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An Efficient Energy Management in DC Microgrid Using Composite Energy Storage System

Shakti Kumar[1], Dr. Shweta Chourasia[2]

[1]Research Scholar, [2]Associate Professor & HOD, Department of Electrical and Electronics Engineering, Bhopal Institute of Technology and Science, Bhopal, India

***Abstract*-- A microgrid is a localized group of electricity sources and loads that normally operate connected to and synchronous with the traditional wide area synchronous grid (macrogrid), as the number of DC-generating renewable energy sources is higher as compared to AC-generating sources, lesser converter units are required. This increases the overall efficiency of DC microgrid. A DC micro grid system is using a power network that enables the introduction of a large amount of solar energy using distributed photovoltaic generation units. This research deals with the energy management in DC microgrid using composite energy storage system. The MATLAB software is used to implement the model and analysis.**

***IndexTerms*-- Composite, Energy, Storage, DC, Microgrid, Renewable, Energy, Photovoltaic.**

I. INTRODUCTION

A microgrid is a gathering of interconnected loads and distributed energy resources inside unmistakably characterized electrical limits that acts as a solitary controllable substance as for the grid. A microgrid can connect and disconnect from the grid to empower it to work in both grid-connected or island-mode. The first motivation for the thought in its initial conceptions at UW-Madison was to make a system that would permit distributed energy resources (DERs) to peacefully coincide with the grid. Preceding work on microgrids, numerous utilities required clients with DERs to disconnect those resources at whatever point they distinguished an issue with the grid voltage or recurrence. These prerequisites, expected to ensure utility specialists and different clients on the grid, made obstacles for those with such resources, making integration and control entangled and costly, and diminishing their attractive quality.

Any case, with an all around arranged microgrid, power clients would profit by having the option to total various sources and loads under one control system, demonstrating advantages, for example, back-up power, co-generation, improved power quality, and diminished environmental impact (when utilizing renewable resources). From the utility point of view, gathering these substances under a microgrid implies there are less loads and resources to monitor and regulate.

Later examination likewise found that all around directed microgrids are fit for giving various different advantages to the bigger grid, including voltage and reactive power (VAR) regulation. This is a territory of ongoing investigation in 2009 the Electric Power Exploration Organization (EPRI) started improvement of a communications convention for between facing microgrids and DERs with utility systems, and the Establishment of Electrical and Electronics Designers (IEEE) built up a standard for interconnecting DERs with the grid.

Figure 1: Microgrid

Microgrids are utilized to accomplish various objectives: protection from disruptions in flexibly, (for example, those because of catastrophic events), decreasing blackout time of basic loads, diminishing CO2 emissions, improving grid stability, and permitting consistent integration of renewable with the grid . From multiple points of view, each of those targets can be taken back to monetary motivation: included worth, diminished misfortunes, and improved profits for renewable energy systems. However, even as the business case for microgrids has become stronger, the advances in innovation have opened up ways which are not carefully spurred by benefit. In particular, microgrids have been envisioned as a solution to the overall lack of access to reasonable and solid electricity.

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II. PROPOSED METHODOLOGY

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 SoC is 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.

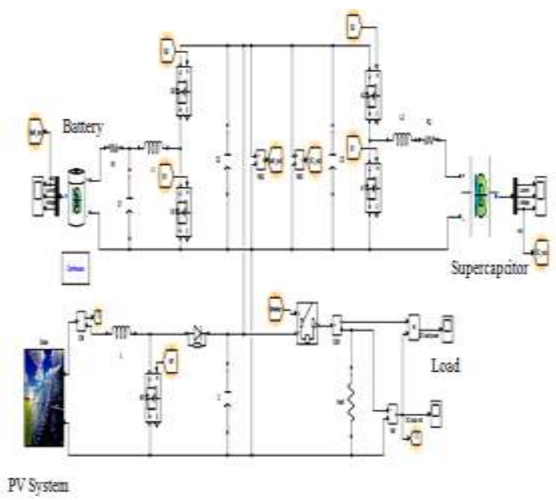

Figure 2: Energy Management Proposed Model

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

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

III. SIMULATION AND RESULTS

The implementation and simulation of the proposed model is done over MATLAB 9.4.0.813654 (R2018a). The various electrical toolbox and blocks helps us to use the functions available in MATLAB Library for various design strategy.

MODE(i) 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.

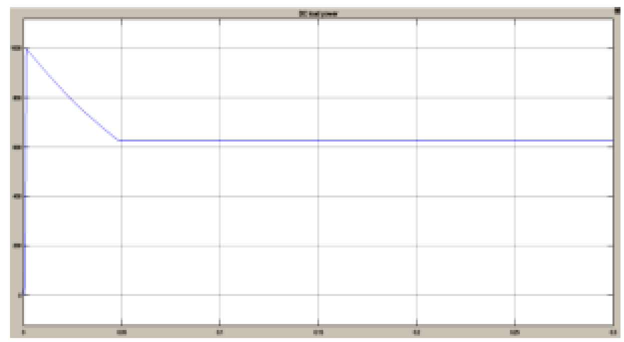

Figure 3: DC Load Power

Figure 3 is showing DC load power graph. Here X axis is denoting as a time scale and Y axis is denoting as a value of power. So load power value is 630W.

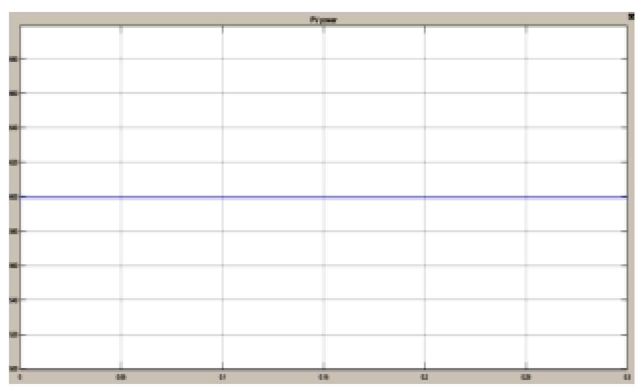

Figure 4: Solar (PV) Power

Figure 4 is showing solar power graph. Here X axis is denoting as a time scale and Y axis is denoting as a value of PV power. So Solar (PV) power value is 600W. Here, the solar power is 600watts < load power is 630watts

Mode(ii) 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.

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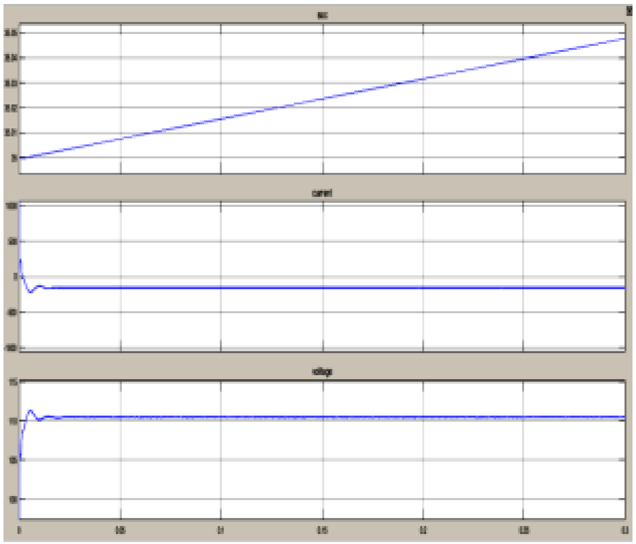

Figure 5: Battery (SOC, Current, Voltage)

Figure 5 is battery state of charge, voltage and current graph. Here X axis is denoting as a time scale and Y axis is denoting as a state of charge, value of current and voltage. Here, the battery is discharged below the lower limit.

MODE(iii) Battery Charging Mode (BCM): In this mode, the PV power is more than the load power and the battery SoC is within limits. Therefore, the battery regulates the DC link voltage by charging with the excess power available.

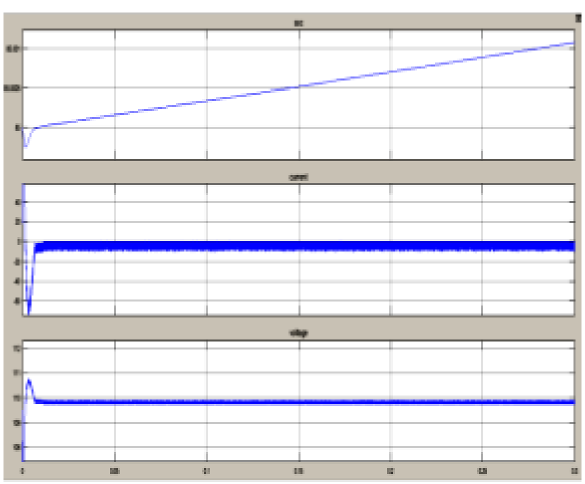

Figure 6: Battery (SOC, Current, Voltage)

Figure 6 is battery state of charge, voltage and current graph. Here X axis is denoting as a time scale and Y axis is denoting as a state of charge, value of current and voltage. Here, the battery is charging.

Mode(iv) 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.

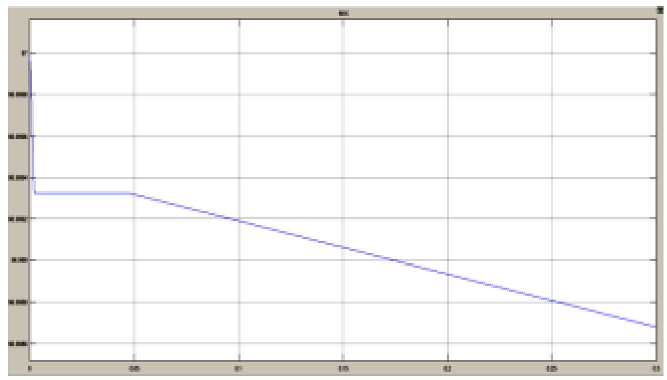

Figure 7: Battery

Figure 7 is showing battery state of charge. Here X axis is denoting as a time scale and Y axis is denoting as charge percentages. Here, the battery is fully charged soc>95%.

Table 1:
Result comparison

Sr No.	Parameters	Existing Work [1]	Proposed Work
1	PV Max Power	9.6KW	11KW
2	MPPT Voltage	435V	450V
3	Nominal DC Voltage	500V	500V
4	Battery Nominal voltage	200V	200V
5	Battery max charged voltage	208V	210V
6	State of Charge	NA	97%
7	Super capacitor	NA	Yes
8	Mode of operation	7	4
9	Sub-Module	PV, MPPT, Bi-directional converter,	PV, MPPT, Bi-directional converter, Supercapcitor
10	Controller	Conventional incremental conductance MPPT technique and PI Controller	Energy Control Controller

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IV. CONCLUSION

The impact of super capacitor voltage variation on the stability of DC micro grid is examined with its accurate little sign model. An ideal super capacitor voltage based DC connect voltage controller structure strategy is proposed to guarantee the adequate addition edge and stage edge at all super capacitor voltages. The simulation and trial results confirmed that the proposed structure gives execution than that of the conventional plan. In this way, the proposed energy management configuration achieves better powerful response over a wide scope of super capacitor working voltages.

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