A SIMULATION OF RENEWABLE ENERGY (PHOTOVOLTAIC & WIND POWER) BASED HYBRID - MICROGRID MODEL

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Abstract—In this paper, a wind-photovoltaic hybrid power generation system model is studied and simulated. A hybrid system is more advantageous as an individual power generation system is not entirely reliable. When any one of the methods is shut down, the other can supply power.A microgrid consists of a cluster of loads and distributed generators that operate as a single controllable system. As an integrated energy delivery system, the microgrid can run in parallel with or isolated from the primary power grid. There are ongoing researches focused on Microgrids and a lot of investigation has been conducted by many research groups to determine the feasibility and benefits of Micrograds. Even though the fundamental principles of Microgrids are well known, the implementation of the system is not always well mastered. The microgrid idea acts as a resolution to the problem of integrating large amounts of microgeneration without interrupting the operation of the utility network.

***Keywords*- Pulse width Modulation (PWM),Hybrid microgrid, Solar Photovoltaic.**

I. INTRODUCTION

Since the growth in technology and change in the lifestyle of humanity, the power demand at the load center has enhanced to a greater extent. With the advancement of the economy and the increase of population, the consumption of energy resources is growing fast, resulting in a series of problems such as energy shortage, environmental pollution, and ecology deterioration. Making full use of renewable energy and achieving sustainable economic development has become a consensus among all countries in the world. In all sorts of renewable energy, wind power and solar energy are used most widely. Due to the instability of wind energy, it has a significant effect on the safe operation of the power grid. The microgrid concept acts as a solution to the problem of integrating large amounts of microgeneration without interrupting the operation of the utility network. With intelligent coordination of loads and micro-generation, the distribution network subsystem (or 'microgrid') would be less disquieting to the utility network, than conventional microgeneration. The net microgrid could even provide ancillary services such as local voltage control. In the cause of troubles on the leading system, microgrids could potentially disconnect and continue to operate separately.

Objective

Hybrid generation power systems that use many power sources can significantly improve the certainty of load demands all the time. Even higher producing capacities can be achieved by the hybrid system. In the stand-alone order, we can able to provide independent fluctuation output to the load irrespective of climates condition. To get the energy output of the PV system converted to store energy, and consistent power delivered by the wind turbine, an effective energy storage mechanism is required, which can be obtained by the battery bank.

The objective of the paper is to achieve a power system that is a hybrid of both Photovoltaic and wind powers. The step by step objectives are

- To study and model PV cell, PV array and PV panels
- To trace the maximum power point of operation, the PV panel irrespective of the changes in the environmental conditions.
- To study the PV module's behavior under partial shading condition.
- To study the characteristic curves and effect of variation of environmental circumstances like temperature and irradiation on them.
- To study and simulate the wind power system and track its maximum PowerPoint
- Implement a hybrid system.

II. IMPLEMENTEDMETHODOLOGY

The block diagram of the suggested architecture photovoltaic in Fig. 1. The output of the solar panel is given to the three-phase inverter through a boost converter. The switching pulse generated from the MPPT algorithm is given to the boost converter. The power from the battery is given to the single-phase inverter through a bidirectional dc-dc converter so that power flow through either direction can becontrolled. The grid voltage is sensed using a PLL, and thegrid current and the reference current are compared using acomparator, and the output of the comparator is fed to the PIcontroller. The PWM pulses to the single-phase inverter aregenerated by comparing the output of the SPVWM controller witha triangular wave.

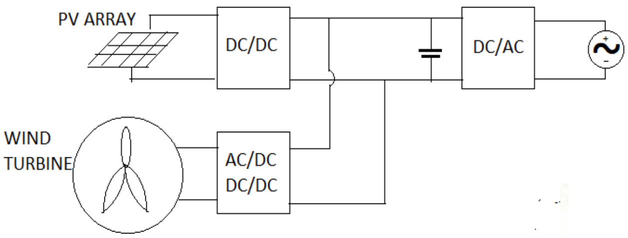

Figure 1: Hybrid grid basic structure

Here is a hybrid solar PV and wind system along with a battery bank that is connected to an AC Microgrid. The system can work in a grid-connected method or stand-alone method. The DC outputs' voltages from single solar PV and wind stream, through individual DC/AC and AC/DC-DC/AC units, are incorporated and combined in parallel on the AC side to produce the power to the grid/loads even with only one basis available. Therefore, in the grid-connected mode of operation, the renewable energy sources act as current sources and inject power directly into the AC bus. The battery system interfaced with a bi-directional converter and can be charged or discharged depending on the condition of the generation, load, and state of charge. However, in the stand-alone mode, the renewable energy sources act as current sources feeding the loads directly, and the battery bank works as a voltage source controlling the AC bus voltage by charging or discharging. The battery converter regulates the magnitude and frequency of the load voltage. The particular RES units can be operated for MPPT systems to have the determined power from the solar PV and wind systems in the grid-connected mode. The corresponding thing can be applied in the stand-alone mode provided that the battery bank endures as a voltage source to control the AC bus voltage by indicting or discharging.

A photovoltaic energy system is mainly powered by solar energy. The configuration of the PV system is manifested in the figure.

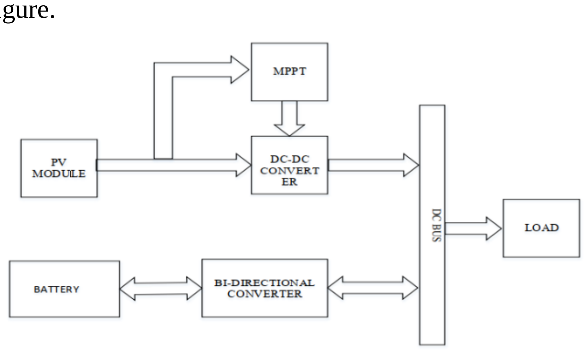

Figure 2: Overall block diagram of PV energy system

It contains PV modules or arrays, which transform solar energy into the usage of solar irradiation into electrical energy. The dc-dc converter alterations the level of the voltage to harmonize it with the electrical apparatuses that are supplied by this system. This DC-DC converter may be each buck or boost or buck-boost contingent on the essential and available voltage levels. The maximum power point tracking system coerces the maximum energy from the PV modules. A bi-directional converter that can supply the current in both directions is used to charge the battery when there is a power surplus, and the energy stored by the battery is discharged into the load when there is a power deficit.

This system comprises of a wind turbine which transforms wind's kinetic power into rotating movement, a gearbox to agree with the turbine speed to generator speed, a generator which converts mechanical energy into electrical energy, a rectifier which converts ac voltage to dc, a controllable dc-dc converter to trace the maximum power point, a battery is charged and discharged through bi-directional converter.

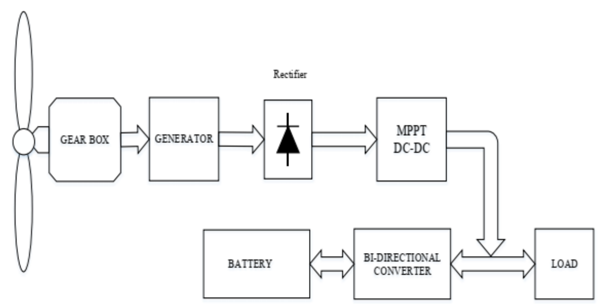

Figure 3: Wind turbine basic structure

A wind turbine converts the kinetic energy of air, i.e., wind power into production power, i.e., rotating motion of the turbine that can be used directly to run the machine or generator. Power obtained by wind turbine blade is a concomitant of the blade shape, the pitch angle, speed of rotation, the radius of the rotor.

III. DISTRIBUTION SMART SOLAR

Distributed Smart Solar (DSS) technology combines an advanced panel-level inverter with the smart grid sensors and communication technologies (Figure 1). A typical configuration is to provide each solar panel with a Smart Energy Module (SEM) connected to the low voltage utility network. All the SEMs form a secure meshed communication network that uploads their information to a data center via communication aggregators. Command and control centers and distribution management systems (DMS) access the data center to manage the solar portfolio as a virtual power plant and also to implement several smart grid functions.

This technology enables each solar panel to become a node in a smart grid and thus facilitates the implementation of many utility applications such as demand response, conservation voltage reduction (CVR) [6], Volt/VAR loss minimization, predictive maintenance, outage notification, theft detection, and street lighting controls. The financial benefits of this technology go beyond those of solar energy generation to The Economic

Opportunity of Distributed Smart Solar Systems Hisham .A. Othman, Ruba A. Amarin those of the smart grid, and thus allow the utility to optimize

the generation, the load, and the distribution assets in between.

Establishing the right solar energy policies and regulations in a country is crucial to the proper expansion of the various forms of solar energy technologies. In this respect, it is essential to understand who, along the electricity value chain, benefits from the solar energy investments in order to allocate the costs to these beneficiaries in a proper fashion. The beneficiaries of a solar energy investment depend on the market structure and subsidy system in a country.

IV. WIND POWER INTEGRATION

speed, and they can generate electricity at both day and night. While the power output of photovoltaic cells is determined by the light intensity and they can generate electricity only at day. The differences of power output feature between wind power units and photovoltaic cells related with time decide that the influences of both on the power grid are different. The wind power units generate more electrieity usually at night. Thus the suitable wind power capacity can be calculated by renewable energy consumption at night in order to make full use of wind energy. While photovoltaic cells can generate electricity only at day and it will make the actual power generation capacities of the power grid at day and night are different. This point should be considered when deciding photovoltaic accommodation capacity. The paper takes the result that the renewable energy eonsumption of power grid at day minus the consumption at night as the ability to consume the photovoltaic power output and deeides photovoltaie capacity according to the result.

V. ENERGY STORAGE MANAGEMENT

Battery energy storage systems are comprised of batteries, power electronics for conversion between alternating and direct current, and the control system. The batteries transform the electrical energy into chemical energy for storage. Different types of battery chemistries have various advantages and tradeoffs in terms of power and energy capabilities, size, weight, and cost. In large grid-tied applications, the most common batteries are typically Sodium-sulfur, Lead-Acid, or Lithium-Ion chemistries. Various other chemistries have been used in pilot projects and laboratory tests, a referencediscussing different electrochemistry is found in [2] Batteries are charged and discharged using DC power, which

must be converted by a bi-directional power electronic interface. The power electronic interface is often referred to as a power conversion system (PCS). The PCS regulates the flow of power between batteries and the power grid and can respond to a changing power command on sub-cycle timescales, far faster than typical peaking thermal plants. The power electronics are capable of taking independent control signals for real and reactive power on the AC side of the PCS, which enables the BESS to provide power factor and voltage support functions. This function is referred to as a four-quadrant operation and can eliminate the need for such system components as capacitor banks at the point of interconnection of the wind plant and the grid.

VI. RESULTS

The results can be analyzed and discussed in terms of its capability to meet the required load demand of the area. The advanced methodology has been applied to simulate a standalone hybrid PV/wind system in MATLAB/SIMULINK environment. The result is presented.

Simulation mockup for battery working independently amongst DC system with hybrid energy storage by super capacitor and battery. In case of abrupt load variation, battery will quickly change its power of charging and discharging so as to accommodate loads. However, lower power density of battery indicates this cannot be satisfied by batteries. In such case when super capacitor is to provide abrupt variation to load power (i.e. high frequency component of load power), battery is only required to provide low frequency component of load power variation. Hence, it can substantially mitigate the impact on battery from abrupt load variation. This will reduce requirements of battery power density and improve dynamic response of the system. In the meanwhile, battery can better stabilize the voltage of DC busbar so that rate of current variation is reduced during charging and discharging. Hence, battery conditions will be well improved. This can reduce damage to battery and extend service life of battery.

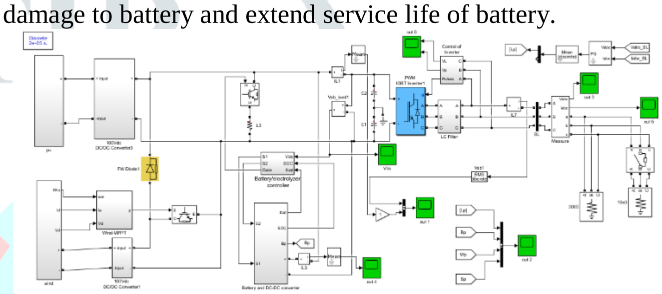

Figure System Simulink Implementation model

Simulation results of PV module

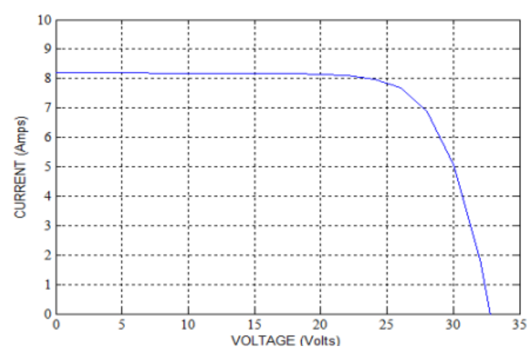

Figure 5: V-I curve of PV module

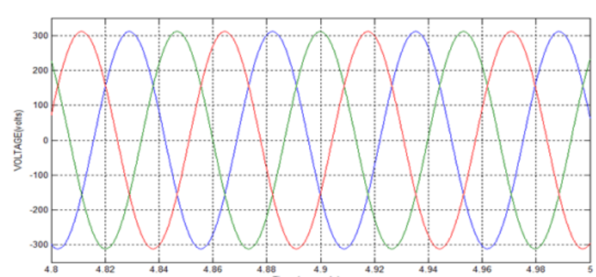

Figure 6: Three phase line output voltage of PMSG

From figure we can observe that during charging state of charge (SOC) of the battery is gradually increasing and also during charging current is negative. We can observe at 40% SOC battery voltage is around 26 volts, as state of charge of battery is increased battery voltage exceeded its nominal voltage.

VII. Discussion

This paper explores the relationship between DC bus voltage and system efficiency in a hybrid photovoltaic-grid power system. An optimal efficiency bus voltage value can be found by loss analysis within a specific voltage range. A new method of optimizing the efficiency of the hybrid photovoltaic-grid power system by changing the dc bus voltage is proposed. It provides an idea to improve the effectiveness of the hybrid photovoltaic-grid Power system. The optimal efficiency point of the system is different under different power states. So this paper proposes a new method to optimize the efficiency in a hybrid photovoltaic-grid power system by changing dc bus voltage.

VIII. Conclusion

The research on power quality of grid-connected wind/PV hybrid generation system was administered at the designing stages of the mixed renewable sources hybrid control system. The power electronic interface and its control strategies were proposed for maximum power generation of the hybrid system with a grid interface. Here, the dynamic analysis models of the system components and power control strategies were addressed. The modeling, along with the simulation study, was carried out based on Matlab2017b.

In this paper, the implementedhybrid wind-solar system modeled and simulated in MATLAB. Grid interconnection of Renewable System is done using DC-DC converter and grid interfacing inverter. An inverter is controlled in such a way that it acts as a grid interfacing unit as well as an active shunt filter. Nonlinear loads are connected at the point of universal coupling. Various Renewable Energy generation conditions with unbalanced and distorted grid conditions are simulated and found that the system works well for different conditions. Thus grid interfacing inverter with the additional functionality of shunt active power filter can be utilized in distribution systems for cost-effective distributed generation with power quality improvement features.

Hybrid generation systems that use more exceeding than a single power source can significantly improve the certainty of load demands all the time. Even higher generating capacities can be obtained by the hybrid system. In the stand-alone mode, we can able to provide independent fluctuation output to the load irrespective of climates condition. To perceive the energy output of the PV system converted to save energy, and consistent power performed by the wind turbine, an efficient energy storage device is challenged, which can be achieved by the battery bank.

There is a considerable electricity demand for stand-alone/mini-grid Renewable Energy Technologies, both in remote and highly populated areas. To meet these demands, policies have to be implemented to promote Renewable Energy Technologies and address the problems still connected with them. Other areas for further investigation are:

- PV cell, module and array are simulated and the effect of environmental conditions on their characteristics is studied.
- The wind energy system has been studied and simulated.
- The maximum power point of operation is tracked for both the systems using the P&O algorithm & Fuzzy Logic.
- Both systems are integrated, and the hybrid system is used for battery charging and discharging.

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