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Power Quality Improvement of Distribution System with Solar Wind Based Using Statcom

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Abstract: *This paper presents power quality improvement for effective power transfer throughout a grid-integrated star photovoltaic- wind energy hybrid system. The hybrid system constitutes a renewable energy farm, supported electrical phenomenon energy generation system and wind energy conversion system. The system occurrences continued interference in AC masses and power output from the property farm. This produces reactive power incompatible and will increase voltage unpredictability and power quality problems. This gap is sometimes eliminated exploitation associate adjustable reactive power supply i.e. static synchronous compensator. 3 case eventualities of the hybrid system, i.e. hybrid system in (I) standalone mode, (II) grid- integrated mode and (III) grid-integrated mode with STATCOM, area unit tested to match their dynamic and transient performances. Results show that scenario-III best fulfilled the dynamic compensation demand among all cases. below this state of affairs, load bus voltage is regulated at around one.0 p.u. and total harmonic distortion in voltages/currents unit of measurement maintained at around one p.c. moreover, this situation incontestable superior transient response towards a step modification in reactive power load, considerably reducing most peak deviation by seventy-three.4% and sinking time by seventy fifth in receiving voltage compared to the critical case of scenario-I.*

Keywords: Solar photovoltaic, Wind energy, Hybrid PV-Wind system, STATCOM, Voltage stability

I. INTRODUCTION

With the urbanization, industrial enterprise and rise in living standards, the utilities area unit burdened with the escalating pace in demand for electricity. the ability provide from mere typical sources is unable to cater to trendy power demand and therefore raising the difficulty of power reliableness and security whereas the massive quantity of pollutants poses serious environmental problems. In last twenty years, renewable and distributed energy sources have emerged as a supplement to standard energy sources and area unit predicted by utility engineers as a potent resolution in fulfillment of load demand in with success overcoming the ability problems. Hybrid Renewable Energy Systems (HRES) based mostly Distributed Generation (DG) is that the recent trend within the renewable energy system because it has shown to enhance the performance and liableness. varied opportunities are argued for effectively exploiting many renewable energy sources for electricity generation. Among all the trending renewable energy resources, wind and alternative energy sources combined along are used expeditiously in various hybrid systems. Recently, star PV-Wind hybrid systems received vital attention from the utilities worldwide. The work conferred during this paper involves the elaborated modelling, technique and comprehensive performance analysis of Wind electrical phenomenon hybrid energy system inter-connected to the grid via power-electronic interfacing. to get a additional sensible state of affairs, variable AC load is utilized within the system in conjunction with intermittent power sources of star PV and WEC system in a trial to introduce severe dynamics into the hybrid system. This primarily drives a necessity for a supply of variable reactive power thus on maintain a voltage profile at the load bus. In these circumstances, STATCOM is envisaged to be a alternative of the device because the same has been verified to enhance the voltage regulation in isolated hybrid systems as steered by many studies. System modelling further because the simulation is finished mistreatment MATLAB/Simulink 2019. Results area unit obtained to assess the performance and verify the practicability of the grid-connected hybrid system over isolated systems and to prove the suitableness of STATCOM within the improvement of the voltage profile of the load bus.

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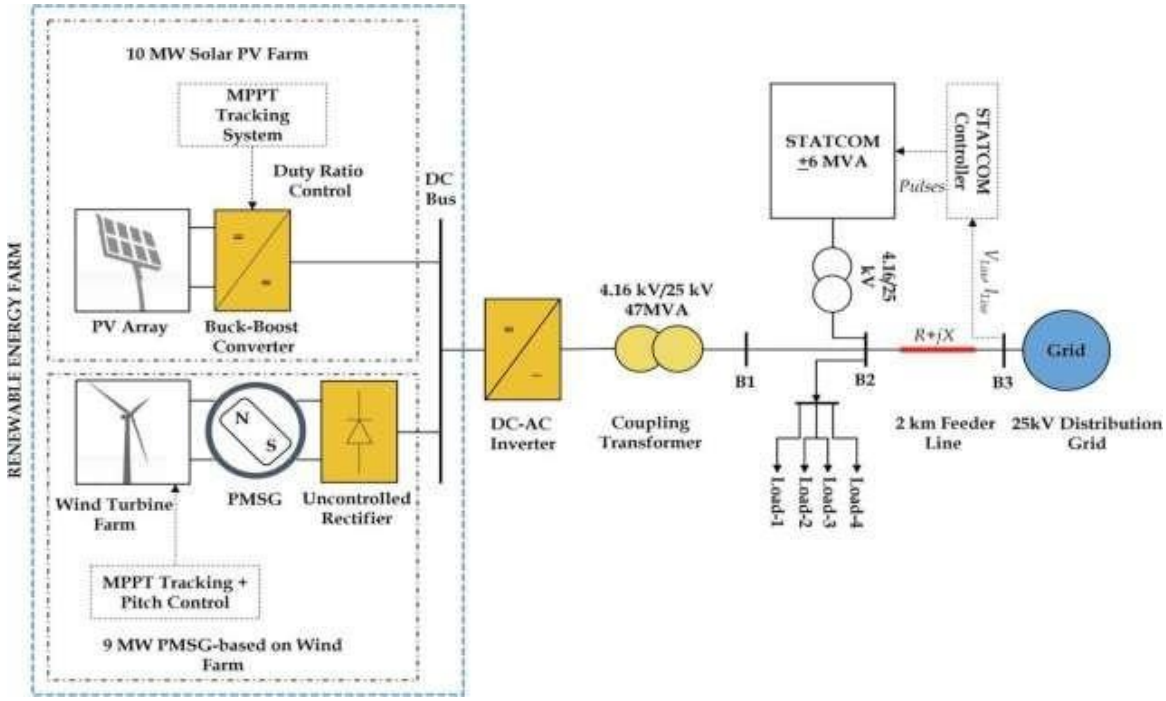

Fig. 1. Configuration of the PV-Wind hybrid renewable energy system interconnected with a distribution grid compensated using STATCOM.

The utilities are burdened with the escalating pace in demand for electricity. the facility supply from mere conventional sources is unable to cater to modern power demand and thus raising the difficulty of power reliability and security while the large number of pollutants pose serious environmental issues [1,2]. In last 20 years, renewable and distributed energy sources have emerged as a supplement to standard energy sources and are foreseen by utility engineers as a potent solution in fulfillment of load demand in successfully overcoming the facility issues [3,4]. Hybrid Renewable Energy Systems (HRES) based Distributed Generation (DG) is that the recent trend within the renewable energy system because it has shown to enhance the general performance and reliability [5]. Numerous opportunities are suggesting for effectively exploiting several renewable energy sources for electricity generation [6]. Among all the trending renewable energy resources, wind and solar power sources combined together are used efficiently in diverse hybrid systems. Recently, Solar PV-Wind hybrid systems received significant attention from the utilities worldwide [7,8] Wind and solar power systems complement one another during each day cycle. solar power, having a possible of even providing as high as fourfold the entire global energy demand during a certain region of North Africa [9], is present throughout the day while strong winds mostly occur during nocturnal period. Usually, strong winds are observed within the course of the already dark also as cloudy days in contrast to weak winds occur during bright days [10]. regardless of their intermittent behavior and inherent drawbacks, Wind-PV hybrid energy systems are wont to supply energy to load with greater reliability and continuity of supply [11,12]. Despite having the ability to provide power with improved continuity and reliability, the volatile nature of such intermittent energy sources which directly affects the critical stability between th e renewable energy sources' power supply and therefore the connected load [13]. As a consequence, deviations in bus voltage and system frequency, oscillations within the system, and unnecessary reactive power generation are observed successively affecting the system's stability and power quality [14]. With the arrival of power electronics technology and associated Flexible A.C. transmission (FACTS) devices [15], the devices find its potential applications in such Renewable Energy Sources (RES) in mitigating power quality issues arising from their i ntegration. Numerous devices available are being utilized and researched, providing satisfactory results [16].

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Out of several devices, SVC and STATCOM are reportedly best suited for reactive power compensation and voltage maintenance sup- port [24]. SVCs are able to successfully improve power quality issues in isolated hybrid systems [25,26] based on reactive power control. However, STATCOM, being a VSC based device exhibits better perfor- mance compared to SVC, considering the identical range and ratings [27,28]. Mohanty et al. [29] presented the benefits of Genetic Algo- rithm (GA) and Particle Swarm Optimization (PSO) optimized STATCOM implementation in an off-shore wind-diesel-tidal turbine hybrid system. The hybrid system was established by adopting the small signal model. Simulation results verified reactive power compensation is accomplished by the integration of the STATCOM controller. Shanthi et al. [30], demonstrated an efficient power transfer structure for hy- brid Wind-PV, made possible with a minimum number of converters, where grid side converter for WEC is utilized as STATCOM for improving grid dynamics. Mohanty et al. [31] have defined various issues associated with poor transient stability in an autonomous Wind/ Diesel/PV hybrid system and presented the effect of UPFC, SVC and STATCOM in suppressing the hybrid system dynamics. The detailed comparison revealed that STATCOM possessed superior characteristics over conventional PI controller-based SVC. The simulation study carried out by Bhatti et al. [32] investigated the effect of STATCOM to regulate bus voltage in an autonomous Wind-Diesel hybrid, by compensating reactive power demand of IG and variable load, thereby maintaining system stability when a step change is carried out in reactive load and wind speed.

Solar PV MPPT control technique

To facilitate maximum power from a PV system, an influence electronic DC transformer is required to take care of the bus voltage at the output to such a group point where maximum power are often observed. This voltage regulator is nothing but an MPPT controller introduced between the PV system and cargo. A buck-boost power converter as presented in Fig. 4(a) is one among the frequently used MPPT topologies. A voltage sensor is employed alongside to get switching pulses based on variable duty ratio control at a continuing carrier frequency so on maintain fixed periodic pulses, as shown in Fig. 4(b Reference volt age Vo(reference) may be a significant signal needed to be estimated using one among the various MPPT control techniques available so far [40]. a continuing voltage method [41] is reported to be the most convenient to use. Though this system demonstrates limited accuracy compared to other advanced techniques, it's still preferred where speed and simple calculations are priorities. this system is fast due to the very fact that reference voltage value is quickly calculated by setting the ratio of maximum point voltage to open circuit voltage (Vamp/Voc) within the range from 0.72 to 0.78 for various insolation as given in (2). This ratio holds true for many of the PV cells commercially available when constant or lethargic temperature variations occur. Thus, the perfect choice for this work since the temperature is kept constant at 25 °C.

Vo (reference) =0.72 × Voc

Comparison of this signal with output voltage signal Vo(sensed) and generation of switching signals are administered by conventional PI controller (with gains set to kP = 1 and kI = 5), controlling the output voltage at around Vmpp. Wind turbine farm wind farms have some installed turbines to provide a single purpose to collect the energy related to blowing winds and convert it into a usable sort of energy, i.e. electricity through electrical generators. The mechanical power Pw produced by a wind turbine may be a function of air density ρ(kg/m3), the radius of blade R (m), wind speed Vw (m/s) and power coefficient CP which may be a function of tip speed ratio λ and therefore the pitch angle of blade β (degrees). Mechanical power generated as a result of interaction between blowing winds and wind turbine are often defined by the subsequent mathematical equation.

Future work

In this paper the detailed modelling, computer simulation and comprehensive performance analysis of Wind Photovoltaic hybrid energy system inter-connected to the grid via power-electronic interfacing. To obtain a more practical scenario, variable AC load is employed in the system along with intermittent power sources of solar PV and WEC system in an attempt to introduce severe dynamics into the hybrid system. This essentially drives a necessity for a source of variable reactive power so as to maintain a voltage profile at the load bus. In these circumstances, STATCOM is envisaged to be

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a choice of the device as the same has been verified to improve the voltage regulation in isolated hybrid systems as suggested by several studies.

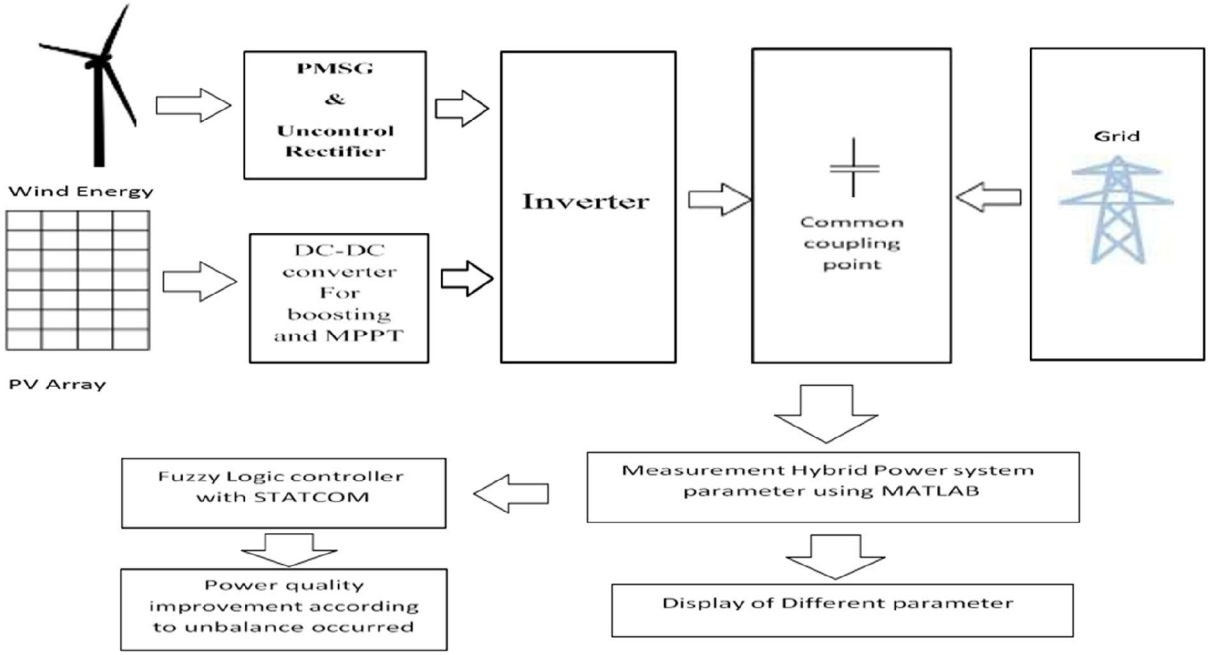

Fig.2 proposed block diagram

II. CONCLUSION

This paper explored the potential influence of STATCOM in associate surroundings of Grid-Tied Hybrid star PV-Wind system in presence of variable loading conditions. three wholly totally different case eventualities were developed to assess the effectiveness of the STATCOM to strengthen the voltage regulation and then, the responsibility of such systems. The effectiveness of every case state of affairs is evaluated grounded on dynamic put together as transient responses. mensuration is additionally performed for transient responses obtained for every case. Results obtained showed that the voltage profile is successfully maintained in presence of STATCOM, that effectively counters the presence of additional reactive power flow on the road and suppress its undesirable effects. Therefore, STATCOM is proved to be a necessity merely simply just in case the hybrid system is functioning in grid integrated mode to any elevate the system performance. Therefore, a conclusion area unit sometimes drawn from the simulation results obtained that the STATCOM possesses the power to stabilize the voltage at the connecting bus by compensating reactive power and can give a surprising answer to the utilities for the event of performance and responsibility of those systems. This work thought of only linear lots, either strictly resistive or inductive in nature, for easy simulation. However, these lots seldom exist in power systems. wise lots mostly embrace non-linear and inductive motor lots, adding any system disturbances in terms of current unbalance and harmonic injections. In future, this work might even be extended by implementing such wise lots in grid- integrated hybrid RES surroundings to review their effects on the system dynamics and explore the potential varied numerous of assorted} of various FACTS controller to accomplish various functions against harmonics and unbalance in system current.

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