Review on EV Charging System with V2G Operation using DC-DC Converter

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Abstract— The rapid advancement in power electronics converter technology and fast speed controller technology has increased the popularity of power electronics based equipment's like battery chargers, inverters, SMPS supply for industrial and commercial application. The power electronics devices are used as a switches for efficient control of power, in various application like electrical vehicle battery charging, power flow in both the direction in grid to vehicle, connect your vehicle to the power grid using a variety of non-isolated and isolated DC-DC converters. The literature includes switched capacitor bidirectional DC/DC converters, cascaded bidirectional buck-boost converters, SEPIC-ZETA bidirectional DC/DC converters, non-isolated bidirectional DC/DC converters, and six types of nested non-isolated converters. is listed. Non-isolated bidirectional DC-DC converter. Non-Isolated Bidirectional DC-DC Converter Bidirectional step-down converters are typically used in electric vehicle charging applications. Isolated DC/DC converter topology full bridge converter is more popular because of its easy control and higher efficiency, in this converter series resonant tank is plays a significant role to a cost-effective solution is to switch** both sides **to zero voltage** during **charging and discharging.** Study **of various bidirectional DC-DC converter applications for electric vehicle charging.

Keywords—Electric Vehicles, DC-DC Converter, Bidirectional

I. INTRODUCTION

On recent years due to global warming CO2 emissions in increased rapidly and air pollution also increased due to various sources like conventional IC(internal combustion) engine-based vehicles, diesel engine-based railway locomotive, heavy vehicles, airplanes, etc. nearly 25% of greenhouse gases are contributed by conventional transportation. Crude oil demand increases day by day because of population growth. In India country population rate is too high and increased hence the consumption of crude oil based vehicle increased. Present-day air pollution in India is very severe health issue [1]. In the world's 30 most contaminated cities list 2019, 21 were in India. As per a study centered on 2016 statistics, at least 140 million persons in India respire air that is ten times or more over the WHO safe limit. Fifty-one percentage of pollution is caused by industrial pollution, twenty-seven percentages by vehicles, seventeen percentages by harvest burning, and five percentages by fireworks shown in Fig.1.

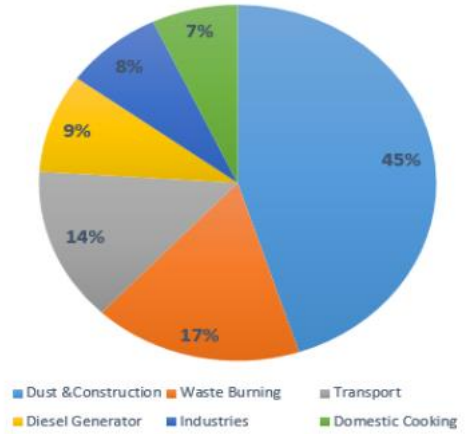

Fig. 1 Sources of air pollution in India

For reduction of air pollution and reduce the import of crude oil from other countries India start an initiative to use renewable energy and alternate sources of conventional public transport based on petrol and diesel [2]. Indian government starts various initiatives like the uses of electric mobility, increasing electric generation based on renewable energy, etc. India includes uses of an electrical vehicle in their transport policies the response have diverse permitting to their stage of financial growth, energy reserve aids, technical capabilities, and political arrangement of responses to environmental deviation. The sales of electrical vehicle in the Indian market are increased by 10X in the next two decade shown in Fig. 2. These circumstances have prompted India to adopt an electric vehicle policy to systematically ensure that India's electric vehicle plan is kept in step by the international scale because big markets due to having taken important steps about the electrification of vehicles. India's development outlook produces the possibility to develop a control position in electric vehicles in specific areas. In this perception, the strategy will promote a way that initiates with the particular features and initiatives of the Indian automotive industry and moves around worldwide importance as well as applications [3].

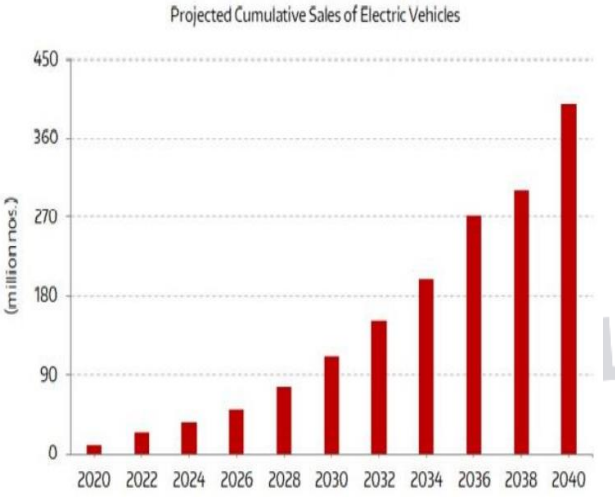

Fig. 2 The sales of electrical vehicles for the Indian market in the next two decades

The main goals of the electric vehicle procedure are:

- Reduction crude oil consumption in transport.
- Ease consumer acceptance of electric and clean energy vehicles.
- Stimulating state-of-the-art techniques in India over adoption, and R&D.
- Enhance the revenues of transport utilized by ordinary people for individual and cargo transport.
- Decrease greenhouse gasses in the urban area.
- Generate electrical vehicle production capability that is of reliable and effective.
- Increase the job demand in solar energy field.

II. LIITERATURE REVIEW

Sithara et al. [1], presents a sun oriented photovoltaic (PV) based electric vehicle (EV) accusing arrangement of the capacity to charge the EV battery capacity framework and with vehicle to lattice (V2G) activity to help power network. The charging framework comprises of a sunlight based PV cluster with a solitary finished essential inductor converter (SEPIC) DC converter, a bidirectional DC converter for EV battery charging and three-level inverter with LCL channel for lattice interface and related regulators. The SEPIC converter is controlled with most extreme power direct following calculation toward separate greatest power from sun based PV cluster and charges EV battery through a bidirectional DC converter and regulator. The planned regulators are proficient to give continuous charging and framework backing to improve lattice execution under unsettling influence and variable PV age. The charger is additionally empowered with V2G power move for dynamic and receptive power backing and improvement of shortcoming ride through capacity for the circulation matrix with environmentally friendly power sources. The proposed framework is executed in MATLAB/Simscape climate and results affirm that the proposed sun powered PV based EV charging framework can charge the EV and give lattice support under fluctuating irradiance and matrix aggravations.

Vikram Singh et al. [2], sustainable power based battery charging frameworks for Electric Vehicles (EV) have seen flood in car research in most recent couple of years. In this study, EVs that are powered by solar PV are thoroughly examined. Zero emissions, load leveling, excellent transient functioning, and the capacity to recover energy while braking are among the many advantages of using batteries to store energy in ground vehicles. To connect PV to the dc-link of the battery, a bidirectional DC-DC converter is required to meet these requirements. A PV-powered electric vehicle must be capable of two modes of operation: charging and releasing. Greatest Power Point Following (MPPT) method is used in this review to gather most power by sun based PV. Additionally, the proposed closed-loop control circuit for a system is verified through MATLAB simulations.

Suraj et al. [3], the petroleum product consumption and flood in power request have prepared to extreme entrance of environmentally friendly power sources, particularly Sun based. The development in photovoltaic framework and its pinnacle power age from 11 am to 3 pm, when the power request is low, requires energy capacity framework (ESS) for productive use of photovoltaic power age. In this paper, Photovoltaic Energy Stockpiling Framework in the Indian situation is created by thinking about the charging of Electric Vehicle (EV) Battery and Assistant Battery (Stomach muscle) during the pinnacle power age of sunlight based photovoltaic (SPV) framework connecting with power electronic converters. In this proposed work, the Auxiliary Existence of High-Limit EV battery is used as Stomach muscle. With the SPV system's hardware setup, a SC-based power converter, and 18650 3000mAh Li-Ion cells used as EV and AB, the proposed methodology is confirmed.

Abdalrahman Elshora et al. [4], recently, it was reported that the transportation sector in Canada was the second largest producer of greenhouse gases. Similarly, researchers are hard at work developing charging control systems for electric vehicles. Energy storage size and charging time are super two issues. Research shows that crossover power capacity can not only reduce overall energy costs, but also increase power depth and reliability. However, controlling multiple energy sources is difficult. This article presents a bidirectional DC-DC converter that can manage multiple energy limits from different energy sources. Special developments of information energy sources are possible by adding some parts. This allows power to flow to all bearings. Using Matlab Simulink, the proposed converter was mimicked and effectively tested in most loading and sharing situations.

Y. Q. Wang et al. [5], a novel switched-capacitor-based T-type multilevel inverter (MLI) is proposed in this paper. The proposed inverter not just accomplishes that the greatest voltage stress of the switches is not exactly the information voltage yet in addition has a voltage support capacity, which makes it reasonable in high voltage applications. It is important to point out that the proposed inverter has two topology extension schemes that help it get a higher voltage gain and output level. A seven-level inverter can be

constructed with just two capacitors thanks to the advantages of low voltage stress and low power consumption. In addition, the capability of capacitor voltage self-balancing can reduce the complexity of the control and circuit. The inverter's capacitor topology, operating principle, modulation strategy, and analysis are presented. The advantages of the proposed inverter will be verified by distinguishing between the proposed crossover MLI and the trade capacitor MLI. Finally, a seven-stage model is built to ensure that the hypothesis study is correct and the proposed inverter is practical and feasible.

S. Bayhan et al. [6], numerous nations have a wealth of sun powered energy assets, and furthermore dislike tail-pipe contamination from a developing number of individual vehicles. The utilization of photovoltaic (PV) age and electric vehicles (EVs) is by all accounts an ideal decision for overseeing carbon impression. This paper presents the lattice attached PV framework with a coordinated EV battery and its power stream control procedure. The ideal technique concentrated on in this paper is to organize EV battery and PV ability to further develop the power framework execution. The framework is displayed and mimicked in PSCAD climate to check the framework execution. As per the got results, it very well may be reasoned that the framework concentrated on in this paper has an extraordinary potential for the future PV based EV charger applications.

E. Mancini et al. [7], the universe of transport is confronting an extraordinary test with individual vehicle representing around 80% of it with vehicles, steadily leaving petroleum products and conventional motors to embrace battery fueled drive, seeing in 2030 a critical dispersion of Electric Vehicles (EVs) in Europe surpassing 40 million units. The paper looks at the effect of various degree of entrance of electric portability on the power organization and Low Voltage (LV) Dissemination organization and specifically, what mediations and advancements the circulation matrix should go through to deal with this new and continuously expanding heap of energy. Metropolitan and provincial framework models have been examined, to underline the distinctions between the EVs influence on High and Low thickness organizations. An administration model for the creation and utilization of power has been proposed to further develop the basic viewpoints got from the primary reproductions, coupling a PV framework with an Energy Stockpiling Framework (ESS). At last, an answer for exploit general society Charging Stations (CSs) where to control the nearby voltage varieties through associated EVs is introduced.

B. Singh et al. [8], a sun oriented photovoltaic (PV) cluster, a in island, network, and DG set related modes, unlimited charging is provided by BES, DG set, and grid-based EV CS. The core of CS is intended to utilize the sun powered PV cluster and a BES to charge the EV battery. Be that as it may, in the event of depleted stockpiling battery and inaccessible sun based PV exhibit age, the CS wisely obtain power from DG set or grid. Anyway, the performance of the DG set is amazing. attracted a way that it generally works at 80%-85% stacking to accomplish greatest eco-friendliness under all stacking conditions. Besides, collaborating with the capacity battery, the CS directs adjust the generator voltage and repeat the process without increasing machine speed. Even nonlinear stacking ensures that the power extracted from the framework or DG set is equal to the joint power factor. The coupling voltage is also synchronized with the mains/generator voltage to ensure constant charging. CS also simulates dynamic/receptive force movements from vehicle to house, vehicle to vehicle, and vehicle to matrix. move for expanding the functional proficiency of the CS. The activity of the CS is tentatively approved utilizing the model created in the research center.

A. Amin et al. [9], this study sums up a basic survey on EVs' ideal charging and booking under powerful valuing plans. A point by point examination of these plans, specifically, Ongoing Estimating (RTP), Season of Purpose (ToU), Basic Pinnacle Valuing (CPP), and Busy time Refunds (PTR), is introduced. Worldwide, the goal is to lessen the fossil fuel byproducts (CO2) has propelled the broad act of Electric Vehicles (EVs). The clumsy charging and uncontrolled combination anyway of EVs to the circulation network break down the framework execution concerning power quality issues. Thusly, the EVs' charging action can be composed by powerful power estimating, which can impact the charging exercises of the EVs clients by offering adaptable valuing at various requests. As of late, with advancements in innovation and control plots, the RTP conspire offers more commitment contrasted with different sorts of tax due to the more noteworthy adaptability for EVs' clients to change their requests. It anyway includes more serious level of charging shakiness, which might impact the client's certainty. Moreover, the RTP plot needs a powerful insightful computerization framework to work on the client's criticism to time fluctuating costs. Furthermore, the survey covers the fundamental streamlining techniques utilized in a unique evaluating climate to accomplish targets, for example, power misfortune and power cost minimization, top burden decrease, voltage guideline, dispersion foundation over-burdening minimization, and so on.

S. Athikkal et al. [10], non-disengaged DC converters with multi input highlight are exceptionally well known in the space of crossover energy reconciliation since they are smaller, cost proficient contrasted with the confined geographies. A Double Info Half and half move forward DC converter (DIHDC) with a smaller design is presented in this paper. DIHDC works in view of the exchanged inductor strategy. DIHDC has two inductors with equivalent qualities that are parallels stimulated in the underlying working modes (i.e., switch on condition) and scatters the put away energy in series in the last working mode (switch off condition). Additionally, the proposed converter can be reached out up to different contributions with slight changes in the design. Basic and minimal design, somewhat higher effectiveness and great voltage transformation proportion are the likely merits of the new converter. Examination of DIHDC in consistent state condition is made sense of extravagantly and the recreation results are introduced. A research center scale

converter model has been created to affirm the effective activity of DIHDC in reasonable circumstances.

III. DC-DC CONVERTERS

DC converters are divided into two classes according to their galvanic isolation: non-isolated DC converters and isolated DC converters. Figure 3 shows the different types of DC/DC converters divided into linear power supplies, hard switching DC/DC converters, and soft switching DC/DC converters. The advantages of using linear power supplies for series and parallel regulators are low cost, simple design, and low noise.

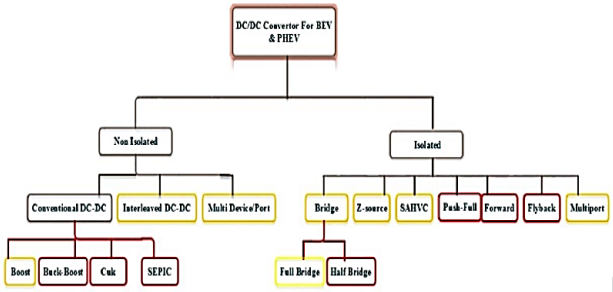

Fig. 3 DC-DC converters

However, the linear power supplies are not suitable for high switching frequency and high power uses as well. The power supplies based on hard-switching (nonisolated and isolated) soft switching DC-DC converters can handle high switching frequencies and high power. The main disadvantages of hard switching converters are low productivity and long on/off switching problems in terms of repeated switching, working data and resulting impact level. DC-DC converters with soft switching can solve these problems.

Non-isolated DC-DC Converters

The BDCs without a transformer [11] can be operated either across boost or buck mode. The converter topology through high-frequency transformer is preferable to deliver galvanic isolation among the source as well as the load. To reduce the overall cost, volume, and improved efficiency, the non-isolated BDCs are alternate solutions to the industry. Non-isolated BDCs can be operated at high power applications; however, the size and weights are lesser than the isolated converters. The non-isolated BDCs are more economical than the isolated BDCs. To achieve the dual characteristics of a converter as bidirectional, a parallel connection of the boost and buck converters has been made. The converter is applied to gain the higher output voltage from the lower input voltage (from the battery) and provides the desired input voltage to the inverter. While the converter is operated in buck mode, the regenerative braking of the motor is obtained. This mode of operations may also provide the path for current in braking.

Isolated Bidirectional Converters

It is a type of A bidirectional DC-DC converter with a high frequency transformer (HFT) providing isolation between the load and the input the HFT can affect the overall cost and creates additional losses. There are many such isolated converter topologies are reported in the last decade [12, 13] as half-bridge (HB), full-bridge (FB), current fed HB, current fed FB, and Push-Pull HBs, etc. The major advantages of these converter topologies are given as follows:

- Galvanic isolation
- Number of component is reduced because of the minimum number of active switching devices In the FB and HB converter topologies, the transfer of the energy in a bidirectional manner is achieved by utilizing the leakage inductance of HFT as part of it.

IV. EV CHARGER

The EV chargers are classified into two types based on the location of the charger: on-board and off-board charger as shown in Figure 4a [14]. If the charger is installed inside the electric car, it is called an on-board charger. Figure 4(b) shows it as an external charger when it is external to the EV. The EV can be charged in three ways: 1) conductive coupled charging, 2) wireless charging and 3) battery swapping [15, 16]. The conductive coupled charging is simple, which has a conductive cable between the charging port and EV. Here, an electrical outlet with the plug-type connector is used to charge the EVs. The wireless charging is done by inductive and capacitive coupling.

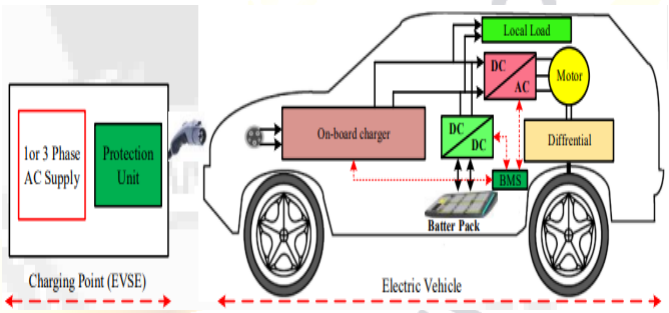

Fig. 4(a) On-board charger

The on-board charger is used for low power applications, an external charger is used for high power applications DC fast charging [17]. The off-board chargers offer fast charging and vehicle to grid charging.

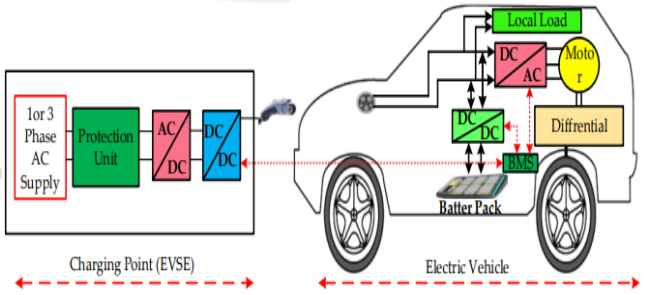

Fig. 4(b) Off-board Charger

V. CONCLUSION

The isolated series resonant full-bridge bidirectional dc-dc converter for electrical vehicle application besides with working principle and features are presented. As the series resonant-based fullbridge bidirectional converter is a two-stage conversion device for bidirectional operation, it provides tremendous interest in the electric vehicle charging industry as well as domestic DC microgrids where fast charging is needed that we are achieving through high switching frequency. The series resonant-based full-bridge converter has several advantages like simple pulse width modulation control is used to control the transfer power, and zero voltage switching for all the switches within vast voltage range is switching frequency fixed at the resonant frequency of the series resonant tank. EV chargers must provide a wide range of output DC voltage to accommodate different nominal battery voltage levels. To meet this requirement, EV chargers must be designed with efficient and reliable voltage regulation and current control mechanisms, ensuring safe and optimal charging performance for different EVs and batteries.

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