Journal of Computing Technologies

Volume-12, Issue-08, August 2023
JOURNAL OF COMPUTING TECHNOLOGIES (JCT)
International Journal
Page Number: 01-04

Renewable Energy with Battery Storage based Electric Vehicle ChargingStation

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***Abstract*— This article presents a hybrid energy system that can be utilized for the operation of a solar-powered charging station for electric vehicles. A battery storage is the component that makes up a hybrid energy storage system. When the solar power fluctuates as a result of changes in irradiance and temperature, it is necessary to make an abrupt change in supply from the storage system. When supply is gained from the storage system, it is also possible to see power fluctuations. In a microgrid that is loaded with DC electric vehicles, the use of battery storage is necessary in order to stabilize the fluctuations in solar output and the voltage of the DC bus. MATLAB SIMULINKS was used in order to arrive at these results.**

***Keywords*— Solar PV system. Battery. ElectricVehicle Charging Station.Electric Vehicle. PowerManagement System.**

I. INTRODUCTION

New loads, such as charging stations for electric vehicles (EV), have contributed to an increase in the demand for electrical power in comparison to the amount of energy that is being produced over the past few years [1]. Because there are a limited number of non-renewable sources and it also has a negative influence on the environment, renewable energy base sources are becoming increasingly important in the accessibility of power networks. Solar energy has the greatest potential, but it is limited in the sense that its output varies depending on the time of day, the season of the year, and the geographical location. Other forms of renewable energy, such as hydropower and wind energy, are also friendly to the environment and can be sustained over time. Large capacity photovoltaic (PV) array systems are capable of running a continuous power generating electric car charging station [2]. On the other hand, the majority of non-conventional sources are non-uniform in nature, which results in power variance in the charging station. The power fluctuations can be managed in one of two ways: either by relying on the support of the grid or with the assistance of a hybrid energy storage system (BS). Relying on the support of the grid would ultimately lead to an increase in pollution [3,4]. In this paper, BS is offered as a means of managing the variations in the flow of power. The PV side dynamic fluctuation is managed by BS by decomposing the lack of power balance into slow and fast variable dynamics. The storage battery is going to be responsible for compensating for the slow varying dynamics, while the storage system is going to be responsible for compensating for the fast-varying dynamics [5, 6, 7].

Numerous pieces of research have proposed an approach known as power management strategy (PMS) to regulate the flow of electricity between solar panels and batteries, in addition to other forms of energy storage such as fuel cells and fly wheels [8].

To direct the power flow between the solar energy and the storage battery & a novel energy management system is proposed in this article. The Fig.1. Shows the basic topology of EV charging station. The contribution of the paper is

- Solar along with battery based a DC charging station is proposed.
- Power flow manages efficiently between solar, battery and DC EV load.

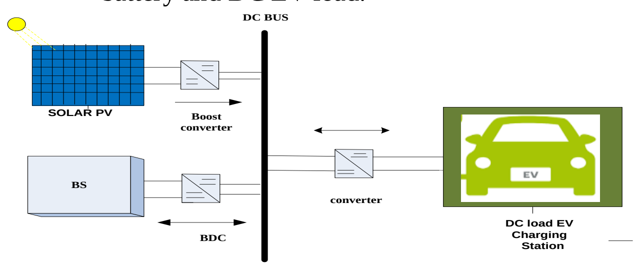

Fig.1. Basic topology of EV charging station

ISSN(ONLINE):2278 - 3814

II. SYSTEM CONFIGURATION

The taken system comprises of PV arrays and a BS. BS isa storage battery (SB).All the component is connected to a common EV charging station as shown in Fig.1.

2.1 PV modelling

A photovoltaic system typically includes an array of photovoltaic modules Fig.2. depicts the PV array equivalent circuit model. PV current is expressed by equation (1).

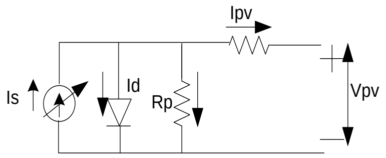

Fig.2.PV array equivalent circuit

$$Ipv = \left(\frac{\gamma}{\gamma ref}\right) Isref + \alpha isc(Ta - Tref) - Io\left[\exp\left(\frac{Vd}{Vt}\right) - 1\right] - \frac{Vpv+RsIpv}{Rp} \quad (1)$$

Where, γ indicate irradiance measure in $w/m2$,T_a shows temp in SI unit, α_{ISC} coefficient of short circuit current and I_{SREF}, T_{SREF} and γref are rated valu, I_S source current in amp, Ipis current through Rp resistance in amp, $I_D$is diode current in amps,$V_{PV}$is PV array voltage in volt,$V_D$is voltage across diode in volt.

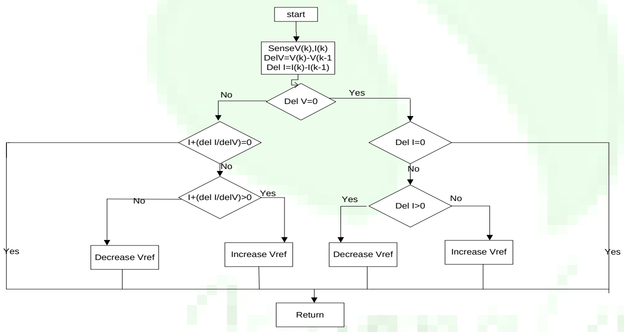

Fig.3. Incremental conductance MPPT algorithm flowchart

Due to the irradiance in PV array, there is variation in the generated power and maximum power point tracking (MPPT). To trace the MPPT, incremental conductance (INC) MPPT method as shown in Fig.3. is performed with an adjustable variable step size. This algorithm itself change the step size to observe the maximum power point (MPP) with step size adaptation coefficient, and a user predefine fix value is not important for the junction of this MPPT method, thus clarify the design of the PV system.[9]

2.2 Storagebattery

A battery is anorigin of electric power made up of one or more electrochemical cells. Its equivalent circuit is shown in Fig.4. SBunit are attuned to diminish theoutput of solar slow power fluctuation. The state of charge (SOC) of the battery is resolved using the method of current integration, where $Q(t_0)$ is the initial charge to the battery at time t_o,α is the discharge/charge efficiency and I is the current

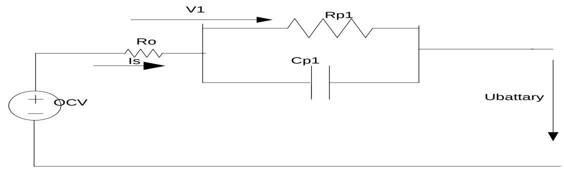

Fig.4. Storage battery equivalent circuit

A. $$U_{battery} = Vocv - V1 \quad (2)$$

Where, $U_{battery}$ is terminal voltage of SB, Vocv is open circuit voltage and V1 is the voltage drop in the battery

$$SOC(t) = \frac{Q(to) + \int_{to}^{t} \alpha . i . dt}{Rated\ Capacity} * 100 \quad (3)$$

III. POWER MANAGEMENT STRATEGY

In this system PMS design, is used maximize the use of power the PV system which is connected to the EV load with a DC-DC boost converter and the BS is connected via a two-sided converter to manage the discharging/charging. SB system process of charging/discharging. Due to variation in solar irradiance, solar output power fluctuates. Therefore, to synchronize the swinging in the flow of power, BS is used in this work meet up the EV loads demand. variation in the power is meetup with the SB.

The PMS works based on the following equation (5).

$$Ppv \pm Phss = Pdcload \quad (5)$$

Where,$Ppv$are the power supplies by solar panel, $Pbat$ is power supplies by storage battery. Positive sign indicates battery in discharging mode and negative sign shows the SB is in charging mode. Here, power is provided by PV array to the EV load. MPPT controller is used to optimize the power. But due to variation in irradiance in solar system, the power is decreasing. To compensate EV demand.

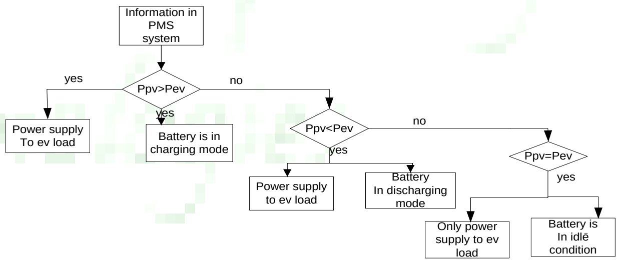

Fig.5. Flow chart of PMS

Flow chart of PMS is shown in Fig.5. Whenever the solar power becomes greater than the load demand, only Solar PV system supply to EV charging station and also supply to battery and SC for charging. Whenever the solar power is less than the load demand, Solar PV system and HSS supply to EV charging station. When HSS is supplying the power then both SB and SC are in discharging mode. In case, the solar power and load demand are equal than only Solar PV system supply power to EV charging station. Both SB and SC are in idle condition

 ISSN(ONLINE):2278 - 3814

IV. RESULT AND DISCUSSION

In this proposed EV charging station, PV system and BSis used for an EV load. PV power varies due to irradiance according to Fig.6.in every one sec, initially solar PV panel have 2000W,at t= 1sec solar power decrease to 1500W, and so on. From t=4 sec to t=5 secsolar PV has minimum power of 150W.In this Fig.8. proposed system that isconstant DC EVload of 1000W continuously takes power from solar PV system up to t=2 sec and after this EV load power is taken from solar PV and BSin time duration of t=2 sec to t=5 sec.To compensate the solar power variation and meetup the charging station demand a battery is used in the system. after t=3sec solar power continuously decrease and solar power less than load demand. To fulfil the load demand battery has supported throughout. Battery has a delay time because of battery time constant. Battery compensates solar power fluctuation for long duration as shown below in Fig.7.

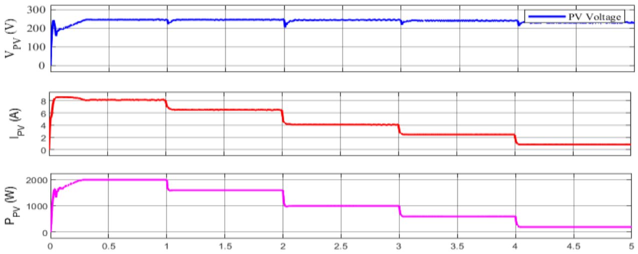

Fig.6.PV result (a)PV voltage, (b)PV current, (c) PV power

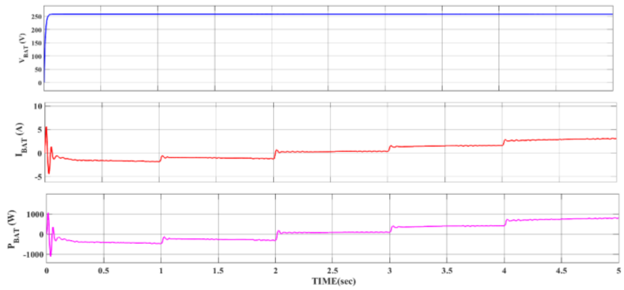

Fig.7 Battery waveform (a) Voltage waveform of battery, (b) Current waveform of battery, (c) Power waveform of battery

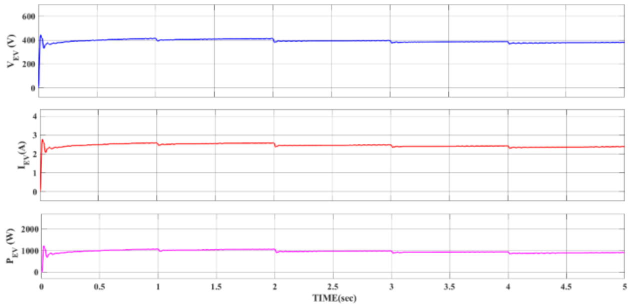

Fig.8.DC load EV Charging station (a)voltage (b) current (c) power waveform

V. CONCLUSION

The suggested PMS manages the power fluctuation efficiency of solar PV systems. storage batteries compensate for long-term power variations and help to meet EV load requirements.it will helps to maintain DC bus voltage constant and also ensure the adequate flow between source and load end. The simulation results confirmed the proposed system as well. The proposed work could be expanded by integrating the grid with the solar system.

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