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ANINNOVATIVEBATTERY CHARGER FOR EV THAT RELY ON PV ARRAYS TO BE LOCATED OFF THE VEHICLE

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ABSTRACT:

One of the main factors propelling the growth of the automotive industry in the last ten years has been the advancement of electric cars (EV). The infrastructure for battery charging is one of the key elements influencing the development of electric vehicles. A higher energy consumption is required of the system when the battery of an electric car is charged via the power grid.Given this, the authors of this research propose a photovoltaic (PV) array-based controller-based off-board EV battery charging system. Together with the PV array, a secondary battery bank is used to guarantee that the electric vehicle's battery is constantly charged.The sepic converter and the three-phase bidirectional DC-DC converter in the recommended system allow the EV battery to be charged at any time of day or night.During the hottest part of the day, both the EV battery and the backup battery are charged. At night or on overcast days, the backup battery assists in recharging the EV battery. The outcomes of a Simulink simulation conducted inside MATLAB using the recommended charge system 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 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

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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 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. LITERATURE SURVEY:

Mr Murat Yilmaz & Mr Philip T. Krein described different Battery Charger Topologies, Charging Power

Levels, and Infrastructure for Plug-In Electric and Hybrid Vehicles along with information on international charging codes & work codes. The authors demonstrated the difference between unidirectional bidirectional chargers & integrated battery chargers' convertors. They investigated several topologies for an integrated battery charger converter, including one motor with one power converter, one motor with two power converters, etc. The author demonstrated these concepts using various configurations, including isolated and non-isolated configurations, the conductive and inductive charging methods, as well as the contactless charger, which is superior to all the methodologies used by the expert. Various charger power levels and infrastructure configurations were provided and defined based on power, charging time and location, cost, appropriateness, required equipment, and other factors. The success of EVs is dependent on the uniformity of criteria, efficient and smart chargers, and improved battery technology. [1]

Morris Brenna · Federica Foiadelli. Carola Leone. Michela Longo focused on technologies used in EV charging schemes. She has reviewed Many distinct types of electric vehicle (EV) charging technologies that have been reported in the literature and put into practice. This paper provides an overview of existing and proposed EV charging solutions in terms of converter topologies, power levels, power flow directions, and charging control systems. The primary charging methods are also analyzed and incorporated to emphasize an efficient and quick charging procedure for lithium-ion batteries in terms of extending cell cycle life and maintaining high charging efficiency. At the outset, the final section of this study employs a genetic algorithm to predict the appropriate size of charging systems and, based on a sensitivity analysis, the possible future scenarios. [2]

Ms. Sujitha Nachinarkiniyan Krithiga Subramanian offered an effort in this research work to reduce the consequences of the intermittent nature of PV arrays by incorporating a power electronic converter into the circuit. We learned from this paper that, whereas onboard battery chargers have complicated control logic implementations and power quality concerns can contribute to the result. To counter this disadvantage, the author concentrated her efforts on the development of offboarding battery chargers using sepic converters.

She demonstrated the 3 states of convertor operations with the help of the Prototype model & its results. She provided a MATLAB simulation and developed a prototype to better understand the nature of the dynamic response. The author concluded that an offboard battery charger has flexible performance over radiation circumstances based on the examination of experimental outcomes and Simulink results. [3]

MS Radha Kushwaha has specifically focused on designing of Improved sepic convertor. The author demonstrated that the PFC converter is cascaded to a DC-DC converter architecture to manage the current through the battery during the charging process. This suggests that the converter produces the same output voltage at a reduced duty cycle. Because of the decreased duty cycle, the proposed converter is suited for high-power rating EV chargers because the switch conduction loss is significantly reduced. The key benefit of this converter over typical SEPIC PFC converters is the decrease in semiconductor switch voltage for a similar output voltage. This converter's performance is adequate for steady-state and abrupt transients in input voltage, with an enhanced gain and lower switch voltage stress over traditional ones. [4]

Sunil Kumara V*, Anusha S M*, Charan Kumar B*, Lokesh Singh M*, and Manjunath B Kanavalli concluded a review of different convertor-based battery chargers' Electric vehicles (EVs) can be charged with renewable photovoltaic (PV) solar power, and contribute to the integration of solar power in the electricity network via vehicle-to-grid systems. In such systems, the role of consumers becomes crucial as they both generate and store energy. Fast charging for electric vehicles is a decisive green light for the prevailing acceptance of EVs. It could be a solution to consumers' range anxiety and the assurance of electric vehicles. This paper reviews different converter-based battery chargers for electric vehicles. There are many DC-DC converter-based chargers available and research is still going on to enhance the performance of this charger. [5]

Arvind D. has made his efforts to demonstrate a simulation model for an off-board EV battery charging system fed from a PV module using a power converter & observed the results against the prototype. The author has designed a controller a PI controller to check the functionality of the prototype. design EV batteries charge continuously, regardless of ambient light levels, regardless of charger settings.[6]

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III. PROPOSED SYSTEM:

EVs require charging facilities and battery recharging convenience, which can be determined by the type and design of the batteries, chargers, and charging infrastructure. Off-board chargers must be carefully examined due to the demand for a fast-charging method. One way is to feed EV battery charging stations directly from the power grid. According to the results of this experiment, it increases grid load demand, reliability, grid instability, and power quality issues. Large losses need heavy electricity bills and maintenance costs. As a result, it is not a cost-effective model, both technically and economically.

Solar power is one of the most abundant renewable energy sources (RES) available on Earth. As a potential RES, solar is a freely available, abundant zero-emission energy source and shall be used to charge EVs with the help of PV arrays. This concept is known as green transportation which is an increasingly popular concept on a global scale at present.

The chronological observations made based on the above literature survey focus solely on charging technology & our curiosity about the concept of offboard battery charging using solar Power with the help of PV arrays. During the survey, we understood the major challenges in designing chargers the same shall be overcome with the help of solid-state electronic devices.

Offboard Battery Chargers:

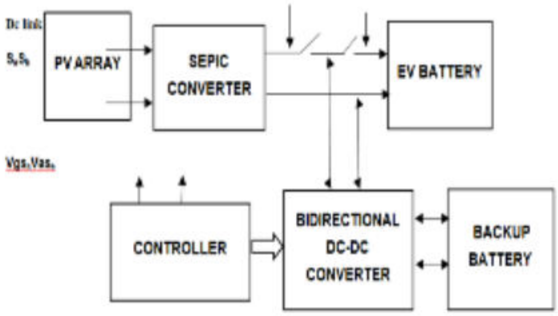

Fig.1-General Block Diagram of EV battery charger

Fig.1 illustrates the concept of a general EV battery charger using a PV array with its distinct parts as under,

PV Array- The solar cell is a semiconductor that provides power when exposed to sunlight. The cells are connected in parallel and series to generate the given voltage and current; it forms a PV module. PV modules are connected in series and parallel with each other, and then it forms a PV array or panel.

Sepic Convertor-The single-ended primary-inductor converter (SEPIC) could either increase or decrease the voltage of the inputs by adjusting the transistor's duty cycle. Under this charging system, the sepic converter oversees maintaining a constant voltage output of the solar panels. The semiconductor converter will include IGBT (Insulated-gate bipolar transistor) transistor, a diode, two inductors, and two capacitors.

Bidirectional Convertor-A buck-boost converter is a type of DC-to-DC converter where the output voltage magnitude is either larger than or less than the input voltage magnitude. Buck-boost converter refers to two distinct topologies. Both may generate a wide variety of output voltages, ranging from substantially higher (in absolute magnitude) than the input voltage to nearly zero.

Controller Interface-We would like to introduce fuzzy logic for the development of a controller to improve efficiency, regulate energy consumption & and reduce nonlinearity in the system & the size of the energy storage element. We aim to assign a rule in such a way to express the relationship between input and output variables which will produce all possible output values to a given input.

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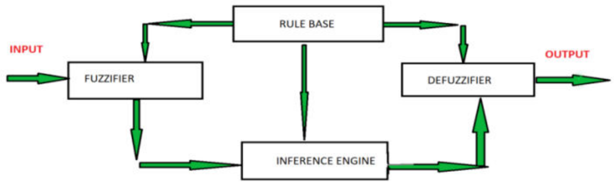

The proposed PV-EV battery charger consists of a PV array, septic converter, half-bridge BIDC, an EV charger. It uses a controller to generate gate pulses for the sepic converter, BIDC switches, and auxiliary switches. The system operates in boost and buck modes, charging the backup battery and EV battery respectively. In addition, the controller generates gate pulses for the auxiliary switches Sa, Sb, and Sc. During periods of high solar irradiation, all auxiliary switches are activated to connect the dc link to the PV array via the sepic converter. When the solar radiation is low, switch Sa is turned off, isolating the PV array and Sepic converter from the dc link. When solar power is not sufficient to charge the backup battery, the switch
Sc is turned off to disconnect the BIDC and backup battery from the dc link.

IV. CONCLUSION

Developing a technique for off-site photovoltaic (PV) array battery recharge for electric vehicles is the aim of this effort. This study discusses the system's flexibility to constantly charge the EV battery under various irradiation conditions. The design and simulation of the system are done using MATLAB's Simulink platform. The results of a lab evaluation of the three modes of operation of the proposed charging system using PV modelling are shown below.

The investigation employs the RCP technique, and both the simulation and experimental settings give the dynamic reaction of the system.

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