

# Development of Battery Energy Management System for EV Charging Station

**V. Dineshraj<sup>1</sup>, V. Prasanna Moorthy<sup>2</sup>**

<sup>1</sup>P.G Scholar, Department of Electrical and Electronic Engineering, Government College of Technology, Coimbatore, India

<sup>2</sup>Professor, Department of Electrical and Electronic Engineering, Government College of Technology, Coimbatore, India

**E-mail:** <sup>1</sup>dineshrajelectricalengineer@gmail.com, <sup>2</sup>prasanna@gct.ac.in

## Abstract

Designing energy storage technologies for applications such as power and smart grids has become a need in the last era, and it is heavily reliant on accurate battery conditions as well as characteristic predictions. A variety of techniques are used to identify battery properties and describe battery states, depending on the kind of battery cell and how it is utilized. This study focuses on estimating the State of Charge (SOC), which is one of the most critical battery states. The most significant aspect of batteries is their State of Charge, which represents their accuracy and state. For charging and discharging, the Coulomb-counting approach is used in mathematical modeling to determine the battery's SOC. The proposed system maintains the SOC of the battery when it undergoes deep outflow in the input ports that exceeds its limitation during the charging of EVs in electric vehicle charging stations. Simulations utilizing MATLAB/ Simulink software are used to assess the suggested method's performance.

**Keywords:** Photovoltaic, State of charge, Coulomb Counting Method, Battery Management System

## 1. Introduction

Energy consumption is rapidly increasing in today's society. The notion of Electric Vehicles (EVs) has been proposed as being fully pollution-free. With the world's population growing, more electric vehicles will be needed. In the electrification of transportation, the electric car has assumed a pivotal role. Vehicles that are charged using a battery energy management system have a longer battery life cycle. Charging electric vehicles with

renewable energy sources such as solar is a cost-effective and environmentally friendly option. In batteries, predicting the state-of-charge (SOC) assists in finding accessible energy and the extension of battery life. In a way to sustain the device's SOC, computational modeling is performed to anticipate its performance and effectiveness while overcharging or draining it beyond its limits.

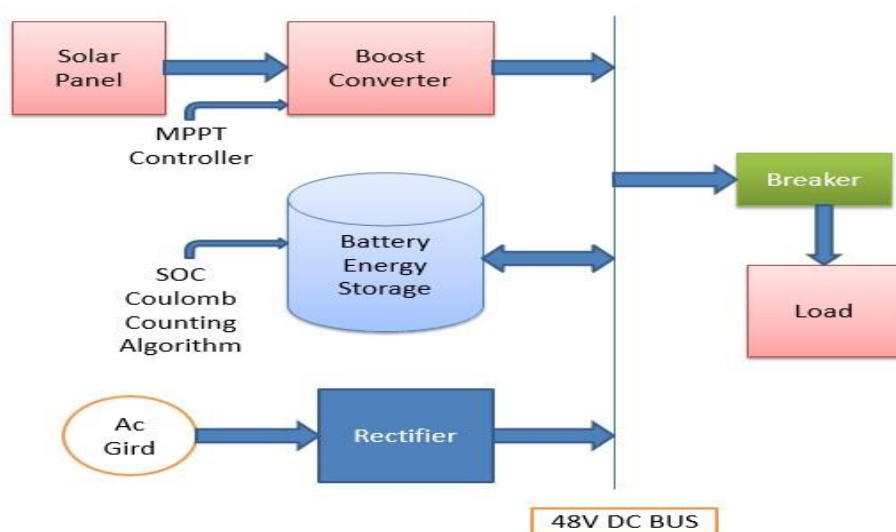
The literature examines a variety of approaches for charging electric vehicles and storing energy from renewable sources usage of a fuel station for electric vehicles in conjunction with a power management system is discussed. [1] explained how to charge an electric car in a charging station using solar electricity, and the battery energy management system was briefly discussed. The battery performance cycle and super-capacitor with the necessary size of the electrical systems were enhanced via recognizing to assess in the electric motor driven by ArifSenol SENER [2]. An electric car is built using outdated technologies. The lithium-ion batteries presented by Jeevak S. Lokhande et al. [3] are environmentally efficient car rechargeable batteries management and energy optimization are two topics that should be aware of considering the difficulty of overcharging and the power is replaced to achieve a more balanced use. Xiangjiang Yang et al. [4] presented a matrix switching network technique for battery management. The accuracy of the battery bank is extensively studied, as well as its cell leveling effectiveness. YashrajTripathy1et al. [5] evaluated several forms evaluate of state techniques that are appropriate for battery charging and cell consequences. The electric bus quick charging station described by Inaki Ojer et al. [6] is transferred with a System for Battery Storage to incoming cars for the goal of minimizing grid power demand. Energy management was described by Viet T. Tran et al. [7] To refuel an electric engine and cut electric grid use a combination of home PV and electric vehicle battery systems is used. Meriem Ben Lazreg and his colleagues [8] explained the improved Coulomb counting algorithm's SOC estimate, which is a chemical that is used in rechargeable batteries to safeguard them from degradation during overcharging and severe reduction.[9] Boost battery efficiency, SOC was calculated utilizing a mixed Coulomb counting approach and fuzzy logic. SOC estimate using a mix of coulomb counting and fuzzy logic technique was explored by Darsana Saji et al. [10].

## 2. Proposed System

This suggested scheme completes the construction of an energy storage system for refueling automobiles at load-carrying sites. Figure 1 depicts the planned electric car

charging station block diagram. The key form of electricity for fast charging is solar. The energy is stored in a battery on the supply side. Solar PV power is transported to the grid side battery, and the battery's battery capacity is maintained utilizing computational modeling techniques. When the weather is overcast or there isn't enough electricity from the PV panels at night, the power is absorbed in the target side battery. On the grid side of the recharging station, the energy stored is used to charge the battery. If the battery on the source side is overcharging or draining, the breaker will trip to safeguard the battery's SOC. In an EV charging station, when the Photovoltaic or input BESS output is insufficient to charge the grid side batteries. In the emergency situations, the essential electricity from the grid is delivered to refill the EVs, assuring the charging station's uninterrupted functioning throughout the day. The study is crucial because correct forecasts may improve the capacity of a battery, SOC efficiency, life duration, as well as effectiveness. Figure 1 shows a block schematic of an electric car charging station.

In the event of a power outage, a battery storage system and solar power output from the grid can be used to charge an electric car. During the day, the solar output will be stored in a battery, which will subsequently supply electricity straight to the load side battery. When the battery is overcharged or discharged, the status of charge is maintained and the coulomb counting technique is employed to safeguard the battery. The battery charger preserves the battery and increases its life only when the soc of the battery drops or when extra power is supplied. BESS is a load-side charging system for electric automobiles. After charging an electric automobile, excess energy in BESS is used to power the demand.



**Figure 1.** Block schematic of the proposed recharging station

SOC refers to the amount of energy accessible in the batteries, but also the life span of the battery. In reality, the battery SOC estimate avoids overcharging and discharging over the battery's limit, which might result in irreversible harm to the battery's inner structure. In general, a battery's fraction of the current battery accessible energy ( $Q(t)$ ) to the maximum controlled energy that could be retained within batteries is known as SOC. The term "state of charge" refers to the state of being charged.

$$SOC = Q(t) / Q(n)$$

SOC is presented as a proportion unit. When a battery pack is recharged, its SOC is 100 percent. The SOC of a deep-discharged battery is zero percent.

The volts a battery bank can achieve and the battery's Ah rating seem to be well, and the required amount of power for an electric vehicle is determined using the solution.

$$E_{EVS} = SOC_r V_{EVS} A_{hrating}$$

The level of charge of a battery may be calculated using a range of mathematical methods (SOC). Coulomb counting seems to be the most common and effective approach.

## 2.1 Coulomb Counting Technique

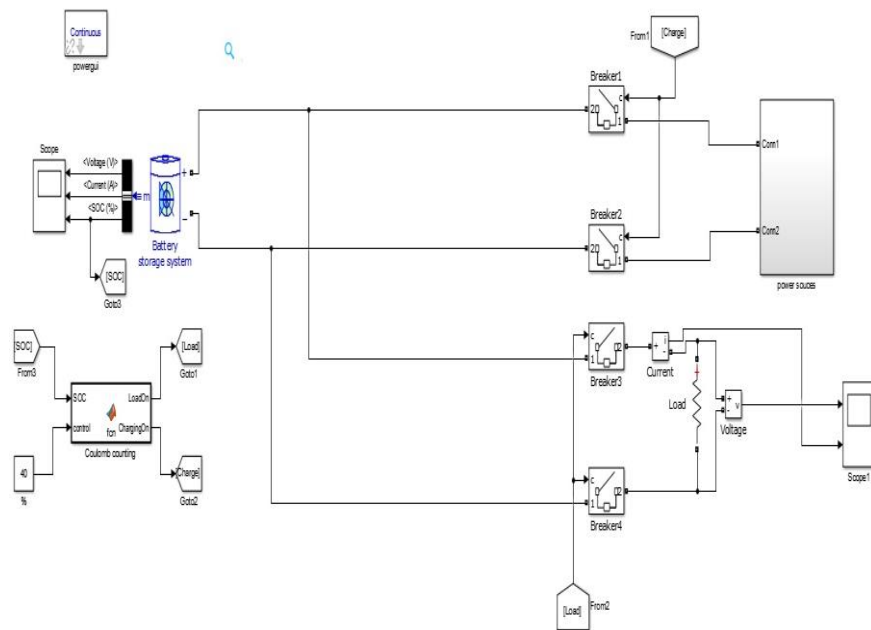
The process of integrating battery current is known as "counting the Coulombs." The energy available in the battery is enumerated over time, and the deep discharging current is taken into consideration. SOC is preserved at the SOC ( $t-1$ ) prior time step and the quantity of energy eliminated/in addition to at the instant time step to achieve energy available in the battery at the present instant. The Coulomb counting method is used to analyze the situation, which is based on deep discharging current and previously obtained SOC values. The proper equation is used to determine SOC.

$$SOC(t) = \int_{t-1}^t SOC(t-1) + \frac{I(t)}{Q}$$

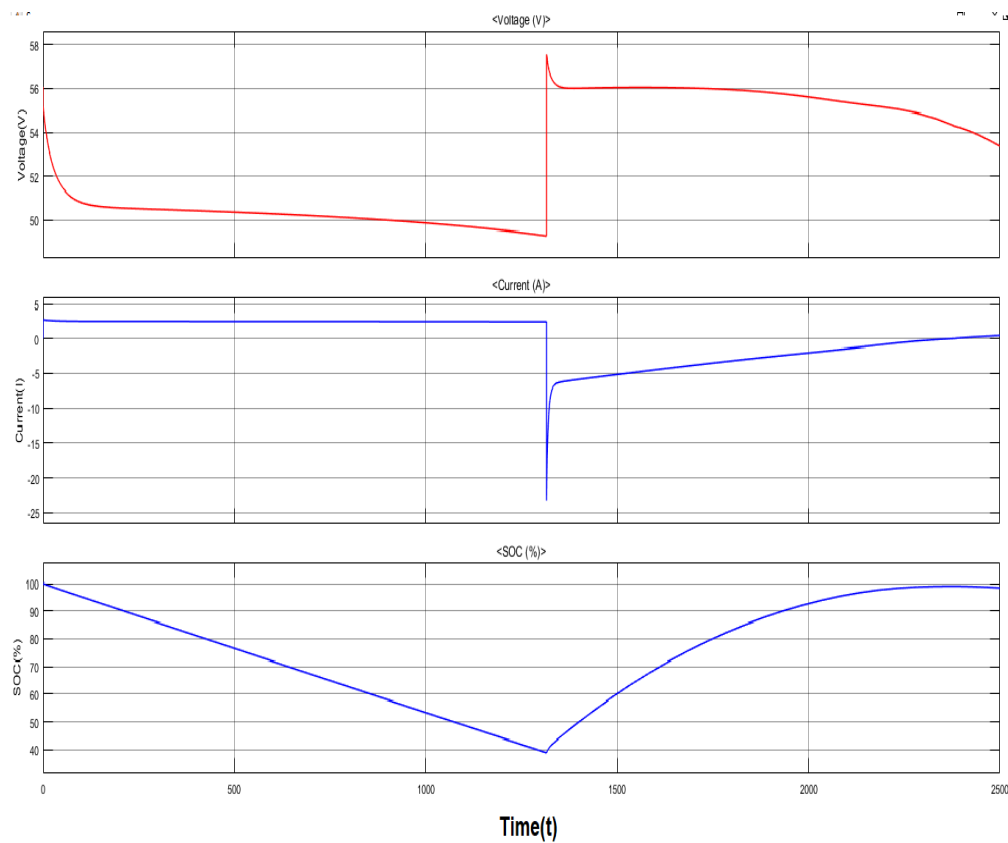
## 3. Results and Discussion

The suggested effort is depicted in the simulation graphic below. Solar PV is the major source of energy for recharging batteries. The energy is stored in the input battery. The suggested simulation result focuses on applying the Coulomb Counting technique to sustain

the current battery SOC. When there is no electricity via Solar panels in dark or when the climate is overcast, the input battery uses the excess power.

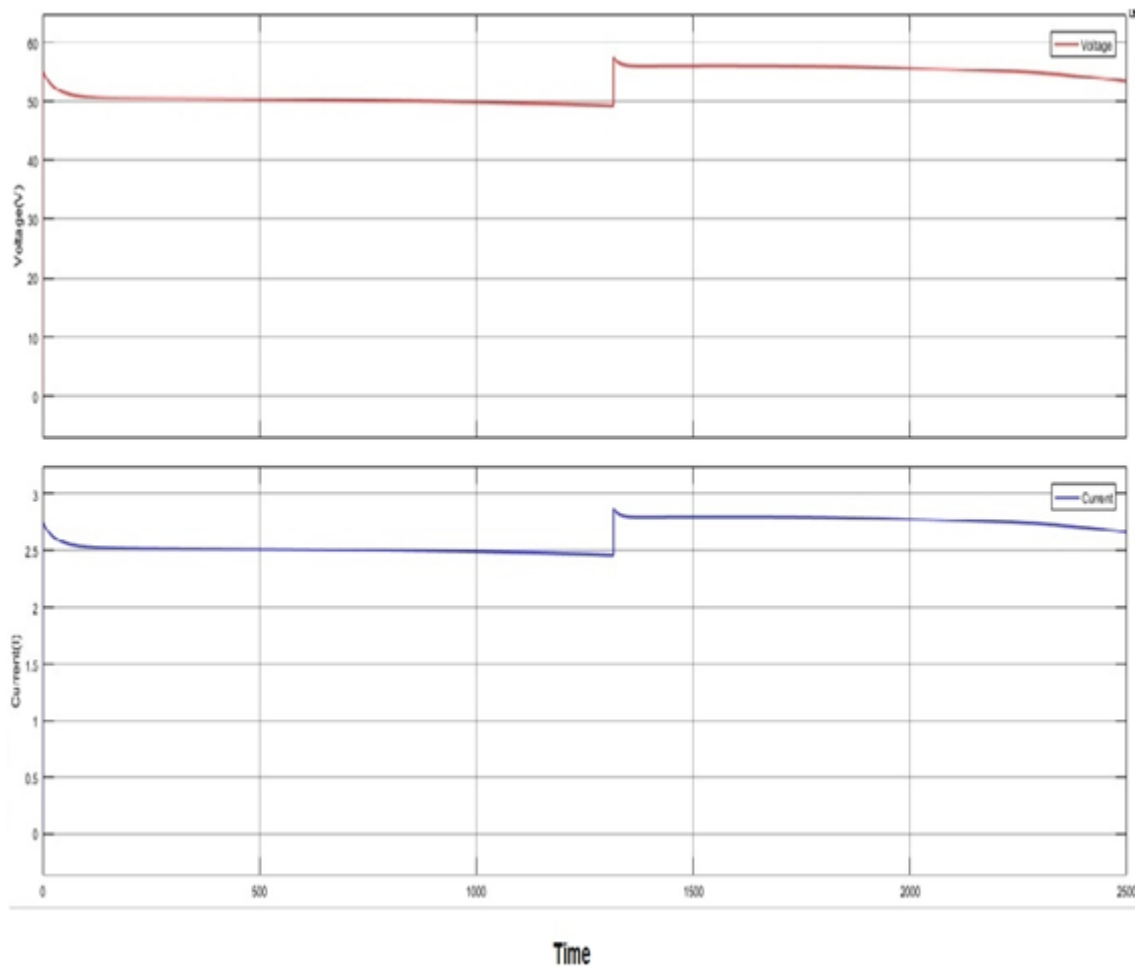


**Figure 2.** Simulation diagram



**Figure 3.** Source Side Output

In the event of a source-side battery failure, the appropriate quantity of power will be drawn from the grid for emergency purposes to ensure the charging station's ongoing functioning across the day. The stored energy is used to charge the battery of an electric vehicle plugged into a power outlet. When the charge time exceeds its limit, the circuit would automatically open to safeguard the battery's state of charge (SOC).



**Figure 4.** Load Side Output

When the current battery supply side is linked to the application, it begins to drain. The current increases, the voltage steadily decreases, and the proportion of SOC decreases. The battery and load are automatically segregated before it reaches the ideal level. On above simulation outcome suggests that when discharging, the battery's SOC does not drop beyond 40%. Current and voltage are the two load-side characteristics that have been studied. Pv System is a significant source of power for recharging batteries. The input battery uses the stored energy in overcast weather or when P generation is unavailable at nightfall.

#### 4. Conclusion

Electric vehicles are becoming increasingly valuable in today's environment for our day-to-day needs. A battery management system is essential in EVs and batteries. For assessing the state of charge in a battery, Coulomb Counting Techniques are utilized. It's the simplest and most reliable method. The major goal of this study is to keep the battery's SOC above 40% during deep discharge, and if extra energy is charged in the input battery as a result of the charge and discharge, it is automatically segregated from the load. In the long term, artificial intelligence and machine intelligence will be used to detect and correct voltage variations in charge controllers, which is then used to recharge an electric car.

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