HYBRID ENERGY MANAGEMENT AND CONTROL STRATEGY OF PHOTOVOLTAIC GENERATION SYSTEMS

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ABSTRACT:
Energy storage is the capture of energy produced for use at a time to time. Hybrid storage devices are used in microgrids to provide power backup solutions when the distributed energy resources (DERs) are unable to supply the load demands. This work deals with the design and stability analysis of a DC microgrid with battery-supercapacitor energy storage system under variable supercapacitor operating voltage. The conventional design method reported in the literature considers the rated supercapacitor voltage in the modeling and design of controllers. However, the supercapacitor unit can discharge as low as 10% of its rated voltage due to self-discharge. It is observed that the conventional method of controller design can potentially make the system unstable. This paper proposed an optimal super capacitor voltage to be considered in the design is calculated and a design method is proposed to ensure the stability of DC microgrid in all operating modes.

Keywords: Energy management, MPPT, bidirectional power converter, photovoltaic, super capcitor, battery, hybrid power unit.

1. INTRODUCTION

The permeability of renewable energy in the microgrid is relatively high, and its intermittence will lead to the fluctuation of power supply in the system. At the same time, the sudden change of load and switch will cause voltage flicker and drop of DC bus, which will threaten the stable operation of the system. The DC microgrid composed of photovoltaic power generation, battery energy storage device, grid converter and DC and it is used as the research object load in this work, what's more, based on the bus voltage information, the operation control strategy of microgrid is designed to realize the independent operation of the microgrid, such as parallel in and off the grid. Tremendous advancements occurred over the next century: the development of induction and synchronous machines, electric meters, high voltage transmission, gas turbines, nuclear reactors, wind turbines, and solar photovoltaic, to name a few. All of these technologies were turned to the development, advancement, and expansion of "the grid;" the system of large-scale centralized generation connected to energy users through a network of transmission and distribution. But while a seemingly endless supply of effort and funding was being poured into "the largest machine ever built", in recent years another trend in research started, as some began to explore the advantages to moving in the other direction: distributed, decentralized, local grids: microgrids. Batteries and supercapacitor use dc current by their na- ture for charging and discharging. This includes the batteries in electrical vehicles, meaning dc power systems can easily integrate with vehicle-

to-grid systems. In addition to the benefits of increasing electrification, another key area of research seeks to identify the most cost effective means for improving electricity access. Several studies have compared outcomes for grid extension vs decentralized generation (using an average cost for all feasible sources), grid extension vs solar home systems (SHS) , SHS vs solar photovoltaic (PV) microgrids, and a three-way comparison between grid extension, renewable-based home systems, and renewable-based microgrids . Each of these studies analyzes some combination of transmission, distribution, fuel, and capital costs for the RE options considered. In general, the results of these studies indicate that while grid extension is typically the least-cost option for RE, decentralized options are significantly more cost-effective in remote and/or sparsely populated areas. In particular, found that in several Sub-Saharan African nations, over 50% of the population could best be served with off-grid power systems. In addition, the rapid decline of solar PV pricing over the last few years indicates that the extent of territory where SHS and PV microgrid systems are the best option will likely increase instead of decrease.

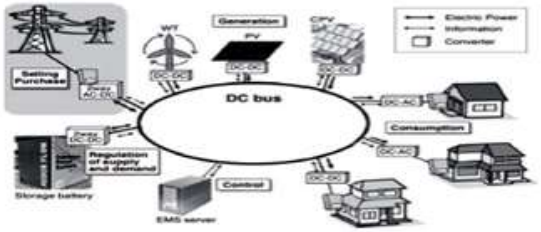


Figure 1: Schematic diagram of a DC micro grid system

Many types of electrical loads use dc power natively The majority of electronics (such as computers, servers, and TVs) use dc power. LED lights also use dc power natively. Many types of motors and drives (especially variable speed drives) use dc power. In all three cases, these sources, storage systems, and loads require converters when- ever they interface with ac power systems; thus switching to a dc power system eliminates the need for such converters, eliminating the losses which are inherent in any type of power conversion. To date, key areas of implementation for dc power systems have included data centers, spacecraft, airplanes, shipboard power systems, traction power systems (for trains, trolleys, trams, etc), and telecommunication infrastructure. Developments in these areas have spurred research on dc microgrids, and in some cases provided testbeds for establishing functional dc microgrids (particularly in the case of data centers and telecoms, where the cost savings potential is significant).

2. LITERATURE SURVEY

- J. Hong et al.,[1] into thought. The reenactments are directed utilizing the Matlab/Simulink programming to check the activity execution of the proposed PV/battery hybrid conveyed power age framework with the comparing control calculations, where the MPPT control circle, the battery charging/releasing administration circle are empowered in like manner in various working situations. I. Ameur et al.,[2] propose an ideal power the board for an independent microgrid made out of a Photovoltaic cluster (PV), a Fuel-Cell framework (FC) and an electrochemical battery dependent on the Pontryagin's Most extreme Guideline (PMP). The three sources are interfaced in corresponding to a typical DC-connect by means of DC/DC converters and are intended to fulfill the heap need particularly in

regions outside the power inclusion. The goal of the proposed procedure is to lessen the fuel utilization by causing the framework to work in its ideal working point as for load request and climate conditions. Some reproduction results are introduced to affirm the optimality of the proposed system.

- L. Liu et al.,[3] presents the quick and precise administration of different smaller scale power sources in the framework can be acknowledged and the steady activity and higheffectiveness control of the power age framework likewise can be guaranteed. At long last, the outcomes completely show that this examination can assist with controlling the activity of disseminated power gracefully and energy stockpiling unit, and add to building multi-energy reciprocal microgrid in provincial and distant zones and off-matrix power flexibly [3].
- K. Longo et al.,[4] The presents model is executed in MATLAB/Simulink condition. Two situations are mimicked to cover the fundamental control objective, for example the balance between power creation and burden request through DC transport. The subsequent situation additionally attempts to amplify the power creation. Another accomplishment of this work is the conversation about the Hybrid Energy Stockpiling Framework (HESS), utilizing supercapacitor to maintain a strategic distance from weight on the battery. The microgrid is estimated and reproduced for a family of ten houses, fixing energy and power utilization for the city Porto Cesareo. This work covers the entire recreation procedure of a microgrid and could be a fascinating base to developed progressively complex DC microgrid structures later on.
- J. Kang et al.,[5] The proposed control and power the board framework steadily manage the transport voltage and well equalization the power, basically through programmed control of every module's voltage and power. Under the influence and Power the board framework, when the heap changes abruptly, the transport voltage stay stable and power stay adjusted. The reproduction is completed to confirm the exhibition of the proposed strategy.
- Y. Singh et al.,[6] High request versatile channel based synchronization controller is executed for smooth changing to independent mode and the other way around with high dependability and hang less control. A MOSSI based control accomplishes matrix current, PCC (Purpose of Regular Coupling) voltage, and battery current under characterized modes and aides in music relief and upgrading the power nature of the single stage framework however removing power from the sunlight based PV cluster. The viability of the proposed structure of MOSSI-PLL is assessed through test results under various modes and conditions on the created model in the research center.
- H. Mahmood et al.,[7] The decentralized coordination conspire organizes accusing the microgrid batteries of lower SOC. Likewise, the control procedure empowers the hybrid units to import power from different units to help charging their batteries. These highlights are accomplished by utilizing the proposed multi-portion versatile power/recurrence qualities in the hybrid unit controllers. Since the technique depends entirely on the nearby voltage controllers, neither a focal energy the board framework nor interchanges among various units are required. The created technique has been approved utilizing nitty gritty exchanging models in PSCAD/EMTDC. S.

Umashankar et al.,[8] This work centers around the remuneration of PV power decrease because of fractional concealing utilizing bidirectional half extension converter with battery stockpiling. This framework considers satisfying the nearby burden request through PV creation and, at that point, to deal with the power among the battery and matrix. In the proposed framework, the considered power molding gadgets territory support converter, 3 stage full-connect inverter, and bi-directional converter. The outcomes are acquired from the MATLAB/SIMULINK condition. Dongxu Wang et al.,[9] This work presents the displaying and reproduction of the utilization of virtual coordinated generator(VSG) innovation in a bidirectional DC/Air conditioning converter and a PV/battery framework in a hybrid air conditioning/DC microgrid. The battery unit in the DC sub-microgrid keeps up DC transport voltage stable and the DC transport is proportional to a capacity framework. The voltage-controlled kind of VSG control system is applied to the bidirectional DC/Air conditioning converter being as the help hub in hybrid air conditioning/DC microgrid.

- Yanping Zhu et al.,[10] Dependent on microgrid recurrence, another photovoltaic (PV)/battery (BA)/fuel cell (FC) hybrid energy the board procedure with changed hang control for islanded application is proposed in this paper. This procedure empowers the attachment and plays ability in the disseminated units with voltage control mode and makes it conceivable to abstain from utilizing the correspondence line or a focal director. The framework recurrence filling in as the specialist furnishes the units with the chances to adaptively look after age/load balance as indicated by various circumstances with just nearby data.

3. PROPOSED MODEL

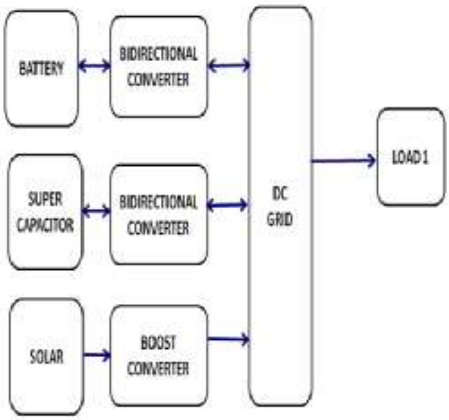


Figure 2: Model Flow Chart

The flow chart of proposed model is based on the control strategy for the DC microgrid considered in this work. There are four possible operating modes. The control strategy regulates the DC link voltage in all the four operating modes using battery or PV source. The four operating modes are explained below. 1) Battery Discharging Mode (BDM): In this mode, the PV power is less than the load power and the battery SoC is within limits. Therefore, the battery discharges to regulate the DC link voltage. 2) Load Shedding Mode (LSM): In this mode, the PV power is less than the load power and the battery is fully discharged. Therefore the loads are disconnected and the available power is used to charge the battery. 3) Battery Charging Mode (BCM): In this mode, the PV power is more than the

load power and the battery SoCis within limits. Therefore, the battery regulates the DC link voltage by charging with the excess power available. 4) PV Off-MPPT Mode (POM): In this mode, the battery has fully charged, therefore, the PV is operated in off-MPPT mode to regulate the DC bus voltage.

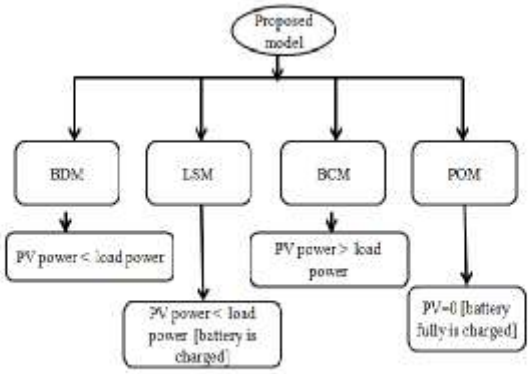


Figure 3: Operation flow chart

The figure 3 is showing the operational flow chart which is discussed above

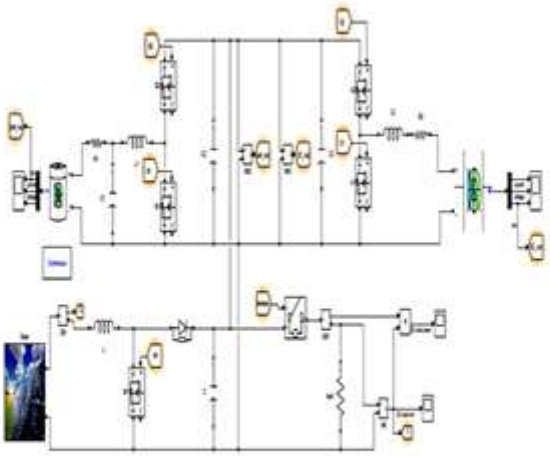


Figure 4: Proposed model

Figure 4 is showing proposed HESS DC-microgrid model.

This model consist various sub models which is described in details. Sub-Modules

- Solar power
- MPPT Algorithm
- PWM Switching
- Boost converter
- Bidirectional converter and mode of operation
- Battery
- Super capacitor

4.SIMULATION RESULTS

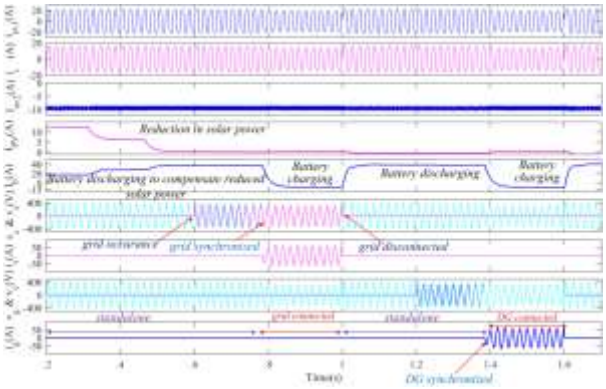
We talk about the CS's performance using both experimental and simulated data.

Outcomes of the Simulation

Figure shows the simulated outcomes of the CS's uninterrupted functioning. At the power conversion centre (PCC), the electric vehicles are charged using the PV array electricity while the CS is running in island mode. The excess power from the PV array is saved in the

energy storage system since it is more than what is needed to charge the electric vehicles. The sun's irradiance drops from 1000 to 300 W/m2 in about 0.32 seconds. This causes the power from the PV array to decrease, which in turn causes the storage battery to begin draining in order to maintain uninterrupted charge. Upon reaching zero power from the PV array, the storage battery is discharged in 0.48 seconds. When this happens, the storage battery will fully back the charging process, provided that SOC is greater than SOCmin. Once the battery has been fully discharged, the controller will synchronise the CS with the grid. The control system began using energy from the grid at 0.79 seconds. If grid and storage battery power become unavailable beyond this time, the DG set will provide CS (Fig. 4). Figure 4 shows that the CS switches modes autonomously in response to changes in generation and demand.

Fig:- simulation diagram of WECS under varying wind speed.



CONCLUSION The simulation contemplates performed with the SC and battery bank models and their charge controllers show that the battery bank is undeniably increasingly appropriate to give power over a long timeframe. The exponential idea of its voltage discharge bend has a considerable region of stable voltage output and can be effectively used to give base power to DC loads. In any case, at whatever point there is an unexpected high prerequisite of power, the battery can't adapt to it. The huge homeless people in the system can be dealt with by a SC bank which discharges high power over brief timeframe periods. Simulated results shows that the proposed models gives better results than previous.

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AUTHOR DETAIL'S

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