Study on Power quality Improvement of Mirco-Grid Power in Photovoltaic Solar System

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Abstract— A micro-grid approach plays an enormous role in the increased penetration of renewable energy resource into grid thus reducing the emissions due to large coal fired power plants. The energy management in micro-grid is a challenging task as a major share of the generation is from Renewable Energy Sources. Usually, there are Power electronic interfaces through which the local generators are connected to the micro-grid which enables the control capabilities such as generation-demand management through active reactive power control, synchronization of the inverter to grid, meeting the power quality standards for the injected currents, maximum power point tracking etc. The active-reactive power delivered by the inverter is controlled by current control with the objective of the steady state and transient state performance requirements.

Keywords: - PV Array, Wind Power, Micro-grid

I. INTRODUCTION

A well-known fact is that, in micro grids several renewable energy sources and conventional energy sources operate together. The switching in and switching out of any distributed generator will cause variation in the structure and model of the micro-grid at any point of time during the operation. So, it becomes necessary to ensure that the control structure and its action should be independent of the system and the operating conditions. From the discussions above, it is clear that intense testing of micro-grids in both the component level and configuration level is very important in the aspect of investigation and demonstration of the adequacy of the design. The testing is to be carried out both under steady state conditions and during transient conditions. To simulate various network configurations under specific input-output conditions, real-time simulators i.e. emulators are vital. Emulators give the flexibility of obtaining different energy flows, creating fault conditions, creating transient conditions help understanding the electricity distribution networks meticulously. For example, micro-grids working under islanded mode, the dynamics are very fast as there are no significant time constants present within the network. The unpredictability of supply and demand is very common under islanded condition, which puts the stability and efficiency of the network under threat and test. Most of the generators are nature driven, and so for consistent performance of the interfacing power converters and the control loops, the experiments need to be repeated for every load/grid condition at every possible input condition. With an actual renewable energy source, it is not practical to repeatedly set the steady state and transient ambient conditions at all ambient values as required. Thus, emulators representing any renewable energy source are primarily intended as a power source to the converters in experiments to verify the 18 reliability and repeatability of operation of the converter in steady state as well as in transient conditions of all possible input/grid conditions. Such a hardware simulator has to produce outputs effectively as will be given by a renewable energy source at any operating condition. Besides the renewable source emulator, the system emulators are also very much crucial in the development of fail-safe micro-grids. System emulators will have the network parameters for the actual spread length corresponding to micro-grids represented by lumped circuit parameters, thus allows the testing of various generators operating on it in a synchronized manner under various conditions. By the use of these emulators the smart grid system designers will get the response from low cost, safe, and easily configurable simulators and emulators instead of waiting for expensive and hardwired deployments for their testing. This will make the micro-grids to be operator-centered and operator-friendly.

II. LITERATURE REVIEW

Waseem Sultana et al. [1], a quick developing of occupants giving power to the humankind is prime face for electrical designing. Execution of ages mounting really fast generally which makes power go about as a spine to maintain any business. A Contemporary origination of utilizing sunlight based PV board inverter as STATCOM, named as PV-STATCOM, in interconnected transmission framework to work on the constraints of stable power move. To further develop stable power transmission limitations, the unblemished inverter assessment of sun based PV ranch which remains aestivating in the long periods of murkiness is sent with voltage. The above objective is achieved for use of the inverter limit in day time which is abandoned the creation of genuine power. In the constantly even while creating enormous amounts of genuine power, improvement is finished by PV-STATCOM under which transmission limits are steady. Assuming there is no hang happens in the transmission line. It tends to be acted in both voltage droop and swell state of activities.

Shriya U et al. [2], environmentally friendly power asset plays a significant job because of expanding energy guarantee.

Power age by PV innovation is one of the quickest developing environmentally friendly power sources because of its spotless, conservative and maintainable property. Framework coordinated PV frameworks assumes a significant part in power age area. As the energy request is expanding day by day, the power move capacity of transmission line is expanding which leads different issues like strength, increment in issue current, blockage and so on. To defeat the issue, we can utilize either FACTS gadget or battery stockpiling or develop extra lines which is practical. This paper manages network associated PV framework, what capabilities as PV-STATCOM. Voltage and damping control are utilized to raise the power move limit and to accomplish managed voltage inside the limits at the reason behind normal coupling (PCC). The examinations are performed on SMIB and the reenactment is done in MATLAB/SIMULINK climate.

The topology suggested in (**AbderezakLashab et al. [3]**) comprises of a combination of three-level (3L) active neutral-point-clamped inverter and floating capacitor connected parallel to the legs of H-bridge. Two switches operated at fundamental frequency are connected across the DC link structure and enhances the topology performance by a two-fold increase in RMS value. Through logical mapping, the switches are turned on /off by deriving the pulses through voltage balancing scheme and the scheme balances the floating capacitor voltage regardless of load angle.

Cascading five-level diode clamped MLI with seven level or 9 level conventional Cascaded H Bridge (CHB) Multilevel Inverters (MLI) results in hybrid topology (**A. Lashab et al., [4]**) for generating 11-level / 13-level respectively. The conventional MLI has a case to case merits and demerits. In the presented topology, the demerits of the conventional topology are minimized by cascading two different conventional topologies. The MLI switches at the fundamental frequency and the operation is shown for a particular modulation index and variable load angle. Capacitor balancing is attained between the charging cycle and the recharging cycle.

A new symmetric structure for cascade multilevel converter is developed in (**Q. Huang et al., [5]**) which is composed of several series-connected switched capacitor diode units and an H-Bridge inverter for polarity reversal. A fewer number of device count is required for configuring the topology. Besides, optimal structures derived from the topology projects the merits by maximizing the number of levels with different objectives such as a minimum number of switch count and sources. The simulation and experimental results added to show the performance of the implemented method and the results are compared with other structures.

MLI structure using a cascade connection of sub multilevel inverter by (**M. Abarzadeh et al., [6]**), the sub-MLI consists of a switched-capacitor converter circuit with inherent boosting and capacitor self-balancing through a series-parallel connection operated in asymmetric mode. The main advantage of the topology is low voltage stress, because the H bridge is not used and the other merit is providing a conduction path for the inductive load reverse current. The topology is validated by simulation and by experiment.

A. Lashabet et al. [7], in this work, the near-state pulse width modulation (NSPWM), adjusted to be utilized as a part of dual-voltage source inverter (VSI) fed open-end load, is acquainted essentially pointing with obviously limit the voltage add up to harmonic distortion (THD). Inside the framework of the strategy, the active time of pulses at the second inverter is moderately balanced inside switching interim (contrasted with the principal VSI). The phase voltage harmonics are detailed for dual-inverter regulated by NSPWM; at that point, ideal change is distinguished by means of a three-dimensional bend of phase voltage THD versus modulation file (MI) and phase edge displacement (PAD). Because of the restriction of MI in NSPWM, the coveted yield voltage is orchestrated with altering MI as well as PAD between references of two VSIs. Moreover, NSPWM naturally exploits better productivity contrasted with traditional space vector modulation because of switching just two phases inside an interim (by clipping one phase to positive/negative dc-rail). The dual-VSI provided by two isolated dc sources is amassed in the lab to tentatively assess the THD diminishment highlight of the implemented technique; additionally, the simulation comes about acquired by methods for a MATLAB/Simulink condition indicate close concurrence with exploratory information.

From a single DC source, step-up voltage with twice the value is obtained in the Switched Capacitor Cell (SCC) developed by (**C. Wang et al., [8]**) with the help of capacitor self-balance by activating the corresponding switches in the charging mode and discharging mode. The SCC has six switches, two diodes and one DC source and two capacitors. When compared with CHBMLI, the total component count is reduced. The essential cells are cascaded to get asymmetric MLI and from the 25 level prototype, the analysis is validated.

Y. P. Siwakoti et al. [9], in this investigation, the near-state pulsewidth modulation (NSPWM), adjusted to be actualized in dual-voltage-source inverter (VSI) fed open-end engine, is implemented with the point of relieving low-arrange harmonics (which prompt current aggregate harmonic distortion (THD) minimization). The accompanying two developed techniques are examined in detail: 1) settling phase edge displacement (PAD) between two VSIs to 120° while altering the modulation record (MI); and 2) settling MI to the foreordained esteem (wherein low-arrange harmonics are profoundly relieved) while modifying PAD.

A. K. Yadav et al. [10], besides, the approaches improve effectiveness by restricting the quantity of replacements inside the switching interim. The examination likewise displays the numerical approaches to accurately decide low-arrange

harmonic segments and switching losses for dual-VSI structure. The exploratory setup, including dual-VSI and open-end induction engine, is collected in the lab to assess execution of the implemented technique. At long last, the simulations comes about, completed in the MATLAB/Simulink condition, are observed to be in close concurrence with exploratory information.

III. MICROGRID STRUCTURE

Microgrid sun powered PV and wind age framework become exceptionally alluring arrangement specifically for independent applications. Joining the two wellsprings of sun powered and wind can give better unwavering quality and their half and half framework turns out to be more affordable to run since the shortcoming of one framework can be supplemented by the strength of the other one. The mix of half breed sun based and wind power frameworks into the lattice can additionally help in working on the general economy and dependability of sustainable power age to supply its heap. Essentially, the joining of half and half sun based and wind power in an independent framework can decrease the size of energy stockpiling expected to supply consistent power. Sunlight based power age frameworks use either photovoltaics or concentrated sun powered power. The concentration in this paper will be on the photovoltaics type. Nitty gritty depictions of the various advancements, material science and rudiments of PV can be found in numerous course books and papers, for example, [4-7]. Kurtz [8] brought up that decade prior the concentrator cell was just ~30% proficient contrasted and over 40% today with the possibility to move toward half before long. Si cells have efficiencies of 26% and multi-intersection III-V-compound cells have efficiencies above 45% (48% in the research facility) as brought up in reference [9]. PV modules produce yields that are resolved fundamentally by the degree of episode radiation. As the light force builds, photocurrent will be expanded and the open-circuit voltage will be diminished [10]. The proficiency of any photovoltaic cell diminishes with the rising temperature which is non-consistently dispersed across the cell [11]. The sunlight based yield power can be smoothed by the conveyance of sun oriented power in various geological regions [12]. Power from sunlight based PV and concentrated sun powered power plants is altogether costly and requires critical drop in cost or change in arrangements by either financing or driving the utilization of these advancements to have the option to accomplish huge market entrance [13]. Worldwide breeze report (2012) demonstrated that the yearly market became by around 10% to stretch around 45 GW and the aggregate market development was practically 19% [14]. Point by point depictions of the breeze energy can be found in references [4] and [15]. Wind turbines (WTs) are grouped into two kinds: flat hub WT (HAWT) and vertical-hub WT (VAWT). The most noteworthy reachable extraction of force by a WT is 59% of the all out hypothetical breeze power [15]. Mixture sun oriented breeze frameworks can be arranged into two sorts: network associated and independent. Writing surveys for crossover lattice associated and independent sun based PV and wind energies were directed overall by numerous scientists who have introduced different difficulties and proposed a few potential arrangements. Because of the idea of cross breed sunlight based PV and wind energies, streamlining strategies can assume a decent part in using them effectively. Realistic development strategies [16], direct programming [17-18], and probabilistic methodology [19] are not many instances of improvement procedures that have been created for techno-financially ideal mixture sustainable power framework for the two sorts. Luna-Rubio et al. [20] led a survey of existing exploration of ideal measuring of inexhaustible half and halves energy frameworks with energy capacity parts for both independent and network associated frameworks. The creators gave brief portrayals about those markers and the different estimating strategies. A survey of control methodologies for a cross breed environmentally friendly power framework was completed in [21] and one more survey was finished in [22] for enhancement of half and half sustainable power framework with more spotlight on wind and sun based PV frameworks. The surveys in [21] and [22] are pertinent for the two kinds; framework associated and independent frameworks.

IV. CONTROL OF MICROGRID

The control strategies for microgrid depend on the mode of its operation. The aim of control technique should be to stabilize the operation of microgrid. When designing a controller, operation mode of MG plays a vital role. Therefore, after modelling the key aspect of the microgrid is control.

1. Control of Grid Connected

In grid connected mode, microgrid acts as a controllable load/source. It should not actively regulate the voltage at the point of common coupling (PCC). Its main function is to satisfy its load requirements with good citizen behavior towards main grid. The balance between generation and demand, control of the parameters of the system is taken care by the utility grid. The voltage and frequency reference of the microgrid is also set by the main grid. Therefore the main task of a DG unit is to control the output real power (P) and reactive power (Q).

2. Control Islanded Microgrid

In islanded mode, the reactive power sharing is highly dependent on impedance of power line. Due to the different distances among DERs interface converters (DICs), the equivalent transmission line impedance could be unequal [51]. *Pf* and *QV* droop characteristics are used in DER interface converters for power sharing operations. The *Pf* droop control provides an accurate real power sharing among the DIC's but the problem arises in *QV* droop control. Because of this unequal impedance load sharing performance of *QV* control can be affected.

V. GRID CONNECTED SYSTEM

The mix of joined sunlight based and wind power frameworks into the lattice can help in decreasing the general expense and

further developing unwavering quality of sustainable power age to supply its heap. The matrix takes overabundance inexhaustible power from sustainable power site and supplies capacity to the site' loads when required. Fig. 1 and Fig. 2 show the normal DC and normal AC transport matrix associated with sun powered PV and wind half and half framework, individually.

Power electronics topologies and control

There are two geographies for network associated sun based PV and wind crossover framework as should be visible from Fig. 1 and Fig. 2. Fig. 1 shows that the DC results' voltages from individual sun based PV, wind and battery bank stream, through individual DC/DC and AC/DC units, are coordinated on the DC side and go through one normal DC/AC inverter which goes about as a connection point between the power sources and the lattice to furnish the ideal power even with just a single source accessible. Subsequently, the environmentally friendly power sources go about as current sources and can trade power with the matrix and the normal DC/AC inverter controls the DC transport voltage. The singular units can be utilized for most extreme power point following (MPPT) frameworks to have the greatest power from the sun based PV and wind frameworks and the normal DC/AC inverter will control the DC transport voltage.

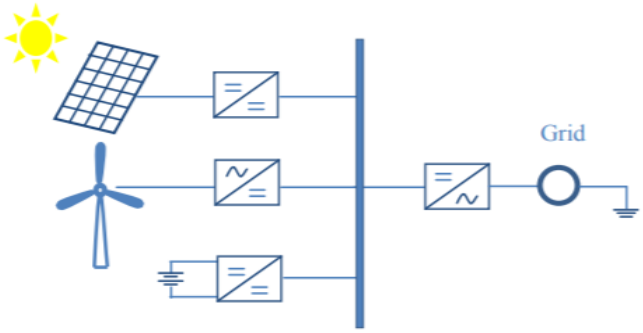

Figure 1: Grid-connected hybrid system at common DC bus

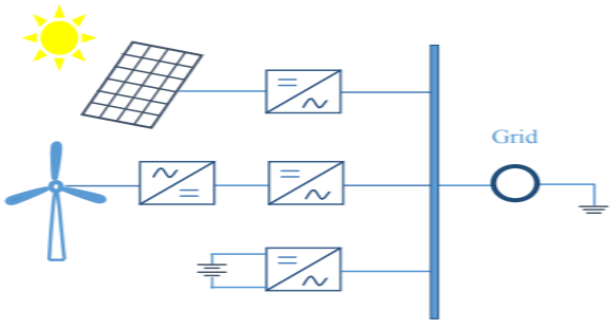

Figure 2: Grid-connected hybrid system at common AC bus

The battery bank is charged when there is an extra power and discharged (by supplying power) when there is shortage of power from the renewable energy sources. On the other hand, Fig. 2 shows that renewable energy sources are injecting power directly to the grid through individual DC/AC and AC/DC-DC/AC units.

Power quality

The expanded entrance of framework associated sustainable power sources affects the matrix power quality specifically frail networks. Voltage change, recurrence variance and sounds are significant power quality issues. Besides, irregular energy from sun based PV and wind colossally affects network dependability. Nonetheless, exact anticipating and planning frameworks can limit the effects. Different factual anticipating and relapse investigation approaches and calculations are utilized to estimate atmospheric condition, sunlight based radiation and wind speed [12-13]. Framework administrator can change other dispatch capable age somewhere else in a framework to manage any deficiency or excess power from sustainable power age [14]. This will diminish the effect of the variances from the age of the sustainable power sources. Furthermore, the conveyances of RES to bigger geological region in little units rather than huge unit moving in one region have some control over the irregularity impact of force age from RES [15]. Energy capacity gadgets like batteries or Uninterruptable Power Supply (UPS) can function as an adjusting devises that give power when there is a lack of energy in sustainable age and store overabundance energy when there is excess power from sustainable age [16-17]. Dynamic power channels, for example, dynamic voltage controllers, static simultaneous compensators and bound together power quality conditioners can be utilized to determine voltage variance [18], [19]. Likewise, power compensators, for example, fixed or exchanged capacitor can be utilized to determine receptive power issue [20]. They are the most recent connecting gadgets among networks and purchaser apparatuses. Unexpected changes in dynamic power drawn by a heap could cause framework recurrence variance in AC matrices. These progressions address unbalance circumstances among burden and age. Considering the abovementioned, it is critical to configuration control circles for power and recurrence control to relieve quality issues [21].Bae and Kwasinski highlighted that a primary goal of a pulse width modulation (PWM) inverter controller was to regulate three-phase local AC bus voltage and frequency in a microgrid. Harmonics are normally caused by power electronics devices and non-linear appliances. Appropriate filters and PWM switching converter can be used to mitigate harmonic’s distortion.

VI. CONCLUSION

This paper has provided a review of challenges and opportunities on integrating solar PV and wind energy sources for electricity generation. The main challenge for grid-connected system as well as the stand-alone system is the intermittent nature of solar PV and wind sources. By integrating the two resources into an optimum combination, the impact of the variable nature of solar and wind resources can be partially resolved and the overall system becomes more reliable and economical to run. This definitely has bigger impact on the stand-alone generation. Integration of renewable energy generation with battery storage and diesel generator back-up systems is becoming a cost-effective solution for

stand-alone type. The wind-battery-diesel hybrid configuration can meet the system load including peak times. Energy management strategies should ensure high system efficiency along with high reliability and least cost. Good planning with accurate forecasting of weather pattern, solar radiation and wind speed can help in reducing the impact of intermittent energy.

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