



OFFBOARD ELECTRIC VEHICLE BATTERY CHARGER USING PV ARRAYS.

¹Prajakta Vijay Balwan ²Dr.S.N. Patil

¹PG Student, ²Associate Professor

¹Department Of Electrical Engineering

¹PVPIT Budhgaon, Maharashtra, India

Abstract: The study's emphasis pertains to battery charging systems. This paper contains information about different battery charging processes that professionals have researched and demonstrated using MATLAB simulations & prototypes. Solar is one of the implicit renewable energy sources that may be effortlessly used to charge EV batteries, hence the suggested system practices PV array energy to charge the EV battery using power converters. Solar is unlimited and pollution-free, renewable energy sources (RESs) are employed to recharge electric vehicle batteries. An off-board EV battery charging system that charges the EV battery from solar PV arrays via a bidirectional DC-DC converter in stage-still mode. It discharges the EV battery to power the EV's vehicles during operation. Due to the intermittent nature of PV cells, power converters are needed to charge the EV battery bank without interruption.

Key Words - *Green Transportation, Renewable energy Source (RES), Onboard chargers (OBC), Offboard chargers (OFC) Hybrid Vehicle (HV), Bidirectional converters (BIDC)*

Introduction:

The Industrial Revolution introduced internal combustion engines to the world, and since then, it has been evolving day by day with the latest automation and IoT technology. However, no modifications have been made to the engine's inner core to reduce gasoline emissions. High levels of CO₂ & pollutants in the atmosphere have affected the environment globally. To reduce the effects of gases, technology experts and automotive companies are currently experimenting with EV vehicles in markets, which outperform petrol or diesel engines and lead the auto industry.

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 Foadelli. 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]

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:

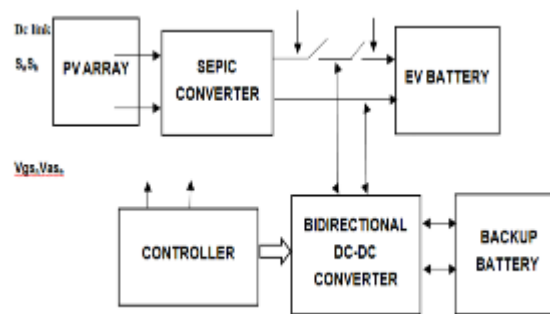


Fig.1-General Block Diagram of EV battery charger

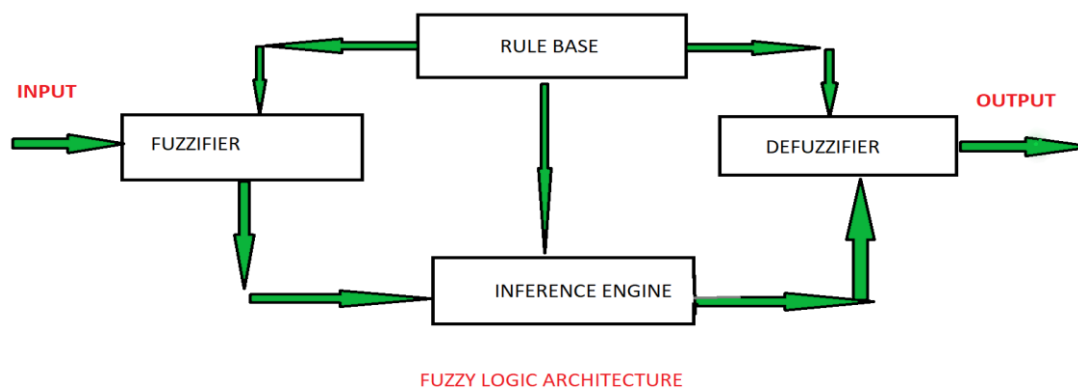
Fig.1 illustrates the concept of a general EV battery charger using a PV array with its distinct parts as under,

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 Converter- 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 Converter- 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.



The proposed PV-EV battery charger consists of a PV array, septic converter, half-bridge BDC, an EV charger. It uses a controller to generate gate pulses for the sepic converter, BDC 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 BDC and backup battery from the dc link.

Conclusion

Based on the literature survey we conclude that the offload battery chargers are an efficient and economical option for fast charging of devices among all the topologies available. With the help of solar energy, we can produce a pollution-free, reliable & stable power source to charge the EV battery. fuzzy logic in the controller will offer a wide band for the generation of expected output irrespective of available solar radiation and input conditions.

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