| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

|| Volume 9, Issue 8, August 2020 ||

Hybrid Solar – Wind Energy System Interfaced to Three Phase Grid with Improved Power Quality

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ABSTRACT*:* The main objective of this project is to present a new system configuration for a hybrid wind photovoltaic energy system Interfaced to Three Phase Grid with Improved Power Quality. Wind and solar energy have being popular ones owing to abundant, ease of availability and convertibility to the electric energy. This work deals with a single stage solar photovoltaic (PV) energy generation system (SPEGS) and Doubly Fed Induction Generator Based Wind energy conversion system (WECS) .SPEGS and WECS are connected parallel and interfaced to the three phase grid at varying solar irradiance, wind and compensating the nonlinear load tied at point of common interconnection. It feeds the generated solar PV power and wind power to the local three phase grid. It reduces the harmonics of loads and furnished a balanced currents of local three-phase grid. The SPEGS and WECS uses a solar PV array, DFIG, a voltage source converter, a nonlinear load, a three phase grid, DC-link capacitance. In case, when the solar irradiance or wind is not available, the proposed system works as DSTATCOM (Distribution Static Compensator) by utilizing same VSC (Voltage Source Converter). The proposed control approach is validated on a developed prototype in the laboratory. A hybrid renewable energy system combining the generation of power through solar and wind system have been installed to meet the demand. This configuration allows the two sources to supply the load separately or simultaneously depending on the availability of the energy sources. In this project, the simulation results are also given to highlight the merits of the proposed circuit

KEYWORDS: DFIG, solar, wind energy, power quality, harmonics, inverter, grid

I. INTRODUCTION

In general, due to increasing energy requirements, public awareness of climatic protection, the depletion nature of conventional resources, and the world political and social issues of nuclear power safety and because of lot of merits, solar PV (Photovoltaic) generation systems and wind energy conversion system are getting increased attention. Moreover, from last few decades, solar photovoltaic energy generation system (SPEGS) is one of the focused area of research community as it is pollution free, renewable, inexhaustible and has a lot of other advantages, Also in recent years, the electrical power generation from renewable energy sources, such as wind, is increasingly attraction interest because of environmental problem and shortage of traditional energy source in the near future. Nowadays, the extraction of power from the wind on a large scale became a recognized industry. The cost factor is one of the main aspect of any technology for its success or failure. Now a days, because of technology development, solar PV and wind power is one of the feasible and alternative option among all non-traditional sources for power generation. From the point of view of utilities, due to the fluctuation of output, it's not appropriate to be directly connected to the power grid. In order to achieve the condition that the output power is suitable for grid-connection, it is necessary to use a control techniques to manage the output produced by the Solar PV/wind turbine generator.

II. OVERVIEW OF SOLAR AND WIND – GRID CONNECTED SYSTEM

A. *Solar Photovoltaic – Grid connected*

The Solar Photovoltaic (PV) – Grid connected consists of the below,

- Modules – Solar electric collectors
- Array – Modules connected together into a system
- Inverter – Converts the DC power produced by the modules to A/C
- Grid Tie Inverter – Converts DC to AC and feeds the utility grid with the A/C power
- Charge Controller – Regulates the power going to the batteries
- Batteries – Stores DC power

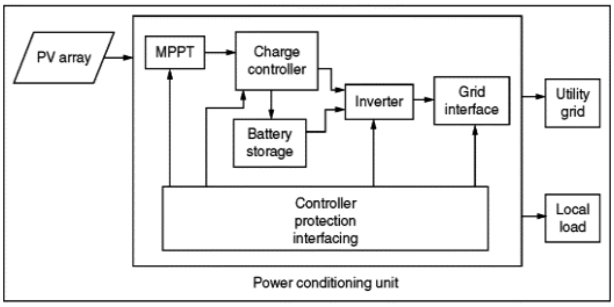

Fig (i) Block diagram

- Grid-connected photovoltaic systems are composed of PV arrays connected to the grid through a power conditioning unit and are designed to operate in parallel with the electric utility grid.
- The power conditioning unit may include the MPPT, the inverter, the grid interface as well as the control system needed for efficient system performance.
- There are two general types of electrical designs for PV power systems: systems that interact with the utility power grid have no battery backup capability, and systems that interact and include battery backup.
- The latter type of system incorporates energy storage in the form of a battery to keep "critical load" circuits operating during utility outage. When an outage occurs, the unit disconnects from the utility and powers specific circuits of the load. If the outage occurs in daylight, the PV array is able to assist the load in supplying the loads.

B.DFIG based Wind Energy Conversion System (WECS) – Grid connected

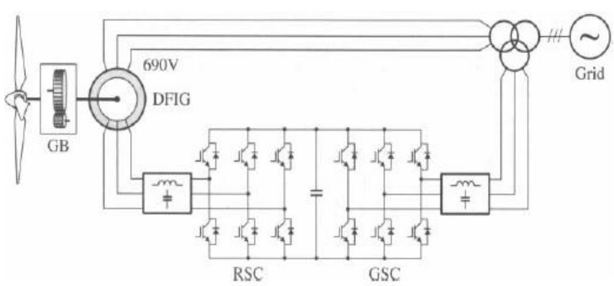

Fig (ii) Block diagram

- The variable-speed DFIG wind energy system is one of the main WECS configurations in today's wind power industry.
- The stator is connected to the grid directly, whereas the rotor is connected to the grid via reduced-capacity power converters.

- A two-level IGBT voltage source converter (VSC) system in a back-to-back configuration is normally used. Since both stator and rotor can feed energy to the grid, the generator is known as a doubly fed generator.
- The typical stator voltage for the commercial DFIG is 690 V and power rating is from a few hundred kilowatts to several megawatts
- The rotor-side converter (RSC) controls the torque or active/reactive power of the generator while the grid-side converter (GSC) controls the DC-link voltage and its AC-side reactive power. Since the system has the capability to control the reactive power, external reactive power compensation is not needed.
- The speed range of the DFIG wind energy system is around ±30%, which is 30% above and 30% below synchronous speed. The speed range of 60% can normally meet all the wind conditions and, therefore, it is sufficient for the variable-speed operation of the wind turbine. The maximum slip determines the maximum power to be processed by the rotor circuit, which is around 30% of the rated power.

III.HYBRID SOLAR – WIND ENERGY SYSTEM INTERFACED TO THREE PHASE GRID WITH IMPROVED POWER QUALITY

A Hybrid renewable system consists of one or two Renewable energy source used together to provide increased system efficiently as well as greater balance in energy supply. A hybrid renewable energy system combining the generation of power through solar and wind system have been installed and Interfaced to Three Phase Grid with Improved Power Quality to meet the demand. This configuration allows the two sources to be connected to grid separately or simultaneously depending on the availability of the energy sources.

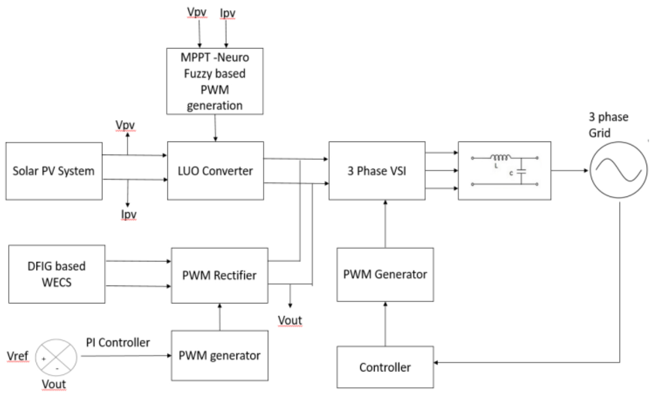

Fig (iii) Block Diagram

The hybrid system consists of two input voltage source, the DFIG which generates three phase AC voltage and uncontrolled diode bridge rectifier makes the uncontrolled rectified DC voltage with higher order ripple contents, and the ripples will be reduced by using the PI Controller. Another DC source is PV system, due to the temperature and irradiation variation the solar output voltage have higher order ripple contents also partial shading effect arises, this variable DC voltage is fed to the Luo converter. Luo converter has one inductor and one capacitor in series and another one in parallel. This reduces ripples from the input voltage and current. Luo converter series inductor and diode combination achieves solution for partial shading effect. The main advantage of Luo converter is its input current is continuous with good output voltage gain.

The Neuro fuzzy logic algorithm provides maximum power tracking from the input supply system and increase the converter efficiency. In grid side, reactive power has been increased due to the nonlinear loads. Due to the nonlinear characteristics of grid, current becomes non uniform, so that a power quality becomes a major issue in grid side. This power quality problem is a major concern for affecting the grid performance. In this paper PI controller achieves grid current compensation and this makes grid current and voltage are in phase including near unity power factor operation. Finally proposed system achieves high voltage stability in the grid side. The proposed scheme is a grid connected topology it does not require any battery storage system. Generally the DC-DC Luo converter achieves 96% efficiency, the Neuro fuzzy algorithm increases the efficiency to maximum. Two different methods are available for connections it means cascaded and parallel connection. In this work parallel operation is achieved for continuous voltage supply.

IV.RESULTS

The Simulink model and its results are represented below.

A. Simulink Model

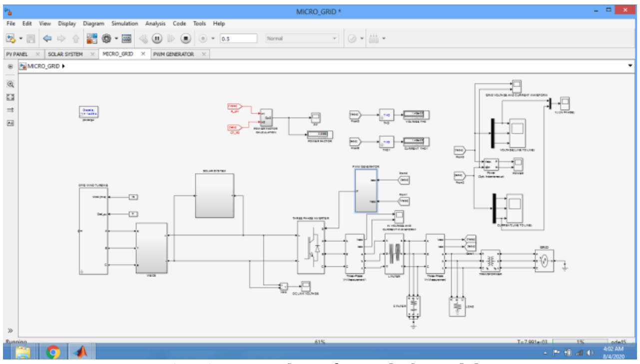

Fig (iv-a) Screenshot of Simulink model A

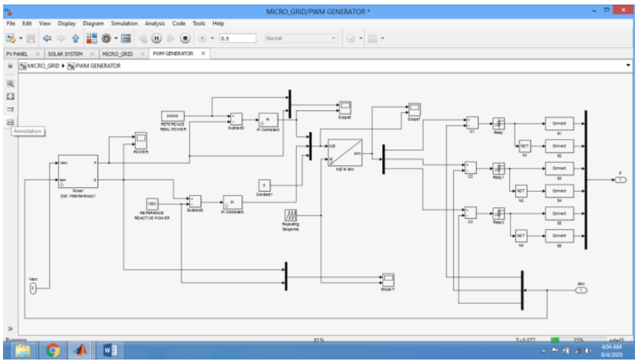

Fig (iv-b) Screenshot of Simulink model B

B. Output waveforms

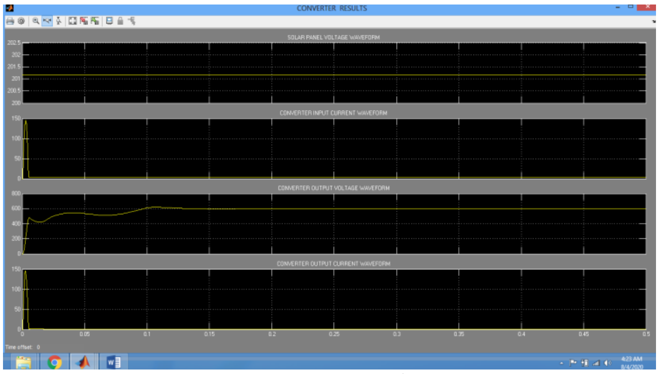

Fig (v-a) Output waveforms

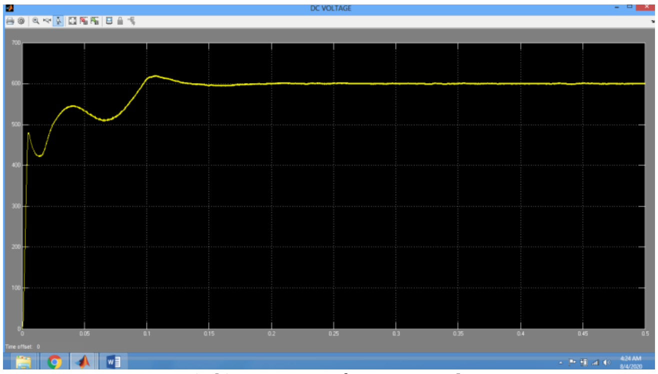

Fig (v-b) PWM Rectifier output voltage

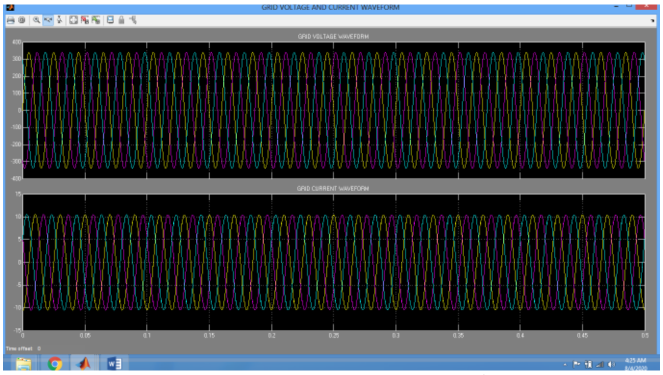

Fig (v-c) Grid voltage and current waveform

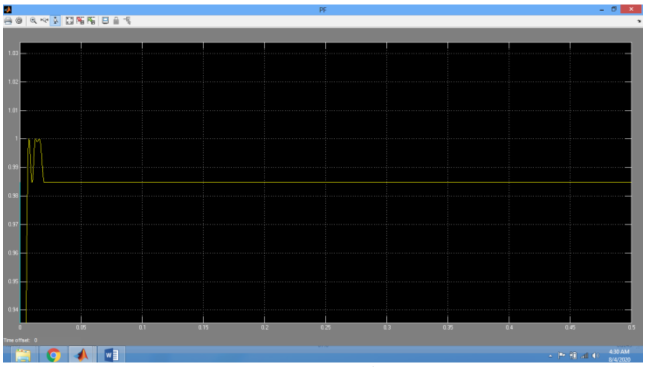

Fig (v-d) Power factor

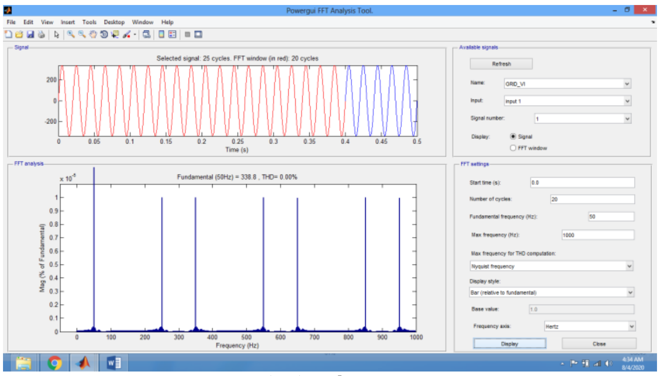

Fig (v-e) Voltage THD

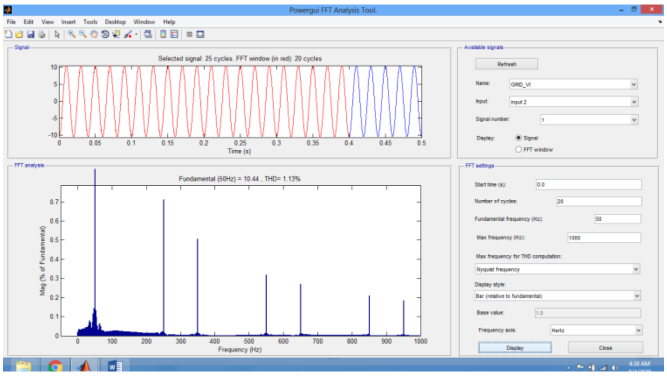

Fig (v-f) Current THD

V. CONCLUSIONS

A single stage SPEGS and DFIG based WECS interfaced to a distribution feeder have been developed for improving power quality. Exhaustive experiments have been performed for the validation of the system. The proposed system is tested at nonlinear load, unbalanced load, existence, and non-existence of solar rays and wind energy. Dynamic behavior of proposed control technique, has been observed better in comparison with existing control approaches. The proposed approach has worked well in all scenarios at unity power factor operation and resolves the problems related to power quality of grid. The THD of grid currents, is obtained in the limit of the IEEE-519 standard.

ACKNOWLEDGMENT

I am greatly privileged to express my heartfelt thanks to Dr.C.Udhayashankar for his expert counselling and guidance to make this project to a great deal of success. The clarity of his comments in the workflow allowed me to complete the project and demonstrate the simulation with result.

REFERENCES

[1] L Robert Foster, Majid Ghassemi and Alma Cota, *"Solar Energy Renewable Energy and the Environment,"* CRC Press FL 2010.

[2] F.A. Farret and M.G. Simões, *Integration of Alternative Sources of Energy*, John Wiley & Sons, Inc., 2006.

[3] Chao-Shun Chen, Chia-Hung Lin, Wei-Lin Hsieh, Cheng-Ting Hsu and Te-Tien Ku, *"Enhancement of PV Penetration With DSTATCOM in Taipower Distribution System,"* IEEE Transactions on Power Systems, vol.28, no.2, pp.1560-1567, May 2013.

[4] S.B. Kjaer, J.K. Pedersen, F. Blaabjerg, *"A review of single-phase gridconnected inverters for photovoltaic modules,"* IEEE Transactions on Industry Applications, vol.41, no.5, pp.1292-1306, Sept.-Oct. 2005.

[5] Jay Verma,Yogesh , Tiwari, Anup Mishra, Nirbhaya Singh *,"Performance, Analysis and Simulation of Wind Energy Conversion System Connected with grid".* IJRTE, ISSN: 2277-3878 Volume-2, Issue-6, January2014.

[6] D Mary,ShinoshMathew,SreejithK*,,"Modeling and Simulation of Grid Connected Wind Energy System.",*IJSCE,ISSN: 2231-2307, Volume-3, Issue-1, and March 2013.

[7] Gupta, T., Boudreaux, R. R., Nelms, R. M., & Hung, J. Y. (1997). *Implementation of a fuzzy logic controller for DC–DC converters using an inexpensive 8-b microcontroller*. IEEE Transaction on Industrial Electronics, 44(5), 661–668.

[8] Wang, L. X. (1993). *Stable adaptive fuzzy logic controller of nonlinear systems*. IEEE Transactions on Fuzzy Systems, 1(2), 146–155.