ISSN ONLINE: 2395-695X
ISSN PRINT: 2395-695X

International Journal of Advanced Research in Basic Engineering Sciences and Technology (IJARBEST)
Vol.3, Special Issue.20, December 2016

Implementation of Hybrid Bi-Directional Dc/Dc Converter in MICROGRID

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Abstract- **High efficiency power is attained using hybrid bidirectional DC-DC converter in micro-grid system Hybrid bidirectional dc/dc converter is based on photovoltaic (PV) and wind system that are driven by permanent magnet synchronous generator are fed to the grid through common single boost converter. A battery that connected to the bidirectional dc/dc converter charges from grid and discharges through grid to the load. Model of the proposed scheme in d-q axes reference frame is developed. Steady-state performance of the system and transient response of the controllers are also presented to demonstrate the successful operation of the new hybrid system. Simulation results are given to validate the simulation model.**

Keywords: Bidirectional dc/dc converter, boost converter, micro grid, Photovoltaic, wind system.

I. INTRODUCTION

The electricity requirements of the world including our nation are ever-increasing at frightening speed and the power demand has been running at the forefront of supply. It is also now widely known that the renewable and non- renewable energy resources, presently being used for generation of electrical energy, are not sufficient to bare the demand of electrical energy of future needs. We need to solve this problem by developing a new kind of hybrid system to generate electricity which provides energy for 24X7 hours with power quality and pollution free. With increasing concern of global warming and the depletion of fossil fuel reserves, many are looking at sustainable energy solutions to preserve the earth for the future generations. Wind and photovoltaic energy holds the most potential to meet our energy demands. Wind energy is capable of supplying large amounts of power but it is predictable by turbine only at 12m/sec. Similarly, solar energy radiation throughout the day vary due to sun intensity and unpredictable shadows cast by clouds, birds, trees, etc. As the wind and photo voltaic system depends on meteorological conditions, we cannot fully depend on them, because of their reliability. However, by combining these two intermittent energy sources and by incorporating Maximum Power Point Tracking (MPPT) algorithms, the systems power transfer efficiency and reliability can be improved significantly. The rest of the paper is organized as follows: section II describes the background and related works; section III describes about the proposed hybrid system.

II. BACKGROUND AND RELATED WORK

Corresponding to developing technology, demand of energy makes us seek new energy sources. Wind and solar energy have being popular ones due to its availability and convertibility to the electric energy. Prior work covers under a microcontroller to utilize the solar and wind power and implemented in accordance with available line-electricity. Batteries are charged by either wind power or solar power. The whole System control confide mainly on microcontroller. Separate boost converter is connected to solar and winds to step up the voltage. Large number of power converters is used to

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generate quality power.

Shay Jiang ET. Al, 2012 presented a novel boost-half-bridge micro inverter and its control implementations for single-phase grid-connected photovoltaic systems.

Their systems consists of a transformer isolated boost-half-bridge DC-DC converter and a full-bridge pulse-width-modulated inverter. The system results are High power factor (>; 0.99) and very low total harmonic distortions (0.9% ~ 2.87%) are guaranteed under both heavy and light load conditions.

Wei-Shih Liu ET. Al 2011, presented a high- efficiency multi cascaded hybrid power system for high-voltage application. From the experimental results from a prototype circuit of the FC hybrid power system show that the hybrid system can provide 200 V of output voltage, 500 W of rated power, and about 1 kW/25 min long- term overload power.

III. PROPOSED HYBRID SYSTEM

A hybrid system consists of two or more renewable energy sources used together to provide increased efficiency. When a source is unavailable or insufficient to meet the load demands, the other energy source can compensate the demands. Most of the prior systems use a separate DC/DC boost converter for PV and wind In order to minimize the conduction and switching losses of the devices, it is necessary to have the minimum number of power converters (power conversion stages). The block diagram of the proposed system is shown in Fig.1

The proposed system consist of a maintenance free simple operation, so it can also be used by domestic consumers in a smart grid scenario.

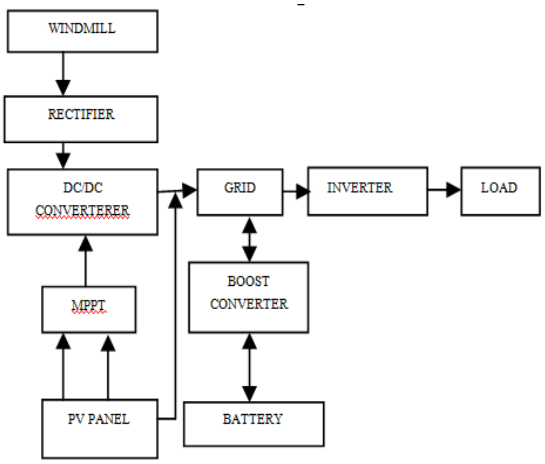

Fig.1. Proposed hybrid system block diagram

The windmill driven by the permanent magnet synchronous generator output is rectified. Output of the MPPT controller is controlled by PV system and the MPPT output are fed into the boost converter to step up the voltage level. The voltage from the boost converter is fed into the grid where the battery gets charged from the grid through bidirectional dc/dc converter. The DC output from the grid gets converted as AC through inverter to meet the basic load demands.

ADVANTAGES OF PROPOSED SYSTEM

- Overcoming disadvantages of standalone renewable electrical energy generation system.
- Producing much more efficiency as two or more renewable energy generation system working

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together in the terms of electrical energy generation.

- Since, the system doesn't have microcontroller or microprocessor the complexity of system testing and understanding became easy in terms of difficulties.
- System maintains is remarkably reduced and becomes easy.
- Renewable energy sources like, sun, wind, are utilized so, no waste production.
- Producing clean, friendly to environment, renewable energy.
- Once the system is designed and developed or manufactured, the installation of system is easy.
- Within certain time period the installation cost gets covered.
- If the system gets damaged in case, no need of changing entire system or subsystem. Just, changing a damage component will work out.

IV. SIMULINK BASED DESIGN FOR WIND GENERATION

V.

The wind generation module is constituted by a windmill, a multi polar permanent-magnet synchronous generator (PMSG), a rectifier, and a boost converter to interface the generator with the dc bus as shown in Fig 2. The wind flows through the wind turbine produces torque and forces. The wind turbine rotates corresponding to the speed of permanent magnet synchronous generator.

The RPM of PMSG, wind speed and constant pitch angle are fed into the wind turbine as feedback. When torque is given as input to motor, an alternating current is generated. The output is rectified and fed into a boost converter. The rectifier output voltage varies according to the wind-speed.

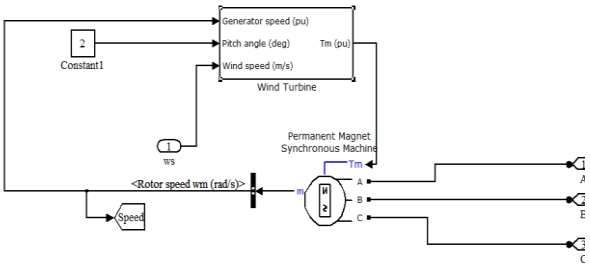

Fig.2. Simulink of wind generation

VI. SIMULINK BASED DESIGN FOR SOLAR GENERATION

A photovoltaic system shown in Fig.3 converts sunlight into electricity. The basic device of a photovoltaic system is the photovoltaic cell. The electricity available at the terminals of a photovoltaic array may directly feed small loads such as lighting systems and DC motors. These converters are be used to regulate the voltage and current at the load, to control the power flow in grid connected systems and mainly to track the maximum power point (MPP) of the device.

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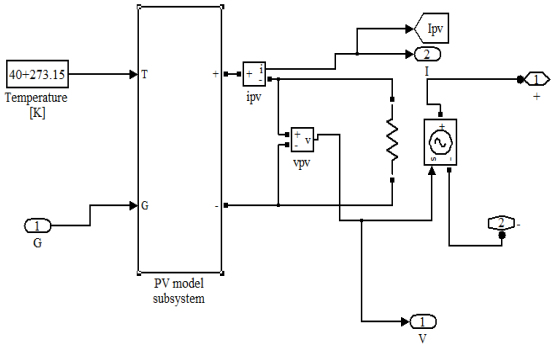

Fig.3. Simulink of solar generation

The purpose of Maximum Power Point Tracking (MPPT) is to maintain constant power. The saturated power from the Maximum Power Point Tracking (MPPT) is fed as feedback source to the solar panel. The DC output is then fed into the source voltage controller from the PV panel. The PV array terminals are connected to the output of the boost converter to form a common DC link for the proposed system. The inverter input terminals are connected to this common DC link. In this system, the setting of DC reference voltage of the DC-DC converter to the peak power point voltage of the PV array and setting the reference current of current controlled inverter corresponding to the maximum current extractable from both the sources, results in peak power extraction from both the sources.

VII. SIMULINK OF PROPOSED SYSTEM

Fig. 4 shows a bidirectional converter used for converting voltage bi-directionally between a high voltage bus and a low voltage bus, comprising a switching converter connected across the high voltage bus. A boost converter (step-up converter) is a DC-to-DC power converter that steps up voltage (while stepping down current) from its input (supply) to its output (load). A battery is connected to the converter, where it charges power from PV and wind system through grid and discharges to load through grid. The performance can be improved by connecting circuit breaker to avoid over charging, also increases the life time of the battery.

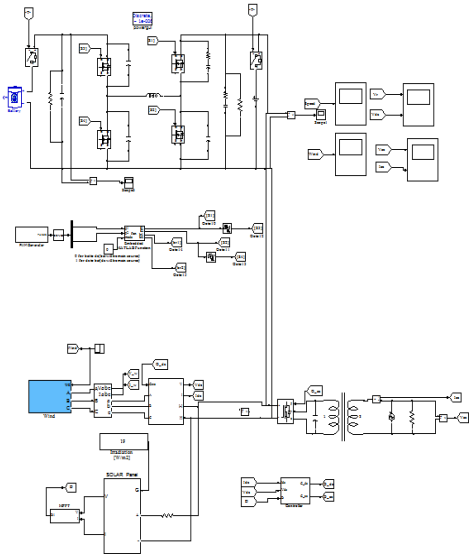

Fig.4. Simulink of proposed system

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VIII. SIMULATION OUTPUT OF LOAD VOLTAGE AND LOAD CURRENT

The output voltage value measured across the load is around 230v and having frequency of 50Hz as shown in Fig.5

Fig.5. Output of load voltage and load current

IX. CONCLUSION

When a source is unavailable or insufficient in meeting the load demands, the other energy compensates for the difference. In this project a New Multi Input Hybrid Wind/Solar Energy systems has been implemented. This system was designed to develop a power solution for remote locations such as rural and research areas as well as improve the general well-being of individuals in developing countries The features of this circuit are additional input filters are not necessary to filter out high frequency harmonics, both renewable sources can be stepped up/down (supports wide ranges of PV and wind input), MPPT can be realized for each source, individual and simultaneous operation is supported. Thus the power was continuously generated to fulfill the wide range power of appliances and medical equipment. Simulation results have been presented to verify the features of the proposed topology.

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