© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 12 Issue: 01 | January - March 2021
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# A Review on Dc/Dc Converter with Dual-Battery Energy Storage for Hybrid Electric Vehicle System

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***Abstract-*** In the present world the major concern is the soaring of prices of oil, increase in carbon emission and depletion of conventional energy sources especially in developing countries like India this is severe due to rapid economic developments, increasing traffic, growing cities. This article fully discusses the general review on DC/DC Converter with dual-battery energy storage for hybrid electric vehicle applications. The HEVs have various configurations depending on the hybridization degree to provide simultaneous traction efficiency for the IC engines and electric batteries. There are a physical description and simulation of hybrid fuel vehicles. Now to reduce the weight, size and the cost of system, proper DC-DC converter topology should be selected so as to optimize the design performance. It also presents the comparative advantages for arriving at the proper design decision for Hybrid Electric Vehicle application.

***Keywords***- Plugin Hybrid Electric Vehicles (PHEV), Electric vehicles (EV), Hybrid Electric Vehicles (HEV), DC-converter link.

## I. INTRODUCTION

Nowadays, EVs are being in focus but actually they are not as new as seen. William Morrison in 1891 created a first successful electric vehicle. The weight of vehicle was about 350kg and its average speed was around 14km/h. The gasoline automobile industries started to expand with the rapid technological growth of gasoline vehicles and even with EVs already sticking to the slow progress of batteries, and EVs were almost lost. Production of EVs reduced drastically and its use was limited to just few applications like in delivery services and trash collection. Till 1970s, Electrical vehicles were almost forgotten. Major automobile makers looked back to electrical vehicles with the oil crises and when public started concerning about the environment and use of renewable energies. But, technological advancement is still a serious concern in EVs. [1]

### *A. Electrical Vehicle*

Electrification of transport vehicles has several economically viable and environmentally important advantages. Because of high fuel economy and less carbon emission, Plugin Hybrid Electric Vehicles (PHEV) or Electric vehicles (EV) are becoming popular. For traction, electric motor is used in Electric vehicles which are powered with the help of battery packs. Either in home charging stations or in any public charging stations, the battery packs can be charged. For city driving conditions, electric vehicles are much more suitable as they can easily charge by using an electric outlet. Owing to inadequate charging facilities and current battery technology, they are not favored for long distance driving. [2]

**Following are the types of electric vehicles:**

1. Battery Electric Vehicles (BEV)
2. Fuel cell Electric Vehicle (FCEV)
3. Hybrid Electric Vehicle (HEV)
4. Plug-in Hybrid Electric Vehicle (PHEV)

The BEV and FCEV come under the category of pure EV while HEV and PHEV are HEV".

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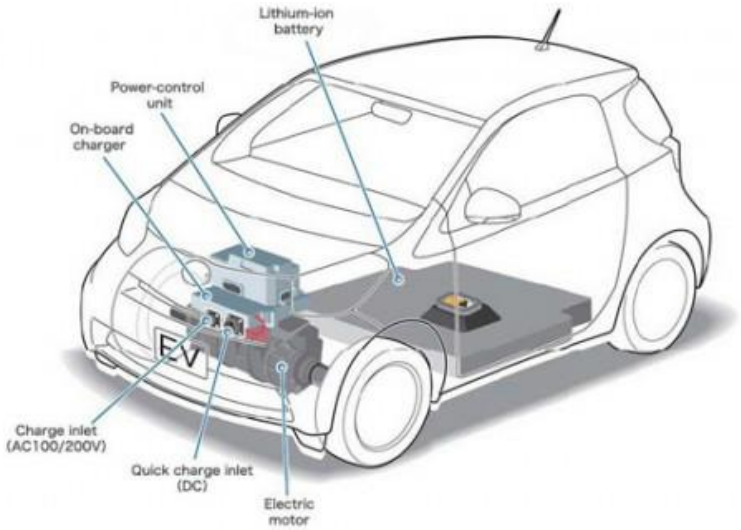


**Figure 1 Electrical Vehicle**

## II. LITERATURE REVIEW

**(Sonar, 2020)** [3] Recently, Hybrid Electric Vehicles (HEV) has seen enormous development around the world. HEV's growth in this field has been huge. Because of rising emissions from traditional cars, rising fuel costs, and global warming environmental issues, the automotive sector is turning its attention towards developing HEVs. The HEVs have various configurations depending on the hybridization degree to provide simultaneous traction efficiency for the IC engines and electric batteries. There are a physical description and simulation of hybrid fuel vehicles. In this article, the bidirectional complete bridge dc-dc converter, and the implementation of this converter in Series-Parallel HEV is discussed. The topology of the transforming converter accounts for motoring as well as regenerating breaking operations. The value of the dc-dc converter is suggested.

**(Sowmya et al., 2017)** [4] It was proposed to promote recovery of energy before and during braking downhill travel by using a bi-face DC-DC converter between the power source and traction engine. This integration will also increase traction driving performance and improve the range by 25 percent. Now the right bidirectional DC-DC converter heading can be used to maximize architecture efficiency in order to decrease weight, size, and system expense. This paper reviews and explores the fundamental bidirectional topology of the DC-DC converter and describes the comparative benefits for making the right electric car design decision.

**(Chakraborty et al., 2019)** [1] This paper discusses the scientific implications, the state of the world of research and development. In the sense of increasing alarm over increased emissions and the resulting global warming, Hybrid Electric Vehicles (HEV) has earned considerable interest. HEV is driven by a battery or mixed with electricity. HEV is primarily driven by a bacterium. HEV and other vehicle configurations such as Battery Electric Vehicles (BEV), Plug-in Hybrid Electric Vehicles (PHEV) is also gaining importance with growing concern towards the environment.

**(Sai Teja et al., 2019)** [5] Highlighted that "a bidirectional chopper (BDC) is the only element which can interface main source (HVS), auxiliary source (LVS), and a DC Bus voltage at different levels which is implemented in Hybrid Electric Vehicle (HEV)". This transformer process is composed of different mechanisms: double operation and refurbishing function in both dimensions with voltage regulation. And the autonomous supply voltage regulates two outlets (i.e., the dual-source buck-boost mode). Simulated results have included the regulation of the loop and the contrast between PI and ANN regulation, as well as the closed neural artificial network (ANN).

**(de Melo et al., 2020)** [6] Submitted that electric hybrid cars and pure electric vehicles, where successful conservation of energy is critical, rely on energy storage systems (ESDs) and electronic transformers. In this paper, a proposed EV architecture is explored based on super condensers (SCs) and packs for a safe and rapid electrical transition. The transfer of power according to the above sources of energy to the EV occurs through the DC-converter link. The topology reveals the small number and high reliability of modules over a wide spectrum of loads suitable for high-performance, high-current values. The systematic modeling method includes the evaluation of the transformer and operation of the control system by a fundamental approach, namely the average current mode function.

**(Devi Vidhya & Balaji, 2020)** [7] The electronic power interface, with its powerful control system, has an important role in the use of energy sources to use electric cars. For this reason, a multiple-input converter (MIC) topology hybrid fuzzy pi-based control scheme is suggested. Include a traditional solid PI controller and fluid transfer PI in the proposed hybrid fuzzy PI controller. The proposed control design also supports the monitoring of a pre-defined speed profile to complete electric vehicle development. Detailed simulation and efficiency analyses are carried out with traditional controllers. The results show that the device is resilient and offers two-way power control, fast monitoring capability with less stable state error, increased dynamic response by improving flexibility and proper use of

energy sources. A simulation of the output of the multi-input converter in the MATLAB/SIMULINK environment with the built control system is performed.

**(Antony & Rajitha, 2020)** [8] Announced that a range of applications such as electric vegetables, renewable sources, and UPS have been transformed by DC-DC converters. These converters are useful to transform the direct current to various voltage levels. A two-way DC-DC converter (BDC) is a DC-DC converter which, with its high power transmission and reduced dimensions, is used to flow power in both directions and dominates unidirectional converters. Therefore the industrial and testing areas of these transformers obtain more attraction. In two key modes, these converters operate. Buck or low-stress mode, while the other is high tension or boost mode. The output voltage in buck mode is lower than the input, and in boost mode, the output is higher than the specified input. These papers propose a two-way DC-DC converter that functions in buck and boost modes and is being tested in its use in battery-powered vehicles. The added value of this converter is the ability to charge the grid.

**(Jagadeesh & Indragandhi, 2019)** [9] Paper with a variety of DC-DC converters such as sepic, boost or bi-directional converter is reported. Integrating the booster, the sepic, two-way DC-DC converter helps you to define the required converter with an exact power rating for renewable energy applications. On the basis of this analysis, the efficiency of the non-isolated converter is evaluated. So the converter is used to move up/down the voltage stage, so the conversion efficacy of PV is low. This paper aims to carry out an analysis of the performance and voltage and current tension on the converters of the DC-DC converters. The simple electric photovoltaic vehicles and electric fuel cells are discussed in depth.

**(Anbazhagan et al., 2019)** [10] clarified that the effects of fossil fuel on automobiles in this rapidly evolving environmental situation is a major concern. A variety of renewable sources are being pursued in most of the countries to offset the exhausting fossil fuel. This paper discusses the energy sources of electric cars, the emerging electric car situation, and their problems in technology. It summarizes the number of advanced research developments and their control strategies recorded over the past two decades in bidirectional dc-dc converters. The output of different topologies of bidirectional dc-dc converters and their references are also tabulated. This work would also provide a good image of the creation of state-of-the-art dc-dc converter topologies.

**(Jyotheeswara Reddy & Natarajan, 2018)** [11] examined hybrid electric cars being the primary option for internal combustion engine vehicles as a result of their dramatic tendency to mitigate the problems of the climate. Hybrid electric cars are exceptional for their performance, reliability, and acceleration relative to internal combustion engine vehicles. However, energy storage capacity is the key downside in hybrid electric cars. In order to minimize the loading time, electric cars use high-specific electricity energy sources (W/kg) and high-specific power (Wh/kg). In general, hybrid electric cars are used as electricity sources and energy storage devices by fuel tanks, batteries, ultra-capacitors, flywheels, and regenerative braking classifications. Both these power devices are connected to separate DC-DC Power converter optimization techniques in order to maximize supply voltage. Multi-input converters have been used in many hybrid electric vehicles in recent years to connect multiple energy supplies to boost vehicle performance and reliability.

**(Lai et al., 2018)** [12] An analysis using main energy storage (ES1), subsidiary power storage (ES2), and dc buses at multiple voltage levels are being generated by the newly built, patented bidirectional DC/DC converter (BDC). The proposed converter can be worked in step-up mode (i.e., double-source power mode with low voltage) or step-down model with two-way power flow control (i.e., high-voltage DC-link energy-regenerating mode). In addition, the model can regulate the electricity transmission independently between two low voltage sources, i.e., buck/boost double source mode and low voltage. Three modes of power transmission are addressed in the architecture, operation, and stability review of the circuit and closed circuit control of the proposed BDC. The converter is tested by using a 1 kW prototype device's simulation and experimental results.

**(Xu et al., 2017)** [13] Explored the essential role of the DC micro grid system that a bidirectional DC/DC converter has played as a central part of reliable system activity and synchronized power supply. These studies proposed an optimized closed-loop ratio control algorithm to solve the unpredictable bus bar tension problem as the power transitions two-way into the DC micro grid system.. The bidirectional DC/DC converter's hardware circuit was planned for the DC micro grid energy storage system, and small-signal modeling of the bidirectional DC/DC converter was analyzed for charging and storage system characteristics of the converter performance in charging mood and in constant voltage production. To show the precision of the theoretical study, experimental results were used. The findings show that when a constant power voltage and an adjustable charging current in the range of 1 A to 2 A, the current-controlled accuracy shift continuously in charge mode. The rate of charge constantly varies when the charging power is 2 A, and the output voltage varies from 24 V to 36 V. The conversion rate for the converter is continuously adjusted in the discharge mode when the output voltage is stable. The bidirectional DC/DC circuit turns over the operating patterns automatically and retains the output voltage's stability as the output stress varies between 32 V and 38 V. In this analysis, the bidirectional energy transfer is accomplished by means of the logical hardware configuration of the bidirectional DC/DC converter. The proposed approach offers a strong prospect of a control mechanism to optimize feasible engineering architecture for bidirectional DC/DC converters.

**(Greeshma & Nayana, 2016)** [14] The usage in fuel cell cars and battery-based energy store systems of high-performance bidirectional DC-DC converters has been on the rise in recent years. The key benefits of fuel cells include safe generations of high density capacity and high efficiency. There is no hydrogen storage space in the fuel cell. Thus an auxiliary storage unit is typically used for an electric vehicle (i.e. a lead acid battery) for cold charging and the absorption of the regenerated power source. A director from dc to dc is required between the power storage battery and the supply for the voltage level balance. The DC-DC converters can be used to carry the battery to provide the regenerated braking power. Here the text introduces a discrete high-conversion DC-DC adapter for electric cars. The

voltage drop of 24 v and high power converter of 200V was simulated using a fuel cell MATLAB/SIMULINK with an input fuel cell and a BLDC power motor.

## III. CONCLUSION

This paper represents a comparative study of the most popular DC/DC converters that can be used for the second life battery applications. These topologies have been studied, and their performance characteristics have been presented. This review has given a focus on multiple performance features, such as output power, component count, switching frequency, electromagnetic interference (EMI), losses, effectiveness, cost and reliability which directly influence the selection of a particular DC-DC converter for Hybrid Electric Vehicle System. From the review, it is possible to recommend that a standard power electronics converters and Uni/Bi-directional charger/discharger system planed for improved quality based EVs. This paper will also guide automotive engineers and PE converter designers to select passive components (i.e., capacitors, inductors) precisely based on powertrains demand.

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