Battery Energy Storage System To Improve The Efficiency Of Pv And Fuel Cell Based On Modular Multilevel Converter

Ch. Santosh Kumar, G. Chandra Sekhar

Abstract: Associate in Nursing optimum complete renewable energy (PV) system installation could be a key to rising the rural electrification is an important consequence for the choice of areas for developing countries as a result of households area unit a lot of wide scattered and tract like mountains and Insular. Generally, a complete renewable energy system uses one charge controller with by grouping all batteries connected into parallel strings. Uncertainty of renewable energy systems, notably the physical phenomenon (PV) and electric cell systems, and constraint of battery power charging and discharging area unit fundamental issues for developing with and managing battery storage systems of complete renewable energy systems. Within the previous analysis localized management mechanism is planned and is a sensible limitation even though we tend to implement a tiny scale model. So in this paper proposes an alternative optimization method called constant current control method to provide system stable performance to optimize the reliability of system to the maximum extent total circuitry is modeled and simulation under graphical user interfacing environment and MATLAB based simulation results are provided. The total proposed circuit configuration will provide optimal performance than a typical decentralized optimization technique.

Index Terms: Fuel cell system, PV system, Battery system, Decentralized Battery Energy Storage System, Modular Multilevel converter.

I. INTRODUCTION

The implimantation of non conventional energy system place a maser roll in developing the rural electrification which results of households area unit a lot of wide scattered and tract like mountains and islands. Typically stand alone renewable energy system uses charging batteries within the parallel strings. This ends up in the diminution of battery life time. additionally, battery charging phenomina of battery is proscribed by the lowest and highest charging dencities power, however power that charging batteries varies, relying the facility lasting from feed load demand. Division the PV-Fuel Cell and Batteries which may be known as to be the localized battery storage system methodology [DBESS], which will offer higher performance, long lifetime storage and minor maintenance price of battery storage systems [1].

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Accordingly, this paper proposes the Decentralized battery energy storage system [DBESS] method with by using the switch group, of which each group has different ratings. The objective of the BESS method is to reduced loss generated by the soiurce. The power liability of stand-alone PV-Fuel cell system give roadmap to find the aconomical size of the system, due to uncertain is to finding the most advantageous sizing of the system due to uncertain solar irradiation levels. The folw chart for power quality has been developed for the system and It makes the proposed BESS is the highly efficient optimum technique to give the better expected results [2]. Therefore, this paper applied the MPPT power algorithm of PV and Battery modules, by PV - Fuel cell – battery system using DBESS method.

II. COMPARISON OF GROUP OF BATTERIES

The most common batteries used in the market today are Li-Ion, lead acid, Nickel-based and sodium based batteries. We focused on Lithium-ion batteries, Lead-acid batteries, and Nickel based batteries since they are most far and wide used ones in built-up applications [3].

A. Li-ion Batteries:

The specific energy and energy concentration are two parameters are mandatory for use in large scale of ESS. The Li-Ion batteries can store up to ten times more energy than that of other batteries comparatively [4]. In progress Li-ion technology under test in grid connected systems indicates life cycles 20 years at 60% depth of discharge [DOD] per day is depicted in **Figure 1**.

Lithium-Ion batteries are 94% efficient in excess of 100% DOD. While the other technologies shows 91% as its maximum efficiency.

B. Lead - acid batteries:

Along with all the batteries used, Lead - acid batteries gives long life compared to all others. The Lead acid batteries have been able to store more energy. The lead acid batteries are 92% efficient over the 100% DOD Shown in **Figure 2**. While the other technologies shows 91% as its maximum efficiency.

C. Nickel based batteries:

Compared to Li-ion batteries and Lead acid Batteries the life time for Nickle based batteries is less and whose efficiency is 88% over the 100% DOD as shown in *Figure 3*.

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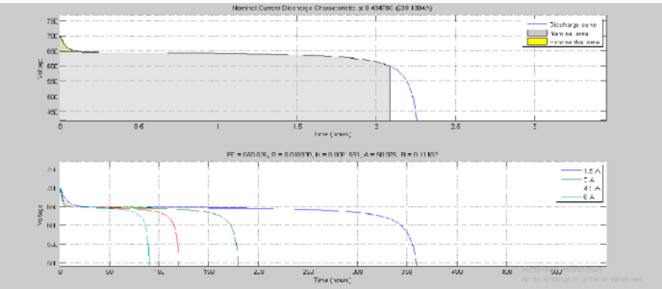

Figure 1 Li-Ion battery

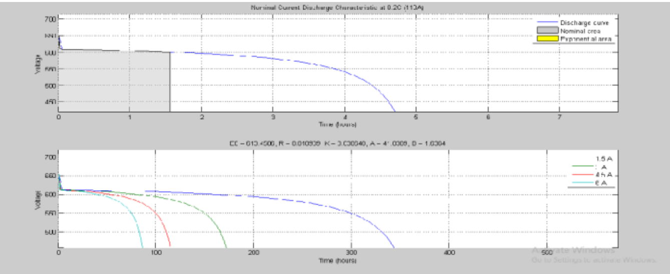

Figure 2 Lead-acid battery

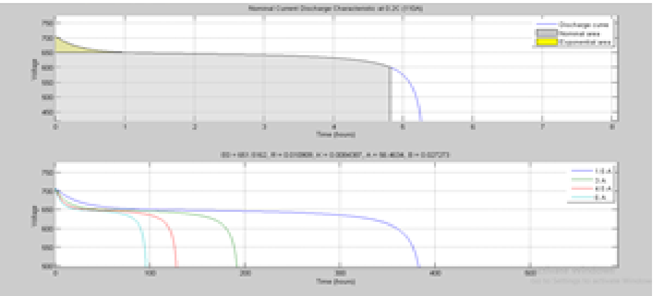

Figure 3 Nickel Based battery

Table 1:

PARAMETER	LI-ION	LEAD ACID	NICKEL BASED
SPECIFIC ENERGY	10 TIMES MORE	MORE	MEDIUM
LIFE TIME	LONG	LONG	MEDIUM
EFFICIENCY	94%	92%	90%
STATE OF CHARGE	100%	98%	98%
DEPTH OF DISCHARGE	64%	NEAR	NEAR
MAX EFFICIENCY	91%	90%	90%
LOSSES	5-6%	6%	9-10%

III. DECENTRALIZED BATTERY STORAGE SYSTEM OF THE GROUP

This paper intend the DBESS method for Fuel cell, PV and Battery group system to improve the efficiency. The fuel cell and PV operating and the battery group depends on load demand. The operation of the system using DBESS method based on battery voltage (V_{batt}), Fuel cell power ($P_{fuel\ cell}$), PV power (PV) and load power (P_{load}) is illustrate in Figure 4. Charging and discharging process as follows [5] [6].

a. The first precedence to a battery group having highest voltage for discharging.

b. If the voltage is below the lower limit, then battery will be charged.

c. If there is continuously high load demand the next battery will discharge V_2. When the voltage of first battery decreases to the voltage of second battery $V_1=V_2$

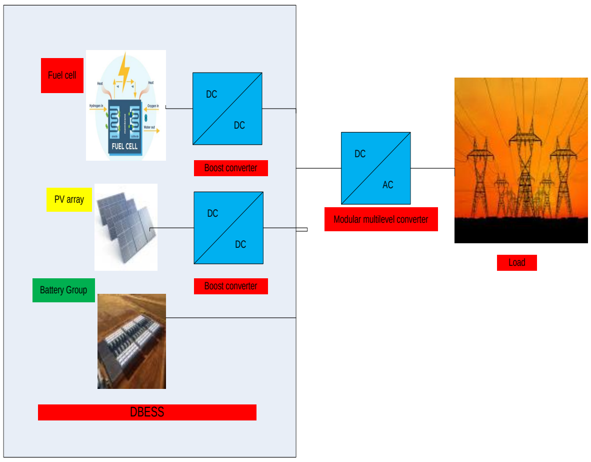

Figure 4 Block Diagram

IV. PROPOSED WORK:

A. *Fuel cell:*

An Fuel cell is a device that generates electricity by chemical process. Every fuel cell has two electrodes named anode and cathode. The reactions that produce electricity at the electrodes are shown in

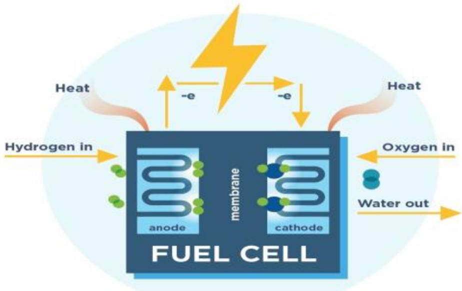

Figure 5. The output power terminals are connected to DC-DC converter which is then connected to dc bus. Fuel cell of 50kw, 625 V_{dc} is considered for this work, and the output of the fuel cell is shown in **Figure 6**.

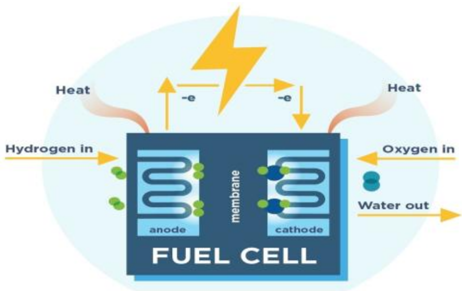

Figure 5 Fuel Cell

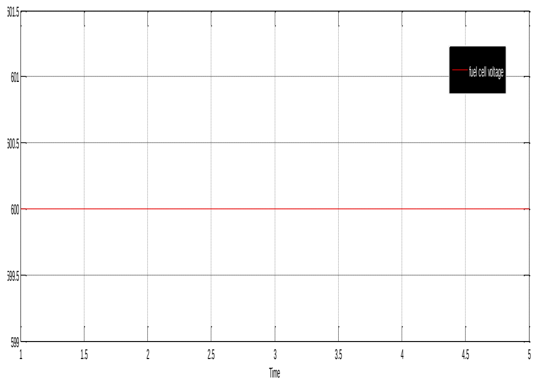

Figure 6 Output voltage of Fuel cell

B. Photo voltaic system:

In the Photo voltaic(PV) system, solar cell plays a major role in generating the voltage by using photo voltaic effect. PV array is the arrangement of solar cells connected asynchronous or parallel for generating the required current, voltage and high power. Every cell is analogous to a diode with a contact intentional by semiconductor material. It produces the current when sun light impacts on the junction, due to electrical phenomenon impact [7][8].The equivalent circuit of depicted PV cell is shown in Figure 7and the current equation is shown below.

$$I = I_{ph} - I_D - I_{sh}$$

$$I = Iph - I_o\,[\exp(q\,V_D / nKT)] - (v_D/R_S)$$

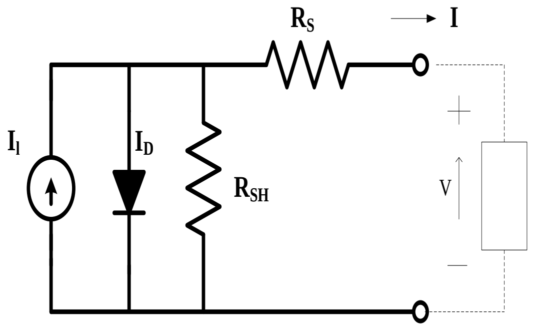

Figure 7 PV cell

C. Maximum power point Tracking:

This fragment covers the concept of MPPT and is used in solar electric charge controllers. By using this technique DC to DC convertion can be implemented which optimizes the match between the solar array (PV panels), and the battery bank or utility grid. In this method the controller otomatically controls the voltage by small amount in accordance with the measurement of power the array. This mehod of atomatical adjustment is termed perturb and observe method which the frequently used to improve the efficiency. This is most common, although this method can consequence in oscillations of power output. P & O method is the most universally used MPPT method due to its effortlessness of accomplishment. Perturb and observe method may result in higher efficiency, provided that a proper analytical and adaptive hill mountaineering approach is adopted.

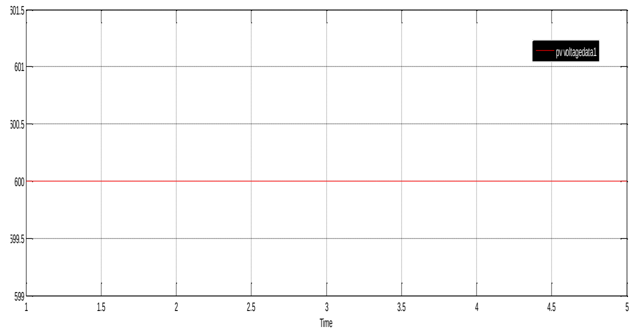

Figure 8 Output of PV array

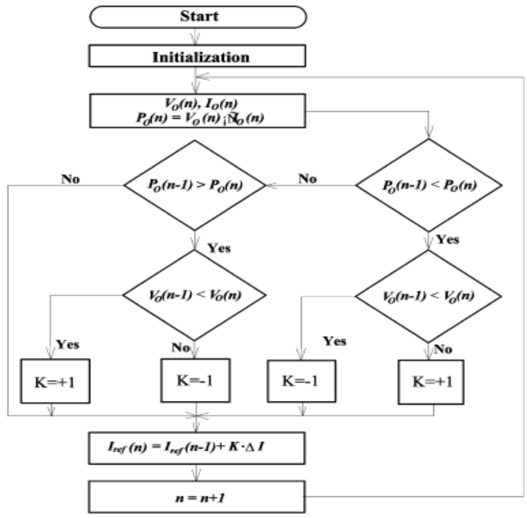

Figure 9 MPPT Flow chart

D. Modular Multilevel Converter:

The modular multilevel converter (MMC) is the lead area under discussion of increasing importance for medium/high-power energy conversion systems. The five-level cross-connected circuit as shown in figure 10. A five-level cross-connected Sub Module also consists of two half-bridge SMs connected end-to-end by two extra IGBTs with their anti-parallel diodes. a variety of pulse-width modulation (PWM) technique, based on using a single reference waveform, that have been developed for the MMC. The salient features of the MMC, i.e., its modularity and scalability enable it to conceptually meet any voltage level requirements with superior harmonic performance reduced rating values of the converter components and improved efficiency [9][10].

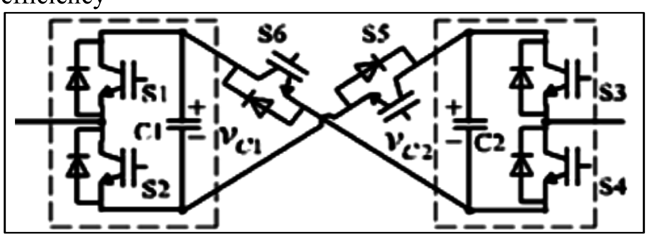

Figure 10 Five level of cross connected MMC

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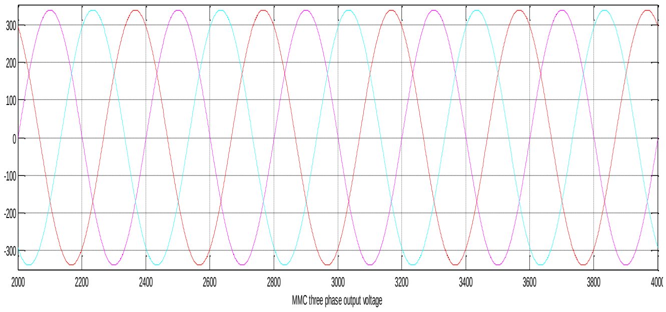

Figure 11 MMC voltage output

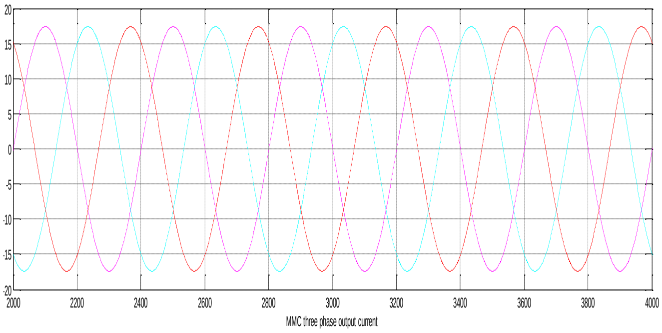

Figure 12 MMC current output

V. RESULTS DISCUSSION:

This paper simulates the DBESS method to improve the efficiency of fuel cell, PV, Battery system using one battery group for which results are shown Figure 13. The DBESS method can get better the consistency of Fuel cell – PV - Battery system. Then the system designed one group. In this system exchange between the project cost and power quality of services for uses. The levelized cost of energy is set to objectives of this optimization problem.

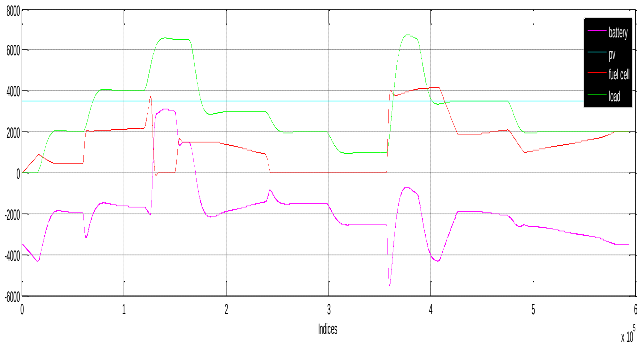

Figure 13. Fuel cell, PV, Battery, Load Results

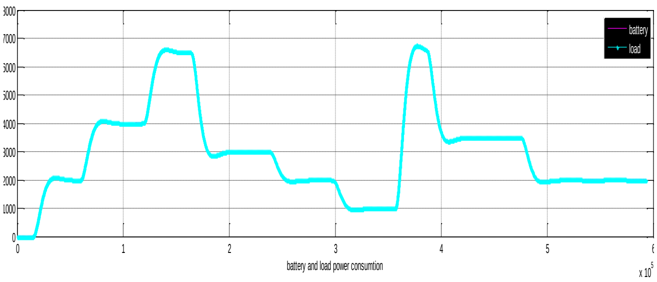

Figure 14 charging and discharging of Battery w.r.t Load

The results of charging and discharging process are shown in **Figure 14**4. The battrey group can be dicharging on depend for load demad, the load will be increase some some energy is required so the battery can discharge. the load demand is low the battery can be charging from the sources. It is the continous process of the charging and dischrging of he system as shown in **Figure 15**. In this can be used pv system more advantages of the Renewable energy system.

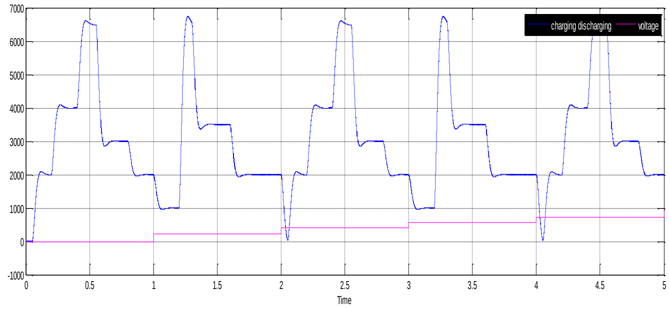

Figure 15 charging and discharging of Battery group

VI. CONCLUSION:

The application of large scale Decentralized battery energy storage system technology in renewable energy sources will become more and more popular. Modeling of load demand connected DBES is one of the important issues in power system simulation analysis. This system is MMLC with distributed, decentralized battery energy storage. It was concluded that the system using DBES method has more reliability and more efficiency than the system using one battery group, while decreasing the number of PV and battery modules leading to lower levelized cost of energy and waste energy. The DBESS can be applied for renewable energy systems such as Fuel cell – PV – battery systems and wind – PV – battery systems, etc. In terms of efficiency, reliability, and future applications beyond that of a BESS, the MMLC with distributed energy storage offers most adoptable topology for future development.

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