IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 11,Iss 09, 2022

OFF-VEHICLE BATTERY CHARGER FOR ELECTRIC VEHICLES UTILIZING PV ARRAYS

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Abstract:

The development of electric vehicles over the last decade has been a major driving force behind the expansion of the automotive market (EV). One of the most important factors in the evolution of EVs is the battery charging infrastructure. When an electric vehicle's battery is charged through the power grid, the system must accommodate a larger amount of energy use.

In light of this, the authors of this paper suggest an off-board EV battery charging system that is based on a photovoltaic (PV) array with a controller. To ensure that the electric vehicle's battery is always charged, a secondary battery bank is used in conjunction with the PV array.

The suggested system can charge the EV battery at any time, day or night, thanks to the sepic converter and the three-phase bidirectional DC-DC converter.

The EV battery and the backup battery both get charged during the day's peak sunlight, and the backup battery then helps to charge the EV battery at night or during cloudy days. The results of a simulation run in Simulink inside MATLAB, based on the suggested charging scheme, are shown.

I.INTRODUCTION

Concerns about the environment are caused by the ever-increasing impact of greenhouse gases produced by traditional internal combustion engines. This opened the way for the explosion in the production of pollution-free electric cars (EVs) in the automotive sector [1–3]. However, charging electric vehicle batteries via the utility grid raises the load demand on the grid. This, in turn, results in higher electricity bills for owners of electric vehicles, which compels such individuals to seek for other sources of energy [4, 5]. It is possible to utilise renewable energy sources (RESs), which do not produce pollution and do not run out, to charge the battery of an electric vehicle (EV). Therefore, electric vehicles powered by renewable energy sources may be referred to as "green transportation" [6]. Solar power is one of the potential renewable energy sources that may be readily harnessed to use its energy to charge the batteries of electric vehicles [7, 8].

As a result, the electricity from the PV array is what is utilised to charge the EV battery in the system that is being suggested, and this is done with the assistance of various power converter topologies. As a result of its high power density, high efficiency, low weight, and small size [9, 10], lithium ion batteries are employed extensively in electric vehicles. Additionally, these batteries have the ability to charge quickly and have a long

IJFANS
International Journal of
Food And Nutritional Sciences
Official Publication of International Association of Food and Nutrition Scientists

ISSN PRINT 2319 1775 Online 2320 7876
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lifespan while also having a low rate of self-discharge. They also have a minimal potential for explosion in the event that they are overcharged or improperly connected.

These batteries need very precise voltage regulation when they are being charged. In order to charge an electric vehicle's battery, thus, a variety of power electronic converters with a voltage controller are used. Because the PV array only produces electricity on an as-needed basis, you will require power converters in order to keep the electric vehicle's battery charged. Among the various converters, multiport converters, also known as MPCs, are the ones that are most commonly used in the on-board chargers of hybrid electric vehicles. This is because MPCs are able to interface power sources and energy storage elements, such as photovoltaic arrays, ultracapacitors, super capacitors, fuel cells, and batteries, with the loads found in EVs, which include the motor, lights, power windows and doors, radios, amplifiers, and mobile phone chargers As a result of the fact that all of the sources are housed inside the EV itself, MPCs have the disadvantage of making electric vehicles heavier, more expensive, and more difficult to maintain. In these converter-based EV battery charging systems, the complexity of controller implementation also rises [11–13]. Therefore, in this work, an off-board charger is presented, in which the EV battery is housed inside the vehicle unit, and the PV array and backup battery bank are housed within the charging station or parking station respectively. In the research that has been done [14–16], several converter topologies for off-board charging systems have been presented.

It is the versatility of the sepic converter to function in both boost and buck modes that gives it the advantage over other converter topologies and makes it the top choice. It also benefits from having the same input and output voltage polarity, as well as low input current ripple and low electromagnetic interference [17, 18]. On the other hand, at times of poor solar irradiation or when the sun is not shining, it is necessary to have an extra storage battery bank in order to charge the electric vehicle's battery. The amount of solar irradiation will determine whether this backup battery bank should be discharged while it is being charged or charged while it is being discharged. Because of this, you will need a converter that can allow electricity to flow in either way [19]. Non-isolated and isolated converters are the two categories that may be used to describe the bidirectional converters. Isolation is provided by the transformer inside the isolated converters, which results in an increase in the cost, weight, and size of the converter. The primary concerns of electric vehicles are their weight and size; as a result, nonisolated bidirectional converters are best suited for this application [20–22]. Among the various nonisolated bidirectional converter topologies, the bidirectional interleaved DC–DC converter (BIDC) is preferred due to its advantages, which include improved efficiency in discontinuous conduction mode and minimal inductance value, and reduced ripple current due to multiphase interleaving technique. By using a zero voltage resonant soft switching approach, the turnoff losses may be decreased, and the inductor current parasitic ringing effect can also be mitigated thanks to the use of a snubber capacitor that is placed across the switches. These are the additional benefits that

ISSN PRINT 2319 1775 Online 2320 7876
 Journal Volume 11,Iss 09, 2022

come along with using this bidirectional converter [23–25]. The system described in [25] is an off-board EV battery charging system. When the EV is in a standstill condition, power from the PV array is passed through a bidirectional DC–DC converter to charge the EV battery. When the EV is in a running condition, the EV battery is discharged to drive the dc load in the EV. The electric vehicle's battery can only be charged while the sun is out. This is a disadvantage. The proposed charger is developed using PV array integrated with sepic converter, bidirectional DC– DC converter, and backup battery bank for the purpose of charging the battery of an electric vehicle (EV). This is done to overcome this disadvantage and to ensure that the EV battery is charged without any interruptions.

II. CONCLUSION

The goal of this work is to develop a method for recharging electric vehicle batteries off-site using a photovoltaic (PV) array. The adaptability of the system to continuously charge the EV battery under varying irradiation circumstances is discussed in this research. MATLAB's Simulink platform is used for both the system's design and simulation. The three modes of operation of the proposed charging system were evaluated in the lab using PV modelling, and the findings are shown below.

The RCP approach is used in the inquiry, and the system's dynamic response is provided in both the simulation and experimental settings.

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