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A REVIEW OF WIND-SOLAR DUAL MODE OPERATION WITH AN INTEGRATED POWER STORAGE BASED UTILITY GRID

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Abstract - The integrated operating of the micro grid with assistance from the utility grid provides both the electricity of the rural settlement and uninterrupted power availability. Utilizing renewable energy sources, such as wind power and solar photovoltaic (PV) arrays, helps to sustain the grid and lowers electricity costs. In this study, a dual mode transferring technique is used, which allows the control to switch from the present control mode to an independent functioning mode in the event of an electrical blackout or grid failure. The signal sent to the static switchboard (STS) determines when the operational modes begin. Reduced renewable interruption of the photovoltaic (PV) array and wind output is one of the major benefits of the grid connection and energy storage supplied to the microgrid. Controlling local load support helps to ensure energy security and sufficiency, as well as an improvement in power quality (PQ).The usefulness of electric automobiles in multiple electrical parts is examined in this essay, along with the benefits and downsides of implementing them as a prudent first step towards a sustainable, environmentally friendly, and efficient system.

Index Terms: EV battery, phase-locked loop detector (PLL) with PID control, buck converters with PI control, MPPT controller, PFC rectifier, and solar panel.

I. INTRODUCTION

Over time, there have been changes in the sources and methods of producing energy. Energy generation from green energy resources (RESs) has received the highest praise of all current technologies and strategies since it produces clean power and emits no carbon. In rural locations without connection to the grid or an AC distribution network, RESs save electricity costs, increase power reliability and resilience, and give access to electricity. These so-called "micro grid" systems ought to be able to function both independently and in grid-connected modes. Another issue that requires consideration is the concern that renewable energy sources like solar and wind PV arrays raise about their unreliability and erratic behaviour when in use. It becomes challenging to forecast the micro grid's smooth and dependable operation. Battery-powered energy storage (BES) is used to meet load requirements and account for fluctuating power output. When used as a subordinate to offset power fluctuations, BES works particularly well for isolated micro grids. In either charging or discharging mode, it functions like a load or generator. By providing power to the essential loads when the grid is unavailable, continuous power supply is guaranteed. In times of disruption, it

provides power backup and greatly increases system stability and dependability.

When considering the advantages of RESs combined with BES, a micro grid's capacity may be fully utilised when it can operate in either a standalone or grid integrated mode. Micro grid reliability is ensured by the four flexible operating modes—grid integrated, standalone, effortless shift from grid to islanded, and seamless movement between islanded to grid integrated—that are offered. The power electronic interface that the renewable power producing units use to carry out these processes gives them flexibility in adjusting the voltage, output frequency, and reactive and active powers. Voltage-source converters (VSCs), which function as coupling elements in conjunction with their controllers, guarantee that the micro grid operates in a way that satisfies local load demands throughout all operating modes.

The low overload, quick acting time, and low inertia capabilities are offered by the VSCs. Still, a lot of power synchronisation affects policy makers. Over the past ten years, a number of studies have been conducted on the micro grid's mode transfer control. To provide a smooth transition from grid isolated form to grid integrated mode for micro grid operations, the load voltage must coincide with the utilities before association. Phase locking loops (PLLs) monitor the phase difference between the load and utility grid voltages to provide synchronisation control. PLLs guarantee dependable operation under balanced grid circumstances. However, under conditions of distorted or imbalanced grid voltages, their performance becomes unreliable. Therefore, enhanced PLLs are another area of continuing investigations. Have offered the VSC controls for both standalone and grid-connected modes of operation. Nevertheless, instability in load current and voltage levels as well as spikes have been noted in the system performance during mode transition. The use of an indirect current technique has resulted in a smooth transition and detailed control. The phase angle is tracked slowly during the synchronisation and resynchronization process, which takes about 18 cycles. Reliable grid synchronisation control has been made available with slow transfer process tracking and minimal current and voltage spikes. The majority of research done to date does not take the IEEE-519 standard's power quality indexes into account while synchronising.

In this study, the authors have taken into account a single-stage solar PV array, a synchronous generator (SG) that operates at a variable wind speed, and a battery energy system (BES) that is deployed at the DC link through an unidirectional buck-boost DC-DC (BDC) converter. Better oversight of the charging and draining of the battery is offered by the BES integrated BDC converter. This setup offers lower battery capacity and longer battery life as compared to a battery connected directly to the DC link. The BDC protects the BES from disturbances in the DC link that are dominated by the second harmonic. A solar PV array with just a single stage layout uses fewer modules than one with a two-stage arrangement. However, because of the system's smaller size, lower cost, lower complexity, and fewer losses, it offers a wide working range. Plot and observe (P&O) approach is used for wind and solar PV array maximum electrical power (MPP) extraction.

II. LITERATURE SURVEY

Clean and green energy is in high demand due to an environmentally conscious lifestyle, environmental concern, and depletion of fossil fuel reserves. The micro grid (MG) is an essential strategy for clean and renewable energy. It is quite easy to provide AC/DC MG that will easily meet both the demands of alternating current (AC) MG and direct current (DC) MG requirements, given the success that is the AC utility grid and the increasing demand for essential loads. The synchronization and interconnection of various power converters are the most important factors in the regulation of AC/DC MG because of the unpredictability of load variations, main grid breakdowns, and intermittent power supply from renewable energy sources (RESs). An overview of the most recent developments in AC/DC MG control techniques and the related power converter control is provided in this study. This study summarizes open perspectives on various topologies, power converter types, power converter controls, and control methodologies of AC/DC MG based on recent research. Lastly, it pointed up a few issues that will need to be resolved in the future to create an AC/DC MG management method that is dependable and long-lasting. Scholars in [1] will use this paper as a reference.

Recently, there has been a lot of focus on the stability analysis of power electronics-based power systems in owner systems, particularly in three-phase voltage source converters (VSCs). In order to do this, various impedance models have been created for three-phase VSCs in recent years, including the dq-domain, sequence domain, and phasor-domain impedance models. All of these impedance models share the tendency of taking into account a standard synchronous reference frame PLL (SRFPLL) for the synchronization of the VSC with the power grid. Despite this, none of these models have any discernible practical benefit over the others [2]. However, due to its low filtering capacity, the typical SRF-PLL may not be very useful in the majority of applications. A large variety of sophisticated three-phase PLLs have been proposed in the literature to address this SRF-PLL problem.

Inverters for distributed generation (DG) have two modes of operation: islanded and grid-connected. These DG inverters frequently create a micro grid when they run in the islanded mode. The main grid voltage's phase and magnitude differ from the micro grid voltage [3]. Under such circumstances, connecting the micro grid to the main grid causes a strong transient overcurrent that is detrimental to the system. A novel, user-friendly, and efficient resynchronization mechanism for universal droop control (UDC) distributed generation inverters is presented in this study in order to facilitate a smooth transition from the islanded mode of operation to the grid-connected mode.

Lithium-ion batteries are becoming more significant for a range of applications as a result of their improved features and declining cost. Such storage devices need to be used with an energy managing algorithm (EMA) in order to function properly. With the wide range of battery issues, several EMAs with different features have been released lately. Typically, an optimization technique serves as the foundation for the EMA of unpredictable battery issues. The choice of such an algorithm is contingent upon a few problem attributes that must be determined and thoroughly examined. Finding the crucial optimization issue parameters that establish the best EMA for a battery made of lithium-ion is the goal of this research. A comprehensive model of the lithium-ion battery serves as the foundation for this endeavor [4]. To maximize the electrical power dispatch of such a battery, three EMAs—dynamic, linear, and quadratic programming—are developed based on algorithms used to solve deterministic issues. For several case studies, the outcomes from these EMAs are compared using actual irradiation and electricity price data.

To make the electricity of an off-grid community feasible, energy sources that are renewable (RESs) must be fully utilized. Because solar and wind are complementary resources, integrating them allows for self-sufficiency in electricity. By employing a battery for storage, the intermittent problems brought up by RESs are resolved. Because the battery reacts more quickly than diesel generators and micro-turbines, it lessens uncertainty during surges in demand, power outages, and overloads. This work focuses on how solar photovoltaic (PV), wind energy, and battery energy storage (BES) may work together to meet high power residential loads at the village level. Evolution based biogeography based optimization control (BBO) based proportional integral (PI) controller replaces the conventional PI controller for the necessary speed management of a wind turbine driven generator. The application of a BBO tuned speed controller, which provides tuning of the weighting components, addresses the pertinent difficulties found by using a fixed gain PI controller, such as inappropriate regulation resulting from improper tuning [5].

The drop in AC voltage and frequency is caused by the sudden commencement of an IM (Induction Motor) load and the frequent changes of a nonlinear load in a freestanding DGS (Distributed Generation System). These loads also cause DGS currents to be distorted. Thus, for voltage and frequency regulation as well as power quality improvement in DGS, an I-RZA-LMS (Improved-Reweighted Zero-Attracting Quaternion Valued Least Mean Squared) algorithm based VSC (Voltage Source Converter) management is proposed in this study. Additionally, at IM beginning and nonlinear loading, the solar PV array's MPPT and DC-link voltage regulation are achieved by the employment of the DC-DC bidirectional converter (BDC) control method. Reactive power compensation, PCC (Point of Common Coupling) regulate voltage, and effective harmonics suppression are achieved in this DGS by estimating the active and reactive constituent currents of deformed load currents using an I-RZA-

LMS based management algorithm [6].Even in the event of a utility interruption, the local critical load should always get power from the distributed generation (DG). Additionally, a lot of work has gone into getting the DG's three-phase inverter to smoothly switch between the grid-tied and islanding modes [7].

For the three-phase inverter used in the DG, this study suggests a transfer method based on indirectly current control. It is primarily made up of two cascaded loops of feedback in synchronous reference frame: the external grid current loop and the capacitor voltage loop. In overall grid-tied mode, the voltage of the capacitor is used to control the grid current. The limiter fixes the voltage loop's reference when islanding occurs. Since the proposed technique places the local load in parallel to the filter capacitor, the load voltage is always directly regulated by the capacitor's voltage loop, ensuring the load voltage's quality. Additionally, adding an inner capacitance current loop enhances the efficiency of the voltage capacitor loop even more.

Because of their inherent advantages, renewable energy (RE) sources—particularly wind and solar—are becoming more and more popular. As a result, countries have set high standards to increase the share of RE in their energy mix. But renewable energy sources—particularly wind and solar power—are sporadic, erratic, and unpredictable. As a result, it's important to make the most of their availability. Furthermore, battery energy storage systems have a great deal of promise to help integrate renewable energy sources into the power grid. In light of the hourly wind power potential, this study looks into the amounts of energy storage from batteries needed to run both a stand-alone and grid-connected micro grid for a whole year. Three operational scenarios were taken into consideration in this study, and the optimal BESS size was recommended based on operating costs. Whereas Scenario 3 is a stand-alone micro grid supported by diesel generators, the scenarios 1 and 2 are net-connected configurations [8].

The ideal operation cost for the micro grids serves as the foundation for the formulation of the optimization issue in each scenario. Scenarios 1 and 2 detail the power drawn from the main grid, whereas Scenario 3 details the additional expenses related to maintaining diesel generators. The operational environmental impacts and costs between all three scenarios are analyzed and evaluated in this study. The nonlinear optimization method is used to tackle the given problems. Simulation results validated the study's efficacy. For the solar energy conversion system (SECS) to operate as optimally as possible while providing active electricity to the distribution network and acting as a distribution static compensator (DSTATCOM), a fuzzy logic based fourth order generalized integrator (FOGI) frequencies locked loop (FLL) control is used. With the ability to mitigate harmonics in a three-phase distribution system, load balance, and rectify power factor, the suggested SECS is multifunctional. When it comes to filtering, the FOGI-FLL is more capable than traditional algorithms. When compared to a traditional method, the suggested control technique's frequency tracking capabilities perform better. The effectiveness of FOGI-FLL and many traditional methods in terms of frequency tracking and harmonics filtering is compared [9].

Micro grids are becoming a crucial part of larger smart grid systems. They supply clean, dependable, and uninterrupted power to the loads and have the controls required to operate in islanded or network attached mode. For a micro grid to seamlessly transition from islanded state to grid linked mode, it needs to be outfitted with a strong grid synchronizations (GS) algorithm. When the electricity system is poor or has inconsistent availability, this becomes even more urgent. This study suggests a controller area network (CAN)-based GS approach that is straightforward but incredibly dependable [10].

The grid synchronizer block detects each of the three phase grid voltages, uses a synchronously rotating references frame-based phase lock loop to determine the phase angle (θ), and sends this information to all micro sources (MS) via the CAN network. The data is received with minor but known and certain latencies by the local controller connected to each MS. As a result, all of the MS can energies concurrently in time with the grid, making it easier to graph all of the MS and cutting down on the amount of time needed to graph the entire micro grid. It is now practically possible and financially advantageous to keep dispersed power generation units as emergency generators in isolated working modes, according to recent technological advancements in their control, protection, and connectivity. Therefore, more sophisticated controls

are needed to recognize the current working condition and modify performance in order to meet the stringent grid interconnection standards, along with the creation of islanding detection methods, and smooth operation in change within islanded and grid associated modes is required. This paper offers a new adaptive control structure based on within model control (IMC) that adjusts the functioning of the three-phase inverter under transitions within islanded and a grid tied conditions using multiple models and a built-in islanding detection approach through an optimized switching mechanism [11].

The system mimics the functioning of a synchronous machine, which does not require a loop that is phase-locked to synchronize during transitions, by utilizing a power synchronizations technique. The Xilinx System Generator and Simulink/PLECS hardware co-simulation environment have been used to assess the controller's transient behavior in the discretized domain and confirm its resilience to parameter changes and load switching scenarios. An examination of the effects of applying different switching rules on transient responsiveness is presented. The outcomes, derived from multiple case studies, validate the noteworthy resilience of the suggested control approach.

III. Conclusion

The following is a summary of the work's main conclusions.

• The main component of the load currents has been generated and harmonics have been efficiently minimised by the BC-IAPL adaptable filter when used in current management mode.

• It has been demonstrated that the MPR microcontroller with DMGI-PLL can follow the AC voltage signal adequately. During a grid outage, the voltage controller functions well.

• There have been no distortions or spikes during the smooth transition from the two different modes of operation to the from grid integration to grid separated and vice versa.

• The THD of grid current is conserved within the IEEE-519 standard, that is, below 5%.

This essay addresses the advantages and disadvantages and explains why using them can be a logical step towards a sustainable, eco-friendly, and effective system.

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