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A Review Bidirectional Power Transfer between Grid and Electric Batteries Vehicle's

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Abstract *– n recent years, the consistent growth of electric battery vehicles has emerged as a promising alternative to address the challenges posed by fossil fuels and global warming. This surge in electric battery vehicles has attracted numerous investors looking to participate in this burgeoning sector. However, the substantial increase in electric vehicles could potentially strain existing power networks within the power system.*

To mitigate this challenge, vehicle-to-grid (V2G) technology has gained prominence as an effective solution for enhancing the stability and power balance of the electrical grid. Various methods for charging electric battery vehicles have been explored, accompanied by an examination of their advantages and disadvantages.

This literature review also encompasses an analysis of common bidirectional AC-DC and DC-DC rectifiers. While multiple converter technologies can facilitate bidirectional battery electric vehicle chargers, our focus remains on ensuring the safe and dependable transfer of power between electric battery vehicles and the grid within a bidirectional system.

Keywords: **Grid, Electric Batteries, EBV, Bidirectional Power Transfer**

I. Introduction

Climate change and its potential solutions have become a paramount global concern, both for governments and individual activists. The primary challenge associated with climate change is the escalating emission of greenhouse gases resulting from various human activities. A substantial portion of these gases can be attributed to the utilization of different fuels, energy sources, and the exhaust emissions from conventionally used vehicles powered by internal combustion engines (ICEs), such as those running on petrol and diesel.

While a growing number of electric battery vehicles are now traversing the roads of various countries, there has been ongoing research to assess their environmental impact. These electric battery vehicles are seen as a potential solution to curb the emissions associated with traditional gasoline-powered cars, which rely heavily on fossil fuel-dominated electric power sources. However, it is imperative to recognize that merely replacing conventional fuel energy sources with electric power from existing fossil fuel-based systems may not effectively reduce the emission of harmful gases.

As the global fleet of electric battery vehicles continues to expand steadily, it becomes increasingly evident that charging these vehicles with electricity generated from conventional fossil fuel sources does not substantially mitigate the emission of harmful gases. To achieve a significant reduction in greenhouse gas emissions, there is a pressing need to transition to cleaner and more sustainable green energy sources to power electric vehicles and move toward a more environmentally friendly transportation system.

In the year 2017, approximately 27% of the total greenhouse gas emissions in the European Union (EU-28) were attributed to the transport sector. Notably, the carbon dioxide (CO2) emissions stemming from transportation witnessed a modest increase of around 2.5% from 2018 to 2020. Consequently, there is a growing imperative to transition from traditional fuel-powered vehicles to electric battery vehicles as a key strategy for curbing greenhouse gas emissions.

Electric battery vehicles equipped with vehicle-to-grid (V2G) technology have emerged as a particularly promising solution. V2G technology facilitates a bidirectional flow of power between the electric grid and the vehicle. This innovation enables utilities to leverage electric battery vehicles as backup power sources, with the ability to charge during off-peak hours and inject surplus power back into the grid during periods of high demand. Vehicle owners can also benefit financially by charging their vehicles during off-peak hours and selling stored energy to the grid during peak demand times.

Several countries have already begun implementing bidirectional battery electric vehicle charging systems. Notably, Nissan Leaf became the first automaker to receive approval from Germany's electricity grid for the bidirectional integration of electric battery vehicles and the grid. Furthermore, the International Energy Agency (IEA) has set ambitious goals, aiming to see 280 million electric battery vehicles on the road by 2040. This figure surpasses the total energy generation capacity of hydropower plants worldwide, opening up new opportunities in the electric utility sector.

Many nations are actively striving to achieve zero-CO2 emissions across the board, encompassing electric energy production, transportation, and various industries. In the context of electric energy sources, it is paramount to provide environmentally friendly, dependable, and cost-effective electricity to consumers. However, the challenge lies in the unpredictable and intermittent nature of renewable energy sources, which may experience surpluses or shortfalls in power generation at specific times.

II . Literature Survey

Vimala Juliet et al. in(2020) [15] has concluded Continuous charging is possible with an electric car charging station operated by distributed energy sources such as DC Nanogrid (NG). The NG is powered by photovoltaic (PV) and wind energy, both of which are renewable energy sources (RES). when a local energy storage unit (ESU) produces excess renewable energy that is then used when renewable energy is in short supply. When NG is overloaded and there is a need for energy in the iESU, the mobile charging station (MCS)i offers continuous charging. Battery iswapping and vehicle-to-gridi connectivity are made possible by the MCS. The MCS is in charge of keeping track of the battery's health and State of Chargei (SOC) (iSOH). monitoring the ivoltage, icurrent, and temperature of the ibattery in relation to the SOC and SOH. To demonstrate the viability of EV to NG conversion and IoT-based battery parameter monitoring, a lab prototype is being created and tested.

Rajanand PatnaikNarasipuram et al. in(2021) [16] has reported in irecent years, iIn order to lessen the impact of greenhouse gases, the market for electric vehicles has expanded significantly. The deployment of efficient and affordable electric vehicle charging stations with cutting-edge control algorithms, similar to gasoline and diesel stations, is necessary for the implementation to be successful. This review paper provides an overview of electric vehicles and various rechargeable battery configurations. In order to achieve an ideal design, the charging stations are categorised according to their power consumption, and various optimisation algorithms, techniques, and future directions are presented. Along with the potential for the future, the key aspects of grid-connected sustainable power and grid-connected, off-grid configurations are also described. The heavy load placed on the grid, particularly during peak hours, can be reduced by incorporating storage and renewable sources of energy into the charging station. The review study aims to give industry experts and researchers deep insight into these important areas for future developments.

XuJia et.al. (2018)When the electric car stops charging the battery, the car's driver in the car will not work. The transport system that supplies the vehicle's weapons system can be viewed. For some devices, it may have the ability to pay fast and V2G (drive to grid). This paper proposes a charge-coupled Z-source system with LCL filtering. The consolidation method based on the integrated sound system is used to reduce the current to the resonant frequency of the current output. The mathematical model of the proposed system is implemented, and the control mode on the DC and AC sides is proposed. Finally, the Z-source test domain is created during grid connection operation. Experience has proven the superiority of the system.

Chandra SekharNalamati et.al. (2018)The growing popularity of renewable energy and electricity (EV) has transformed the structure of the global energy industry. In the charge-coupled charge system for renewable energy, bidirectional AC / DC converters are used for more reliable power generation operations. This paper presents a bidirectional AC / DC converter that combines an AC-DC bidirectional converter (GBC) and a bidirectional De-Battery (BBC) battery charger. The GBC printer can facilitate bidirectional flow between the AC and DC networks, while the BBC converter can provide bidirectional power between the energy storage / EV and DC grid systems. In order to transmit power in the trunk, powerful power management technology is required. Hysteresis based power management technology is used to inject electrical energy into the container. AC-DC conversion offers asymmetric PWM strategies with minimal conversion. PSCAD tools are used in simulation to validate the proposed control algorithm.

Fatama-Tuz-Zahura et.al. (2018)The draft proposal and the current control system for mains inverter are proposed. The Controller can also be used with an energy storage system (ESS). The volume management system described in this article is based on a standard PI regulator that provides a low DC connection voltage and low response speed. The current monitoring strategies used here can improve the old shortcuts and eliminate long-term errors. Simulation is performed with MATLAB Simulink. By comparing the simulation results to the literature results, the performance of the system is optimized. The system can be used to improve the short- term response of bidirectional operators.

MengRunquan et al. (2019)When generating a DC microgram with an AC microgrid, the bidirectional AC / DC converter (BIC) voltage associated with the AC and DC subnets must have a microgrant AC voltage with amplitude, frequency and phase The same magnitude. Therefore, the frequency, phase and amplitude of AC voltage needed for network services are known quickly and accurately. Therefore, a communication method is proposed. First, the principle of bidirectional AC / DC converter is introduced, and the problem of water loss during power relations is addressed. In the meantime, determine the BIC transmission status, and appropriate control strategies for AC / DC microgrid connectivity. Finally, the proposed control algorithm is validated by the Matlab / Simulink simulation.

III. Method

A crucial feature of bidirectional battery electric vehicle chargers is their capability to not only charge but also inject power from the battery back into the grid, in addition to conventional charging methods. In Section 3, various converter technologies proposed for bidirectional battery electric vehicle chargers, including both two-stage and single-stage systems, were reviewed from the existing literature. After a comprehensive evaluation of these reviewed rectifiers, a two-stage conversion model of an electric battery vehicle charger with the ability for two-way power transfer was developed and simulated.

The charger employing a two-stage conversion consists of two rectifiers. The first is a two-level three-phase bidirectional rectifier employing six switches connected to the three-phase grid. The second is a half-bridge buck/boost bidirectional DC-DC converter utilizing two switches to connect the DC-link and battery pack. While the two-stage approach offers better DC voltage regulation, it comes with the drawback of increased size and higher costs.

Crucially, V2G technology is anticipated to play a significant role in enhancing the reliability and efficiency of grids dominated by renewable energy sources. While electric battery vehicles with unidirectional chargers can contribute to power system balance, they are not as effective as those equipped with bidirectional chargers. The traditional method of load balancing with unidirectional chargers involves adjusting electric battery vehicle charging rates based on the electric utility's status, often referred to as peak shaving or load shifting.

For instance, consider a scenario involving a wind power plant. During certain times, such as nighttime, if the wind turbines generate surplus power that cannot be immediately used or sold, the only option is to shut down the turbines to maintain nominal frequency and prevent network instability. However, with several vehicles equipped with bidirectional connections, the excess energy generated can be efficiently utilized by charging the cars during such periods and injecting power back into the grid during peak hours. This underscores the significance and advantages of bidirectional chargers over traditional unidirectional chargers, motivating further investigation.

This section proceeds with a detailed step-by-step modeling of the bidirectional battery electric vehicle charger in MATLAB/Simulink, followed by simulation results and a comprehensive discussion. The subsequent subsection focuses on the bidirectional DC-DC converter, highlighting its role in efficient electrical power transfer and battery charging. The non-isolated bidirectional half-bridge buck-boost converter is presented, capable of operating in both buck and boost modes. This converter is developed through the combination of separate buck and boost rectifiers.

V. Conclusion

In this presentation, various methods of charging electric battery vehicles from different energy sources and converter technologies for bidirectional power transfer are extensively explored. The discussion encompasses an overview of the currently available standard bidirectional electric battery vehicle chargers. A two-stage model for a bidirectional battery electric vehicle charging station is meticulously designed and separately simulated, both with and without galvanic separation techniques. The choice of the two-stage converter approach is motivated by its ability to regulate voltage effectively within the power system.

The pursuit of innovative charging methods for electric battery vehicles, free from harmful gas emissions, takes center stage in this discourse. Charging stations exclusively powered by renewable energy sources are identified as an optimal solution. Converter technologies facilitating bidirectional energy transfer between electric battery vehicle batteries and the grid are presented, accompanied by a thorough examination of their respective advantages and disadvantages. The concept of vehicle-to-grid (V2G) emerges as a potent force for advancing grid development and addressing supply challenges within the power system.

Several companies are actively engaged in the development of upgraded bidirectional charging solutions, with a target completion date set for 2025. In the final phase of the presentation, a detailed modeling and simulation of a bidirectional battery electric vehicle charging station is showcased. These charging stations feature bidirectional three-phase AC-DC and DC-DC converters, available in both isolated and non-isolated configurations. The simulation results for both models demonstrate a high level of satisfaction, reaffirming the feasibility of bidirectional power transfer with the developed models. This marks a significant step forward in realizing the potential of bidirectional electric vehicle charging and its integration into the broader energy landscape.

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