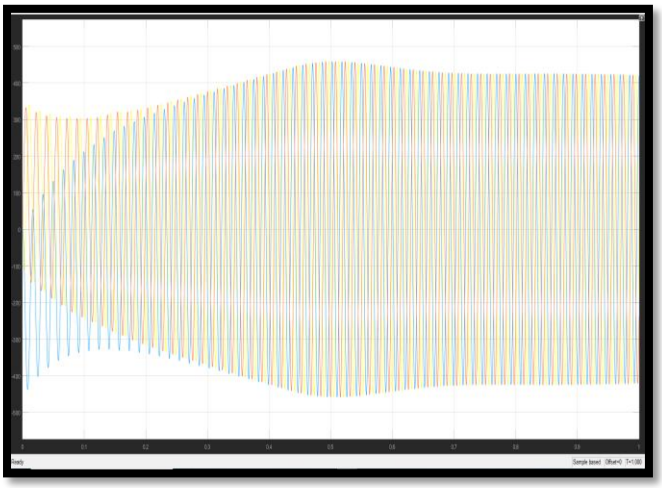


Fig 20 Hybrid A.C output current of Solar-Wind

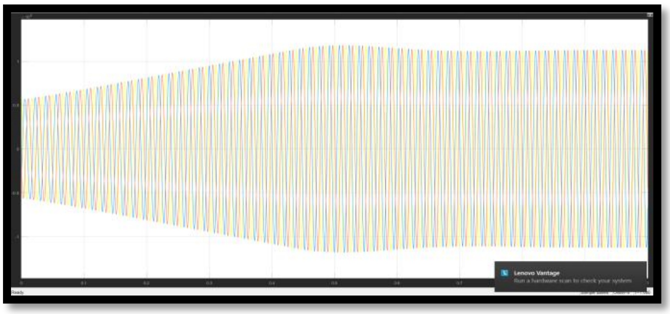


Fig 21Grid Side Synchronized Output Voltage

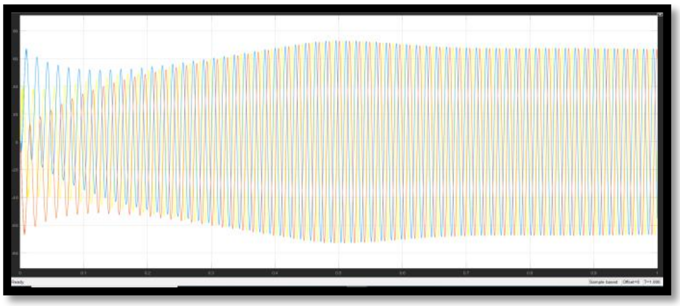


Fig 22 Grid Side Synchronized output current

VI. CONCLUSION

This paper presents a hybrid wind/PV energy system for standalone system. The standalone hybrid system is better than a single energy source. The wind energy systems may not be technically viable at all sites because of low wind speeds and being more unpredictable than solar energy. The combined utilization of these renewable energy sources is therefore becoming increasingly attractive. This Paper also highlights the future developments, which have the potential to increase the economic attractiveness of such systems and their acceptance by the user. This Paper also represents the modelling and Simulation of Solar PV System using MATLAB-SIMULINK software. The Simulation results show the ideal I-V and P-V characteristics of the solar PV system. The wind power plant simulation and its three-phase output voltage also show in the simulation results. The grid integration and synchronization of Solar-Wind Hybrid system has been successful done in this paper.

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