IJIRMET ISSN (Online): 2456-0448
International Journal Of Innovative Research In Management, Engineering And Technology
Vol. 1, Issue 1, February 2016

Enhanced Power Management Strategy For Islanded Microgrid Using Solar-Wind Hybrid Systems

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Abstract: ***In this paper, a control strategy for power management of islanded microgrid, using Solar-wind hybrid model, is proposed. The hybrid system includes four sources namely-photovoltaic (PV),wind energy systems(WES) ,super capacitor and battery unit that act as a voltage source which use an adaptive droop control to share the load with other sources while charging the battery. This hybrid system behaves like a Maximum Power Point tracker supplying the maximum power to the micro grid as long as it can suffice the load; else, the unit will automatically follow the changing load and the excess energy gets stored in the battery. Modifying the PV operating point and wind speed to match the load, whenever the PV and wind power output is higher than the load is the designed control strategy of the system. Along with functioning as a voltage source when the PV and wind power is unavailable, the battery and the super capacitor have additional functions, such as regulating the voltage and frequency. The PIC microcontroller gets input from all the four sources and connects the most appropriate source to the load, depending on the load fluctuations.***

Keyword: ***Battery storage, wind energy, supercapacitor, microgrid, photovoltaic (PV), power management, PIC microcontroller.***

I. INTRODUCTION

PHOTO-VOLTAIC (PV) arrays have advantage of decreasing cost, increasing efficiency, high reliability and low maintenance that make it a desirable choice among renewable energy sources in distributed generation application. Photovoltaic are controlled as a current controlled device. Photovoltaic array are becoming one of the most reliable and efficient alternative sources of renewable energy. Photovoltaic arrays are one of the most promising technologies in today's era in terms of reliability and efficiency.

Battery storage is an inevitable part in standalone PV application due to the intermittent nature of PV for maintaining the generation/load balance in the system. With maximum power point tracking, it has become possible to obtain the maximum output from PV at any point of the day ensuring maximum efficiency.

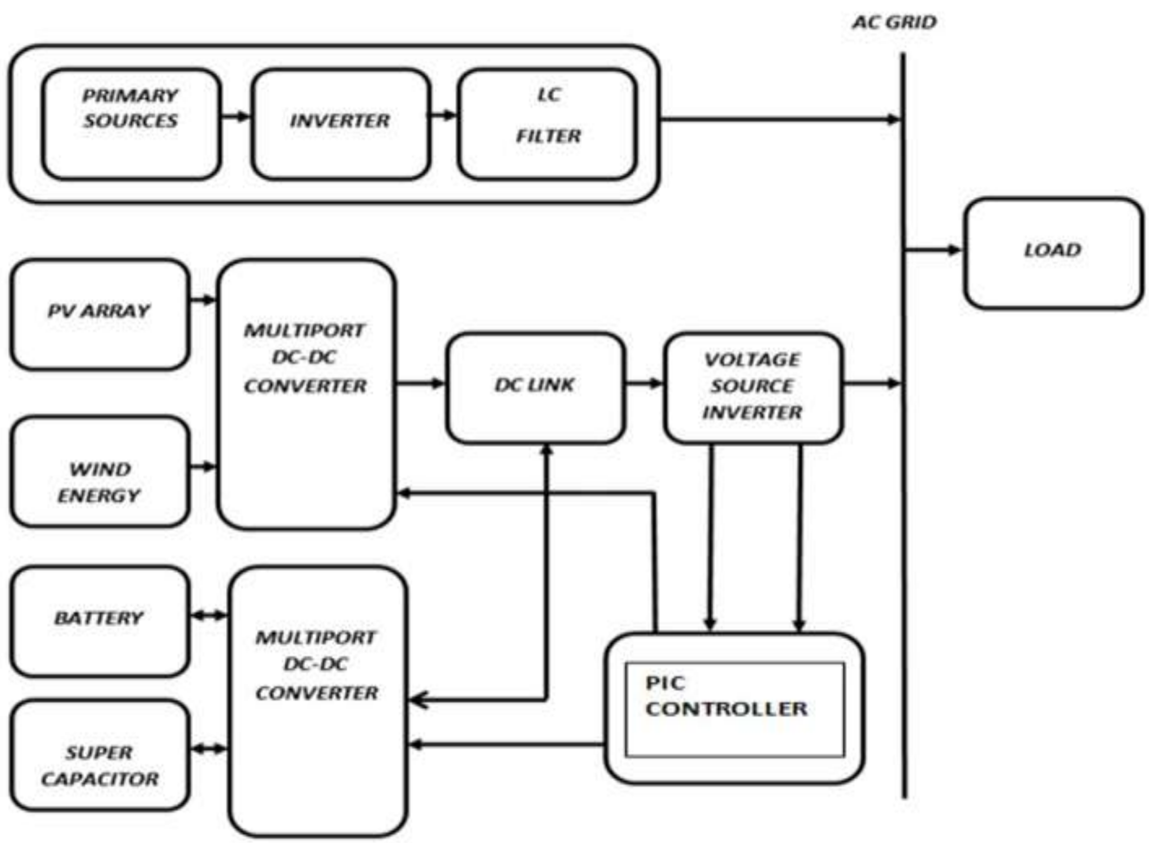
Battery storage is mainly used for storing the output of renewable energy sources as they are mainly intermittent in nature. Battery storage make it possible to store the PV and wind energy and make it available to the load during Durations when the PV and wind energy is unavailable. Also battery storage is required to regulate the voltage and frequency and also to ensure the load/generation power balance is the pressure of intermittent sources such as PV and wind energy.

Generation of electrical power from wind power and its interface to the local microgrid is a newer concept and gaining importance due to its utilization and environmental advantages. A wind turbine can be used in wide variety of ways to generate electrical power. There are many aspects to use electrical power generated from the wind power. These include feeding local loads, interface to the existing power grid, strengthening local micro grid, etc. Besides these the wind power can also be used for power quality enhancement. Wind system can be connected to the electric grid through your power provider or it can stand alone (off-grid). This makes small wind electric systems a good choice for rural areas that are not already connected to the electric grid.

Supercapacitors have the highest capacitive density available today with densities so high that these capacitors can be used to applications normally reserved for batteries. Supercapacitors are not as volumetrically efficient and are more expensive than batteries but they do have other advantages over batteries making the preferred choice in applications requiring a large amount of energy storage to be stored and delivered in bursts repeatedly. The most significant advantage Supercapacitors have over batteries is their ability to be charged and discharged continuously without degrading like batteries do. This is why batteries and Supercapacitors are used in conjunction with each other. The Supercapacitors will supply power to the system when there are surges or energy bursts since

Supercapacitors can be charged and discharged quickly while the batteries can supply the bulk energy since they can store and deliver larger amount energy over a longer slower period of time.
The energy storage can be deployed as a separate unit that connects to the microgrid bus through a voltage sourced converter (VSC), or in combination with PV or wind energy system in a single DG unit. In the first configuration, a power imbalance occurs when the supplied PV and wind power is higher than the load and the battery is fully charged. Accordingly, a supervisory power management system is required to coordinate the operation of the PV and battery units in this configuration. Power management strategies have been developed for islanded microgrid that includes PV, wind
energy system, supercapacitor and battery units. These strategies require that the energy management system(EMS) has access to the power measurements at every DG unit and load node.
Therefore, all load nodes and local loads must be equipped with power measurement and communication modules, which are not practical or readily available in most conventional distribution networks. Otherwise, the central EMS may make an undesirable decision if the power measurements are not available from one or more loads. In addition, according to the algorithm the battery and the fuel cell are used to share the deficit load using droop control when the power supplied from the PV and the micro turbine is insufficient. This could deplete the battery storage, which is the most critical element in the operation of the islanded microgrid, and may result in shutting down the microgrid. Instead of sharing power, the battery storage is commonly used to supply/absorb power during transients, and to supply the deficit power only after all other energy sources reach their ratings. A central energy management system is employed to coordinate the dispatchable units so that the battery neither supplies nor absorbs any power at steady state. A power management strategy is presented for islanded dc microgrids that include PV, wind energy system, supercapacitor and battery storage.

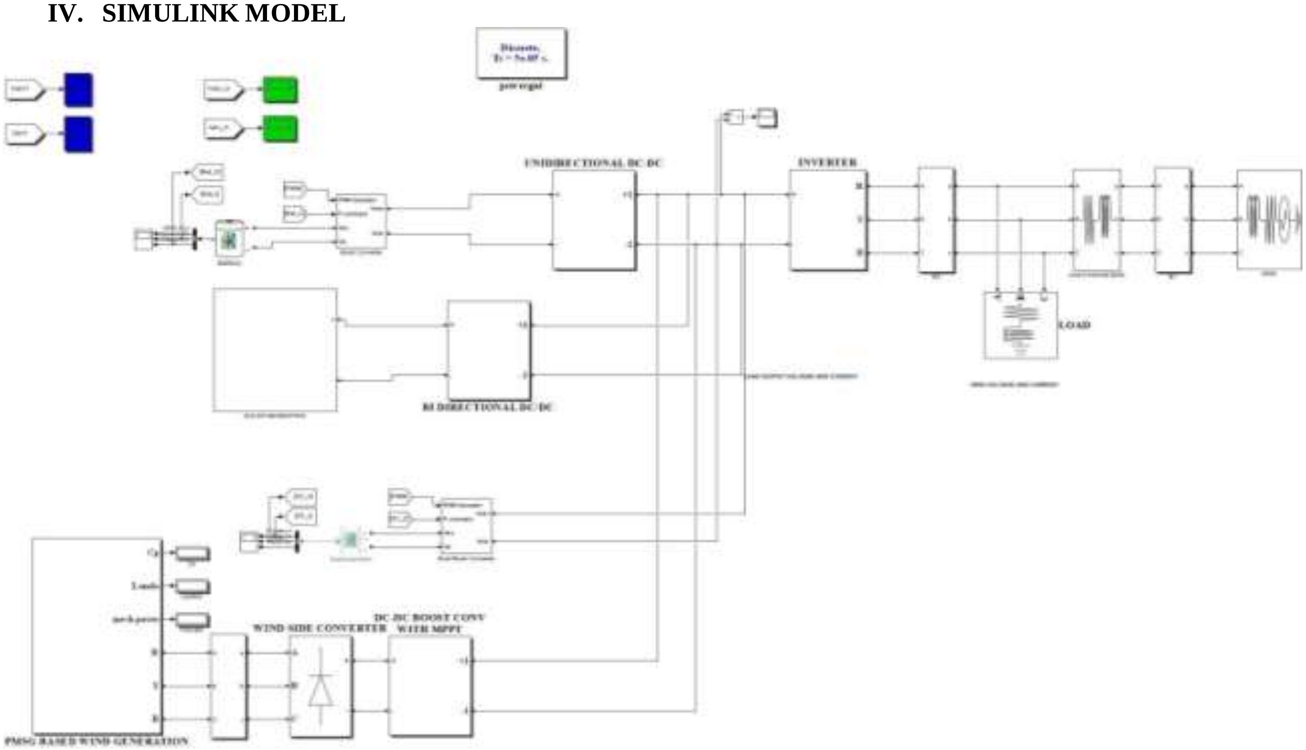
II. PROPOSED SYSTEM



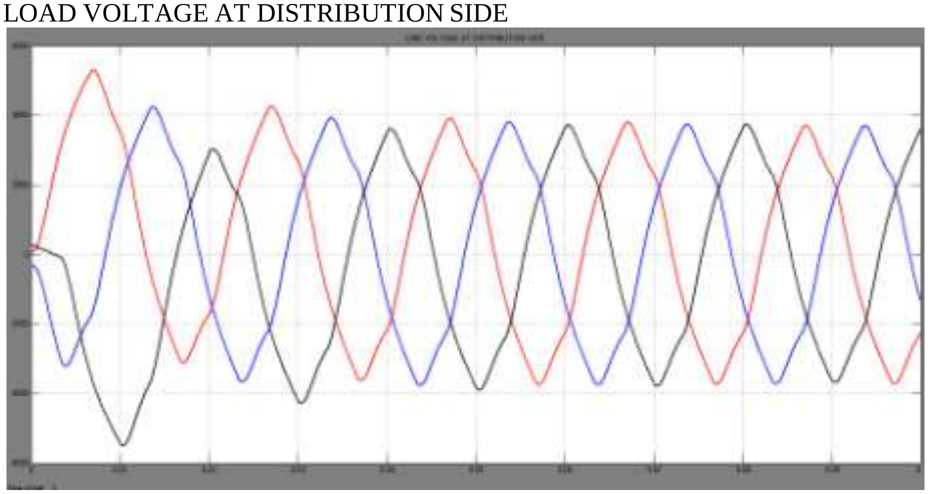
III. DESCRIPTION

In the proposed system there are two parts of energy sources 1) primary energy source 2) Hybrid energy source which consist of PV,wind, battery and, supercapacitor. Unidirectional dc to dc converter maintain the balance voltage between hybrid energy sources and microgrid**.** PV and wind energy system generates dc power which is converted into ac power then it is given to the islanded microgrid. Mppt controller is used to achieve maximum power from the PV and wind energy systems. Bidirectional dc to dc converter helps for charging and discharging of battery and supercapacitor according to the load. In this model, Power management of the system is improved due to multi segment adaptive droop control. Also the system performance is improved by the unlimited cycle life and quick charging characteristics of supercapacitor. In addition, it provides uninterrupted power supply to the islanded microgrid and no full charge is required in the supercapacitor.

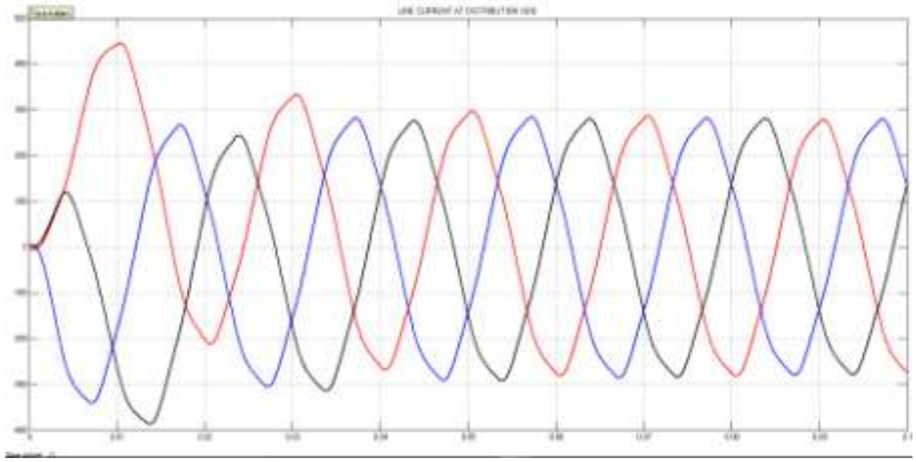
IV. SIMULINK MODEL



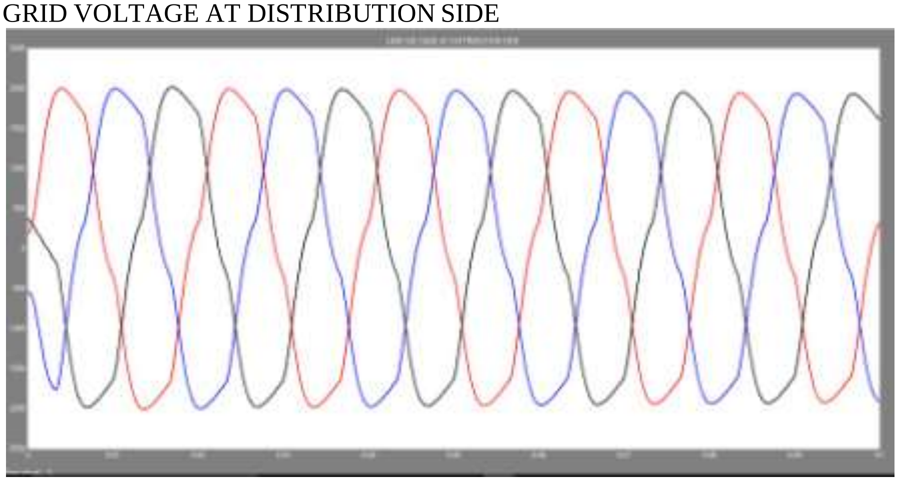
LOAD VOLTAGE AT DISTRIBUTION SIDE



LOAD CURRENT AT DISTRIBUTION SIDE



GRID VOLTAGE AT DISTRIBUTION SIDE



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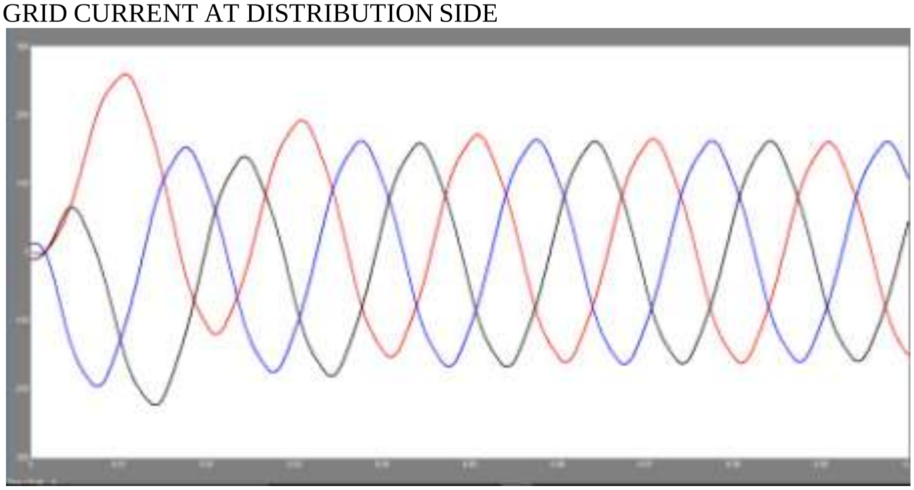

V. ADVANTAGES

Power management of the system is improved due to multi segment adaptive droop control.Unlimited cycle life and quick charging characteristics of supercapacitor improve the system performance. It provide uninterrupted power supply to the islanded microgrid. No full charge is required in the supercapacitor.

VI. APPLICATIONS

Applications of hybrid systems range from small power supplies for remote households providing electricity for lighting or water pumping and water supply to village electrification for remote communities.

VII. CONCLUSION

"Enhanced Power Management Strategy For Islanded Microgrids Using Solar-Wind Hybrid Systems"has been successfully design and implemented. In this project, a power management strategy for PV/battery hybrid units in an islanded micro grid has been proposed. The PV/battery unit is controlled to operate as a voltage source that employs an adaptive droop control strategy, in contrast to the PV control strategies in the literature where the PV units are controlled to operate as current controlled sources (PQ control). It has been shown that controlling the PV/battery unit as a voltage source with the proposed adaptive droop provides the PV/battery hybrid unit with several unique features. First, the hybrid unit has the ability to share the load power with other sources while storing any excess energy in the battery. Second, it can track and supply the maximum PV power to the microgrid provided that there is sufficient load demand in the microgrid. Otherwise, the hybrid unit will autonomously match the available load while charging the battery with the excess energy as in standalone strategies. Third, the control strategy modifies the PV operating point to follow the load when the total microgrid load is less than the available PV power and the battery is fully charged. In addition, the battery may also provide the operational functions that a separate storage unit may provide in an islanded microgrid, such as regulating voltage and frequency, and supplying the deficit power in the microgrid.

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