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Solar-Wind Hybrid Power Generation with Smart Grid Interconnecting System

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***Abstract:** As we know the demand of electricity is increased day by day which cannot be fulfill by non-renewable energy source. So we use renewable energy source to fulfill the demand of electricity. The main objective of this research paper is study various aspect of performance of hybrid power generation system.[1] Voltage and frequency fluctuation and harmonies are major power quality issues in smart grid interconnected hybrid solar and wind power system. To overcome this issues we use Flexible alternating current transmission system (FACTS).The application of FACTS devices has been playing an important role in improving the flexibility, stability of smart grid.[3].*

***Keywords:** Solar, wind, hybrid power, Smart grid, power quality, FACTS devices.*

I. INTRODUCTION

Electrical energy is very important for development of any nation for generating electrical power our primary sources are coal, oil and natural gas. As we see that there energy sources are use harmful for our environment so we can use these sources in limited way. And then we increased the use of renewable energy sources such as solar, wind and biomass.[2] By using renewable energy sources we are facing many problem's to achieve more power. So many research is going to obtain the efficiency of renewable energy sources.[5]

We first talk about solar and wind sources due to easily available everywhere by using these energy sources there is no harmful affect on environment. The power grid fans significant challenges such as voltage fluctuations and frequency fluctuations and Harmonics in the system (FACTS) technology, which playing an important role in the process of efficient smart grid by using FACTS devices, the variable (voltage, impedance, phase angle and power flow) of the smart grid can be minimized and power quality of the grid can be impressed.[6] FACTS devices and smart control strategies have been gaining am are prominent role in energy generation from solar and wind system significant research hand been focused on maximizing the energy extraction from Renewable energy sources. The results of the implementation of FACTS devices in smart grid with hybrid solar and wind power generation systems are encouraging.[8]The aim of this review paper is discuss hybrid solar-wind power generation interconnected with smart grid and use of FACTS devices to improve the power quality of the system.

II. LITERATURE REVIEW

Some of paper published in IEEE journals and conferences were reviewed; literature discussed about power quality and reliability in renewable energy generation, various forecasting aspects concerning voltage and frequency fluctuation and harmonics reduction have been highlighted. For improving the power quality of renewable energy generation hybrid power system into the function of power electronics devices and Flexible AC Transmission System related to these troubles.[10] Recent presents developments in power electronics for the combination of wind and photovoltaic (PV) energy generators. Discuss about approximately common and future tendencies in non conventional energy systems based on totally on reliability .Type of numerous power quality problems utilized by using specific researchers has been executed. Applications of various techniques are carried out for power quality issues in grid connected hybrid solar and wind power generation system. Simulation model of hybrid solar and wind energy system connected to smart grid is carried out.[9]

For the evaluation and performance measurement various simulated experiment is done. Switches used in the proposed model are less so switching losses are less. Hence in this paper the smart grid connected to hybrid system is study in simulated using MATLAB SIMULINK under various kinds of load and studied the total number of harmonic distortion and voltage fluctuation also.

Rapidly increasing undamped power oscillations in small term can arise from an insufficient power sharing coordination between several Renewable energy sources in smart grid[11].The benefits of having Flexible Alternating Current Transmission System (FACTS) devices in a system with high penetration of Distributed Generation as well as the influence of Static Var compensators (SVC) and static synchronous compensators (STATCOM) on voltage stability is presented. In recent power systems, low frequency oscillations are damped by FACTS and/or power system voltage variable. In the literature, a FACTS device is placed in a machine

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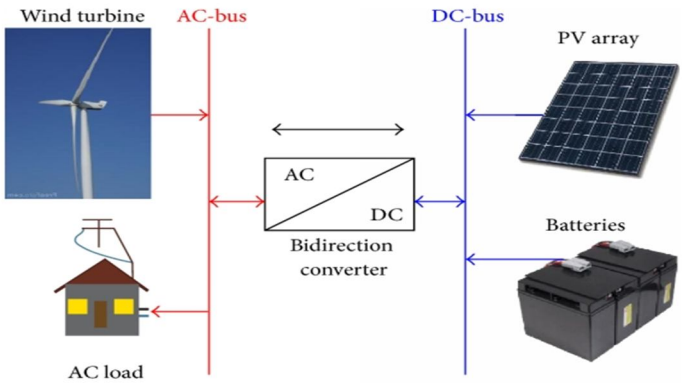
with infinite bus bar system and it was given that electrical power system stable voltage parameters can be optimized using a support vector return-controlled FACTS device in real time. FACTS devices are classified into series controllers, shunt controllers and combination of series-series and series-shunt controllers[6].

The simulations indicated that harmonics is nullified and current at unity power factor is delivered to the grid. The efficiency and the performance of renewable energy sources can be increased by the development of the control structure of grid connected inverter[8].

III. HYBRID SOLAR WIND POWER SYSTEM

The integration of hybrid PV and wind power generation systems supply to the grid can further help in reforming the overall economy and reliability of renewable power generation to supply its load. Similarly, the integration of hybrid solar and wind power in a stand-alone system can reduce the size of energy storage needed to supply continuous power.[8]The photovoltaic (PV) energy is the most promising source of energy considering it is pollution unfastened and abundantly to be had anywhere within the world. PV energy is in particular useful in distant sites like deserts or rural areas where the difficulties to transport of fuel and the less of electrical grid lines make use of non renewable energy sources are not possible.[12] PV systems and wind power generation system are alternative energy useful resource complementary in hybrid systems were turning into eventual because of the enlargement of research and improvement work on this zone.[6] A best way to maximize the success of the PV structures, a high reliability, an cheap value, and a consumer- friendly framework should be carried out in the proposed PV topologies. To transform dc power of PV into ac with help of converter and also to transfer power to the grid. Wind turbine makes use of the variable-speed turbines as their annual energy take is set 5% more than the fixed-speed period, and the active and reactive power issues also can be easily handled however it wishes an more energy converter[9].To gain a desired load distribution among the various inverters a proper power balancing technique is required. In different way, all Renewable Energy sources and batteries can be connected to a common DC-bus and the DC-bus will be connected to AC-bus by bidirectional converter[10]. The design principles of this system is relatively not simple but it has good efficiency and reliability compared to the series configuration.. In an AC coupling system, the various energy sources are combined by their own power electronic interfacing circuits to a power frequency AC-bus[11]. Rather of connecting the all hybrid energy sources to standalone DC or AC-bus, as we explain previously, the different power generation sources can be connected to the DC or AC-bus of the hybrid system depending on the output of both type of power generation system. As a outcomes from this system, the system can have higher energy efficiency than standalone system and cost is minimized. On the other way, control of energy and energy management may be more complex than for the DC- and AC-coupled schemes. Interconnection of wind energy system with the AC-bus directly[12]. Choosing of the suitable configuration parameters depends on the type of output electrical power of the most of the generation of electricity and supply to loads. When most of the generation by sources and loads which are connected is DC, it is appropriate to use of DC-bus coupling or use of AC-bus coupling if required. If more power sources of a hybrid system generate a combination of AC and DC power, then a hybrid-coupled integration plan may be considered which is the state in this paper as shown in Figure 1.[5] The remittance of the system is very easy to be understood where the load is supplied mainly from Wind Turbines and PV with the help of bidirectional converter, respectively.



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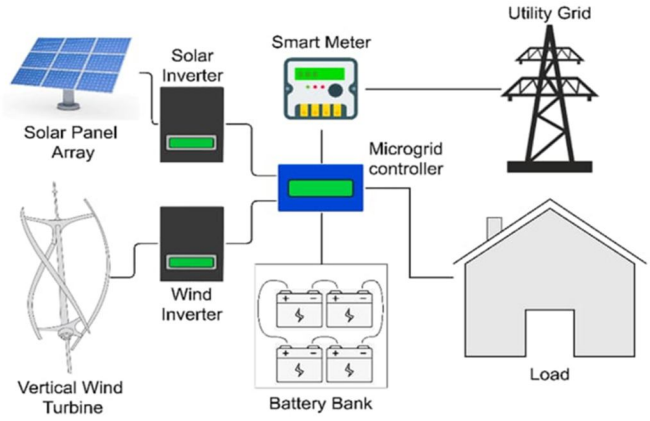
IV. SMART GRID CONNECTED HYBRID SYSTEM

Solar and wind power hybrid power systems interconnected to the grid can help in decreasing the overall cost and reliability of renewable power generation is improved to supply its load. The grid takes adequate renewable power from renewable energy site and supplies power to the loads connected to their site when required[9].

Figure 1 shows the construction of the PV and wind hybrid energy storage system. The system consists of wind turbines, Bidirectional converter, DC bus and AC bus, Photovoltaic array, and energy storage from both solar and wind system[7].The solar and wind hybrid power generation system produces electrical energy, which reaches the inverter through the DC bus and then it is converted into AC by the inverter[15]. Hybrid energy storage systems regulate energy to ensure that the power generation system provides more stable electrical power to the connected load and supply to grid.[9]



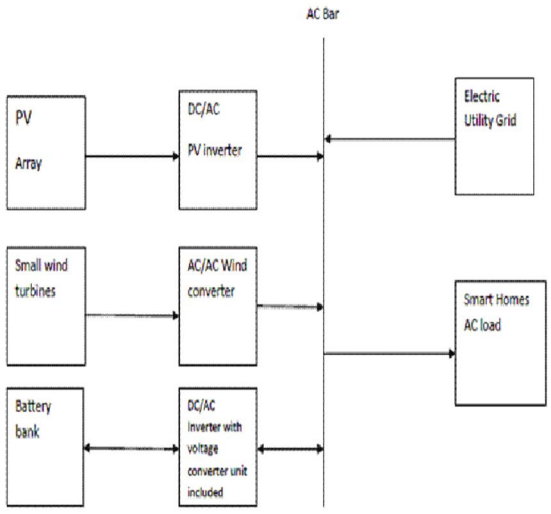
V. TYPES OF FACTS

FACTS devices are grouped into two generations according to their use. In the first generation, the FACTS devices based on the installation of its power system are grouped like tap changing transformers, synchronous condenser and capacitors. FACTS devices are used at the end of generation to control and improve the power flow of the system[11].The 2nd generation FACTS devices respond faster; these devices are subdivided into two other groups

Thyristor Based Devices

Devices Based on voltage source

VI. BLOCK DIAGRAM



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Hybrid systems are formed with an integration of solar panels and wind turbine, the output produces from this integration system is usefull to charge batteries, this amount of stored electrical energy can then be transmitted to local power stations[4]. This hybrid system have wind turbine which are used to generates electricity when wind is available in nature and solar system are used when solar radiations are available in only day time . Electricity can be generated by both the system of power generation at a time also. Uninterrupted power supply is obtained from the storage batteries [5]. This system requires more capital investment. But the reliability, long-time period and require less maintenance overcome this disadvantage. The output terminal power of the wind turbine is in AC nature which is converted in DC with the use of a rectifier.[6]

VII. ROLE OF FACTS DEVICES IN IMPROVING POWER QUALITY

The power output from both sources have some unstable condition so to reduce this effect require the use of FACTS devices and stabilization power electronic converters, together with fast acting control strategies[11]. New FACTS topologies are becoming to satisfy decoupled ac-dc interface, improved voltage security, reactive power is compensated, voltage and improvement in power factor, and losses decreament[10]. FACTS technology have VSCs, STATCOMs, SSSCs, UPFs, active power filters and Gate-Controlled Series Capacitor (GCSC). Recent power systems with latest need of consumers smart metering and integrated PV and wind mills will require recent modified smart-soft computing, control strategies and extended power electronic converter topologies to secure reliability, security, power quality and able utilization of output power from both generation system without transient over-voltages and stress currents. Improved energy utilization with influential voltage regulation at key interface bus regulations will conditioned sizing of distributed renewable and other generation system[6].

VIII. CONCLUSION

In this system we added grid connected inverter after which a bidirectional inverter is used and the energy generated can be stored or used for further transmission and distribution. Interconnection of the system makes it smart which has two way communications[11]. In future we can add some other renewable sources also to improve the efficiency and reliability of the system. This paper has presented about FACTS based solutions to maintain with the extensive use of nonlinear loads, renewable energy sources, battery storage[9].

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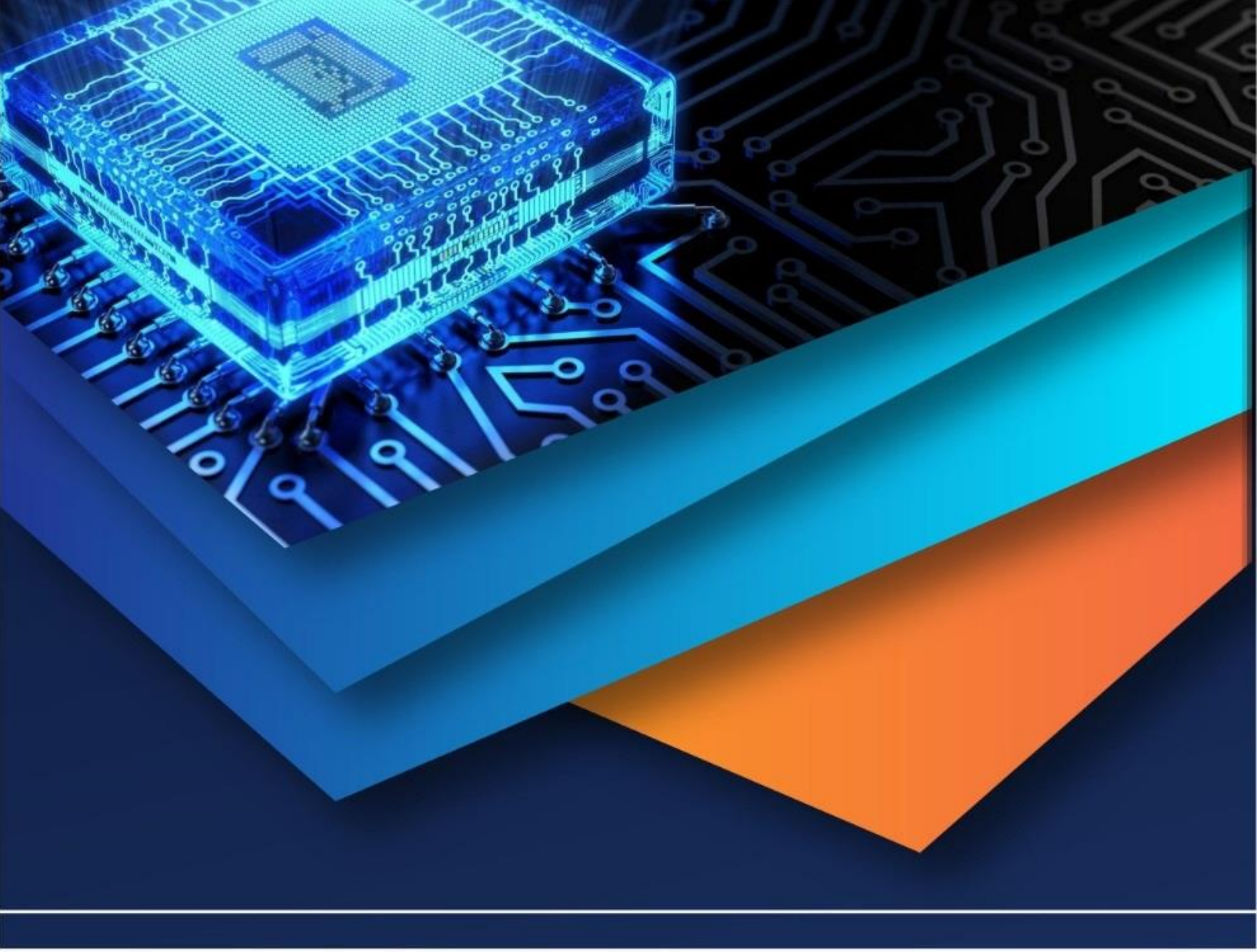

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