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Review on PV-Wind-Battery-Based Grid-Connected Bidirectional DC-DC Coupled Multi- Distribution Transformer

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Abstract- The objective of this synopsis is to provide a control scheme of a power flow management of a grid connected hybrid PV-wind-battery. The hybrid PV wind-battery system is connected to a multi-input transformer coupled bidirectional dc-dc converter and using a fuzzy controller. The power from the PV along with battery charging/discharging is controlled by a bidirectional buck-boost converter. The power from wind is controlled by a transformer coupled boost half-bridge converter. A single-phase full bridge bidirectional converter is used for feeding ac loads and interaction with grid. The proposed converter design has lessened number of power transformation stages with less segmentally, and diminished misfortunes contrasted with existing grid connected hybrid frameworks. In this proposed work analyzing the multi response of a grid connected hybrid PV-wind-battery in different cases. In the proposed system has two renewable power sources, load, grid and battery.

Index Terms- Hybrid PV-Wind-Battery, Bidirectional dc-dc converter, Fuzzy controller, Transformer coupled boost half-bridge converter, Bidirectional buck-boost converter.

I. INTRODUCTION

Fast consumption of fossil fuel reserves, regularly expanding energy demand and worries over environmental change persuade control age from renewable energy sources. Solar photovoltaic (PV) and wind have risen as well known energy sources due to their eco-accommodating nature and cost adequacy. Be that as it may, these sources are irregular in nature. Consequently, it is a test to supply steady and nonstop power utilizing these sources. This can be tended to by proficiently coordinating with energy stockpiling components. The intriguing corresponding conduct of solar insolation and wind speed design combined with the previously mentioned points of interest, has prompted the examination on their combination bringing about the hybrid PV-wind systems. This hybrid PV-wind system is connected along with a battery because of intermittent nature of wind and solar. In [1], S. A. Daniel and N. A. Gounden - they have been proposed, Dynamic performance of a stand-alone hybrid PV-wind system with battery storage is analyzed. In integrated converters for PV and wind energy systems are presented. PV-wind hybrid system, proposed by Daniel has a simple power topology but it is suitable for stand-alone applications. A unique standalone hybrid power generation system, fed by four power sources: wind power, solar power, storage battery, and diesel engine generator, and which is not connected to a commercial power system. It is anticipated that this hybrid power generation system, into which natural energy is incorporated, will contribute to global environmental protection on isolated islands and in rural locations without any dependence on commercial power systems.

A distribution transformer is a key component in the electrical power distribution system that reduces the high voltage of electricity transmitted over long distances to a lower voltage suitable for residential, commercial, or industrial use.

These transformers are found in various locations within the power distribution network, from substations to utility poles or even underground, facilitating the final step-down in voltage before electricity reaches end users.

Key Characteristics and Functions
Voltage Step-Down
The primary function of a distribution transformer is to step down the voltage from transmission levels (typically in the range of thousands of volts) to distribution levels (usually under 1000 volts for residential use and higher for commercial or industrial facilities). This makes the power safe and usable for everyday electrical devices and systems.

Efficiency
Distribution transformers are designed to have high efficiency, often above 95%, as they operate continuously, 24/7. They are typically sized to match the load demand as closely as possible to minimize losses and improve efficiency.

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II. EXISTING SYSTEMS

In [9], Y. M. Chen, C. Cheng, - they have been proposed, a grid connected hybrid PV-wind power generation system with improved DC bus voltage regulation strategy. However, despite simple topology the control scheme used is complex. To feed the dc loads, a low capacity multi-port converter for a hybrid system is presented. This system is mainly focused on improving the dc-link voltage regulation. In the sixarm converter topology proposed by H. C. Chiang [3], the outputs of a PV array and wind generators are fed to a boost converter to match the dc-bus voltage. The steady-state performance of a grid connected hybrid PV and wind system with battery storage is analyzed.

Advantages of Hybrid Wind Systems

Co-locating energy storage with a wind power plant allows the uncertain, time-varying electric power output from wind turbines to be smoothed out, enabling reliable, dispatchable energy for local loads to the local microgrid or the larger grid. In addition, adding storage to a wind plant can enable grid-forming or related ancillary grid services such as inertial support and frequency responses during transitions between grid-connected and islanded modes. A hybrid system can also increase revenue by storing rather than wasting energy that cannot be used because of system rating limits or the absence of loads. Additional benefits of hybrid energy systems can come from sharing components between other generation sources such as inverters and optimizing electrical system ratings and interconnection transformers. It is worth noting, however, that limiting the full system rating can result in a decrease in revenue. For example, the use of storage during periods of high wind energy output might be limited restricted because of a limit on the total power output of the combined system. For this reason, rigorous assessments—including hybrid system modeling, planning, and sizing of the components—are critical to maximize system benefits based on the application, expected load, and desired grid services. An assessment should also consider the specific grid and local weather conditions.

One of the most significant renewable energy sources that has seen growing attention in recent years is solar energy. When compared to other energy sources, solar energy is the most readily available and it is abundantin nature [1]. The sun provides the world with enough energy in a single day to meet all of its energy demands for an entire year. Since solar energy doesn't generate any pollutants or by-products that are damaging to the environment, it is clean and emission-free. Numerous areas can benefit from the conversion of solar energy into electrical energy. Solar thermal and sun photovoltaic systems may both convert solar energy into electrical energy. Solar photovoltaic systems employ silicon or specific semiconductor-based cells to turn light energy from incoming sunlight into direct current (DC) power [2]. Storage of the produced power into batteries is required to account for intermittent and night time use. Low-cost flat-panel solar panels, thin-film technology, concentrator systems, and many more cutting-edge ideas have all seen a rise in research and development recently [3]. The pricing of small solar power modular units and solar power plants will soon be within the reach of large-scale solar energy production and utilization. There are known dedicated converter setups for combining diverse sources. The design, analysis and creation of efficient control structures and power/energy management plans is the primary focus of the works that are covered in these article [4]. Having a separate converter for each source, however, makes the control structure more complex and results in lower utilization, greater costs, and worse efficiencies [5]. In order to integrate different sources, multi-input converter configurations that potentially handle the aforementioned problems are attracting a lot of interest [6]

III. HYBRID POWER SYSTEM (HPS)

Hybrid power system (HPS) are self-sufficient power creating frameworks that have more than one renewable sources, worked alongside related supporting gear (counting stockpiling) to supply capacity to the network or on location. Through this joining of different energy sources in a single supply framework, the innovation of hybridization gives a perfect opportunity to utilize locally available sustainable power hotspots for supply control in remote areas. Hybrid system in the main covers complete systems still as island grids of little and medium power ranges. Altogether cases, it contains two or a lot of power generation sources so as to balance every other's strengths and weaknesses. A hybrid system may contain AC (or DC) diesel generators, an AC (or DC) structure, loads, renewable power sources, energy storing blocks , control converters, rotating converters, coupled diesel frameworks, load management options or a supervisory control system. Examples of hybrid systems include:

- Wind turbines with battery storing and diesel support generators;
- Solid oxide cell combined with a turbine or micro turbine;
- Sterling engine combined with a solar dish;
- Engines (and diverse prime movers) joined with energy storing gadgets, similar to flywheels.

IV. LITERATURE REVIWE

P. Ramesh et al. [1] Electric vehicles (EVs) have emerged as cutting-edge technology in mainstream transportation. But, the accessibility of opportunities to charge the battery cells has become a contentious issue. Even though EVs are constituted a dynamic load, regulating available grid electricity or sustainable assisted electricity generation to recharge EVs incorporates a range of variables. This study

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represents the hierarchy of a DC microgrid, unit concepts and methods. Finally, an effective control action is to maintain the power for charging, depending on multiple energy usage circumstances. The proposed fuzzy operate decentralized to maintain power distribution between the microgrid DC-link and the ESU. The total PV coupled with the DC microgrid charging point control system is investigated under a variety of realistic conditions such as low and full PV array energy production, network overflowing, existing energy storage, and vehicle to vehicle. The laboratory-scale MATLAB/Simulink simulation and experimental of multiple EV charging plug spot DC microgrid has been studied and validated under numerous different microgrid settings, and they coincide with the suggested charging station upshot.

M.S. Keerthana, G. Uma , U. Sowmmiya et al. [2] Progress in Direct Current (DC) power technologies has paved way for the emergence of DC Nano Grid (NG) as a new research area drawing international attention. This paper aims to design a simple and cohesive control algorithm for a solar PV and wind generator coupled low power residential DC NG with electrical and thermal energy storage systems. The envisaged NG control architecture extracts maximum power from solar PV, effects maximum active power transfer from wind generator with voltage regulation of the DC bus, draws/delivers balanced sinusoidal currents at Unity Power Factor (UPF) from/to the grid and monitors power scheduling to DC and thermal loads. The maximum solar PV power is extracted through incremental conductance algorithm and maximum wind power is tracked using a polynomial curve fit equation derived from the wind power curves without implementation of any speed/torque control loops. The maximum active power transfer from wind and UPF operation of the grid is achieved using a reference current generation method based on symmetrical components theory of equal current strategy with no complex transformations. A power factor of 0.99 with generation of balanced sinusoidal currents during both grid power import and export is achieved.

Karan Doshi et al. [3] Depletion of fossil fuel reserves and GHG emissions from fossil fuel based-centralized power plants has led to an increased interest in the generation of electric power from renewable energy resources such as wind, solar PV and like-wise. In this paper, a simulation based integrated renewable energy system model has been developed using MATLAB/Simulink. The system operates as a DC microgrid, consisting of solar photovoltaic and wind as renewable generators, lithium-ion as battery storage and inductive loads.

Eluri N.V.D.V. Prasad et al. [4] DC microgrids are very much focused on the present scenario due to the increase of power applications. In this paper, a new adaptive integral back stepping fractional-order sliding mode control (AIBFOSMC) is proposed for the DC microgrid in which renewable distributed energy sources with energy storage systems are presented. Initially, mathematical equations are developed for the proposed DC microgrid and then control equations for PV with wind and battery are derived. To extract the maximum power from the PV and wind systems, an improved incremental conductance (IIC) based maximum power tracking method (MPPT) is introduced in this paper. The main aim of this control is to stabilize the DC bus voltage under different operating conditions such as generation change, DC load change, temperature change and DC faults.

Muhammad Fahad Zia et al. [5] DC microgrids are becoming integral part of a modern power system due to the growing penetration of DC distributed energy resources and loads, with additional advantages in terms of power quality improvement. They can be used for remote area electrification including villages, mountains, and islands. In this paper, an islanded DC microgrid is considered as a case study for islands with tidal energy potential, which consists of renewable energy resources including solar, wind and tidal, along with Li-ion battery storage. To ensure the efficient operation, an optimal energy management system is proposed for resource scheduling and utilization.

P. Meenalochini et al. [6] A Hybrid CSA-QNN approach is proposed in this manuscript for grid-connected PV with an efficient inverter-based wireless electric vehicle (EV) battery charger. The proposed hybrid method combines the performance of both the circle search algorithm (CSA) and quantum neural networks (QNN), commonly named the CSA-QNN technique. The Circle Search Algorithm helps find the best charging spot by creating a virtual circle, while the Quantum Neural Network optimizes the overall power flow and charging efficiency. Together, these technologies contribute to making wireless charging for EVs more efficient and convenient. The major goal of the manuscript is the design of a wireless EV battery charger with PV integration. Wireless EV charging systems (WEVCS) may be a feasible alternative technology for charging EVs without a plug-in problem.

Varsha Yadav et al. [7] An integration of hybrid renewable energy systems (HRESs) to the grid results in power quality issues at the point of interconnection. This paper proposes an approach to investigate and mitigate power quality issues and uncertainties associated with integration of a HRES that includes a solar photovoltaic (PV) array, a wind generator, and battery energy storage (BES). The system functions in grid tied mode, standalone mode and seamless mode transition between these modes. Primary objective of proposed control approach is to ensure stable and reliable operation while mitigating effects of power quality issues.

Hafiz Muhammad Mehdi et al. [8] Conventional power generation resources are depleting rapidly and world power

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sector has been moving towards renewable energy sources (RESs). In this paper nonlinear control for renewable energy and hybrid energy storage system (HESS) based DC microgrid (DCMG) has been presented. PV and wind energy being the renewable sources whereas fuel cell, battery and ultracapacitor constitute the HESS. The global mathematical model of the said system has been presented. Datasets of varying solar irradiance and temperature have been trained by Artificial Neural Network for the reference voltage generation of PV. Integral terminal sliding mode controller (ITSMC) has been proposed for the output DC bus voltage regulation. Lyapunov stability criterion has ensured the overall stability of the system.

Randa Kallel et al. [9] This paper proposed a suitable control strategy for power sharing management for hybrid AC/DC residential PV systems. This control method is used as an Energy Cooperative Approach (ECA) to manage the power flow between a PV and battery-fed smart grid within a DC micro-grid, supplying some connected houses. In fact, using an ECA which is based on photovoltaic (PV) power transfer between three houses, connected to the AC network; through a DC micro-grid, the photovoltaic energy can be effectively used to satisfy the load demand. Such a process ensures a continuous demand satisfaction, lengthens the storage system life time by minimizing the resort of the battery, and alleviates the stress of the main grid minimizing the consumption of electricity fed by the AC grid. In fact, this strategy increases the system efficiency and the power supply quality.

Mohamed S. Soliman et al. [10] With increasing energy prices, nuclear energy concerns, climate changes, and electrical grid losses, the demand to rely on more renewable energy is growing. The majority of people currently prefer to live and work in smart environments, such as smart cities and smart institutions with an integrated smart microgrid. Energy management is a complex topic because a large amount of these smart microgrid systems rely on hybrid energy sources. As a result, a smart energy management controller needs to be created. The current research provides a new energy management control technique for a smart DC-microgrid based on a combined fuzzy logic controller (FLC) and high order sliding mode (HSMC) methods. The hybrid energy provider integrated into the DC-microgrid is made up of a battery bank, wind energy, photovoltaic (PV) energy, and tidal energy source.

V. CONCULUSION AND FUTURE SCOPE

This proposed work presents the modelling of DC Grid-connected with solar and wind as their input source. These renewable sources are integrated into the main DC bus through bi directional dc-dc converter. Wind energy variation and rapidly change in solar irradiance was considered in order to explore the effect of such environment variations to the proposed grid connected system. Network are utilizes elective power structures to help these load focuses, for example, sun based power, wind control and so on. In this exploration work solar power was chosen as an elective energy source. In this simulation proposed system is manage load variation and manage quality output. The inexhaustible power which can be created from the sustainable assets can be incorporated by the aggregated model.

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