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Bidirectional Power Transfer between Grid and Electric Batteries Vehicle's

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Abstract *– Now In the last few years , the regular growth of Electric battery vehicles is promising an alternative to solve the problem developing by the fossil fuel and the problem of global warming. So many number of Electric battery vehicles increasing day to day so many investors are trying to invest in this sector , This growth of electric vehicles can create overload in the existing power network of the power system. so now a day's vehicle- to-grid (V2G) technology is used as the best way to solve the problem in the electric grid by providing regular service and power balancing in regular the power system.*
Different effective ways of Electric battery vehicles charging are solved. . Advantage and disadvantages Electric battery vehicles charging are discussed. A study of literature review of common bidirectional AC-DC and DC-DC Rectifiers are discussed. Several converter technologies can be used to implement the bidirectional Battery electric vehicle chargers.but our requirement is safe and reliable power transfer between Electric battery vehicles and the grid in bidirectional system ,all presently used bidirectional charging standard is investigated. Two-stage bidirectional Battery electric vehicle charger with and without galvanic division is designed and simulated on MATLAB/Simulink. After this the simulation results is discussed the final result come that the two-way power transfer with the proposed bidirectional Battery electric vehicle charging station models is possible.

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

I. INTRODUCTION

all over the world about climate change and its solutions are among the biggest concerns of governments, including individual activists. The main problem of global warming is due to the increase in green house gas discharge by different human activities. A max. part of greenhouse gas is produced by different fuel , energy sources and discharge from reqularly used vehicles with an internal combustion engine (ICEs) like petrol and diesel. A large number of Electric battery vehicle are already on different countries roads; however, one research study on that Electric battery vehicles will help on discharge of the traditional cars powered by gasoline because of the fossil fuel dominated electric power supply. So this is important to replace those regular fuel energy sources with new green energy sources. Day to day as the number of Electric battery vehicles is growing continuously. In this research we seen that charging Electric battery vehicles from regular fuel power supply can not reduce the discharge of harmful gases.

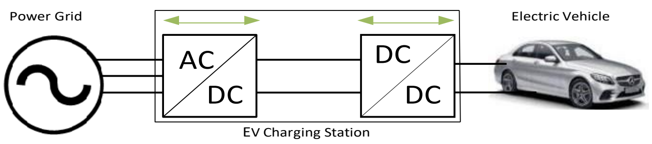

Figure 1:Block diagram EBV

In year 2017, approx 27% of the total EU-28 greenhouse gas discharge was produced by the transport sector . The CO_2 released from the transport vehicles raised approx 2.5% from year 2018 to 2020. So this is required to replace fuel cars by Electric battery vehicles is a best way to get a reduction in greenhouse discharge. Electric battery vehicle with vehicle-to-grid (V2G) technology is very helpful for this. In this techniques V2G the power is transferred from the electric network to the vehicle and vehicle to electric network. The V2G technology enables the utility to use the Electric battery vehicles as backup power by charging during off-peak hours and inject power back to the grid at high demand. The vehicle owners can also get money by charging during off-peak and selling the stored energy back to the grid during peak hours. Several countries already implement the bidirectional Battery electric vehicle charging system. According to , Nissan Leaf is the first car maker approved by German's electricity grid to apply the bidirectional integration of the grid and Electric battery vehicle , and. Further more, the International Energy Agency that are trying to cover 280 million Electric battery vehicle on the road till 2040. That is much greater than the total energy generated by hydropower plants in the world today. This will create the new business opportunity in the electric utility .

Currently, most of the countries are trying to get zero-CO2 discharge from electric energy production, transportation, and other industries. If we discussed to electric energy sources, it is important for provide environmental friendly, reliable, and economical electricity for customers. However, it is complex to predict and may not be possible to dispatch some renewable energy sources due to the random variation of their availability. The renewable energies may have a surplus or insufficiency of power generation at certain times. For example PV panels may produce excess electricity in the day time ,not during the evening or night time , and this excess energy will not be used if the produced energy is more than consuming energy by the load if we are not having any storage system . power generation at evening or night time or during cloud will reduce, and at this time, so this time the power stored energy will be the main issue . so we can't get supply regularly with this type of system .

Fig.no. 2: Stand-alone PV energy Electric battery vehicle charging station .

II . Technology of Bidirectional Converter

In Several researchers done research on regularly used converter techniques for Electric battery vehicle chargers . They have only one stage front-end Rectifier and for better voltage regulation DC fast charging back-end DC- DC converter is connected with them . The bidirectional Battery electric vehicle charger has two side connection of power Rectifiers. During battery charging operates as a rectifier. During battery discharging operates as a an inverter. In next step the DC-DC converter step down the voltage to the required voltage level for the Electric battery vehicle during charging mode .And step up the voltage when it works in discharging mode.

The bidirectional Rectifiers play an important role for vehicles to develop the energy storage system for electric battery vehicle . with the help of two way charger we can transfer the power in two-way. The Electric battery vehicle can be used as energy sources. The two way charger charges the Electric battery vehicle and during discharge give the power to grid with the same connection. With the improvement in semiconductor technologies, so many companies are working on better development in bidirectional Rectifiers. The techniques of Rectifiers can be done on full-bridge or half-bridge but half –bridge switch are , low in cost, and its performance is better . Same in full- bridge Rectifiers cost is high , .Metal-Oxide-Semiconductor-Field-Effect-Transistors (MOSFETs) and Insulated Bipolar-Transistors (IGBTs) with anti-parallel diode are the most famous in the power switching converter because of the ability of bidirectional conduction, and higher frequency capability. The Rectifiers used in the EV charger for two-way power transfer are bidirectional AC-DC and DC-DC Rectifiers .

Bidirectional AC-DC Rectifiers

The power transfer in the bidirectional Rectifier is divided in into two modes of operation. rectifier mode, and as an inverter mode . Both mode are used in unidirectional power flow application. The current flow in both directions realizes the two-way power transferring in the converter. Some uses IGBTs and some uses MOSFETs for switching of converter in bidirectional conduction. Historically, the grid-connected bidirectional converter is developed from the front-end PWM rectifier to supply power from the mains to DC machine drives. Conversely, during regenerative braking, the inverter mode is used to provide the power back to the grid instead of wasting it. Both rectifier and inverter mode have the same control method, PWM. However, when power is to be injected into the grid from regenerative braking or other renewable energies, it requires better power quality to provide the utility by applying such as filters and a better control system. The control of the Rectifier should operate in such a way that the phase voltage of the power system should not be affected by charging the EV or providing back power to the grid from the Electric battery vehicle battery. Rectifiers with diodes and thyristors introduce harmonics to the grid, but Rectifiers controlled with PWM increase the power factor result in raising real power transfer and improve the current harmonics . The bidirectional Rectifier can be implemented with a single-phase and three-phase.

Single-Phase Bidirectional Rectifier

Single-phase ac-dc bidirectional converter is broadly used in different applications, such as load connected to the grid and distributed energy resources (DERs), Electric battery vehicle connected with bidirectional charger, and uninterruptible power supply (UPS). When the Rectifier is connected with the grid, there are several requirements to be satisfied like low distortion line current, power factor correction factor, high-quality dc output voltage, and efficient bidirectional power transfer capability . In single-phase Rectifier, half-bridge, and full-bridge techniques can be used. The half-bridge scheme experiences higher components stress, but fewer components and lower cost .

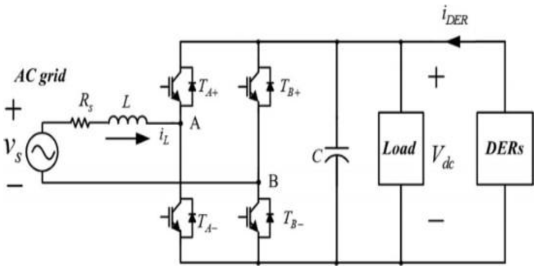

Fig.no. 3: A bidirectional single-phase Rectifier in a load connected to dc microgrid and the grid

III. METHOD

The An important property of a bidirectional Battery electric vehicle charger is the ability to inject power from the battery and push back to the grid in addition to the conventional charging. Section 3 presents several converter technologies that proposed for bidirectional Battery electric vehicle charger either two-stage or single-stage from different works of literature. In this section, by evaluating all the reviewed Rectifiers, Electric battery vehicle charger with the two-stage conversion with the possibility of two-way power transfer is modeled and simulated. Fig.no. 5.1 shows the simplified techniques for the V2G Electric battery vehicle charger developed in MATLAB/Simulink environment. The charger with two-stage of conversion is made of two Rectifiers. The two-level three-phase bidirectional Rectifier is using six switches connected to the three-phase grid, and the half-bridge buck/boost bidirectional DC- DC converter uses two switches, which joins the DC-link and battery pack. The two-stage techniques has an advantage of better DC voltage regulation but have the drawback of increased size and max .cost .

Importantly, the V2G technology is expected to play a significant role in enhancing the reliability and efficiency of the renewable energy dominated grid. Electric battery vehicle with a unidirectional charger can also support the power system balance, but not as Electric battery vehicle with a bidirectional charger. The primary way to balance the load in the system with a conventional unidirectional charger can be accomplished by increasing and decreasing the Electric battery vehicle charging according to the status of the electric utility, and this is called peak shaving or load shifting. A wind power plant can be taken as an example, at a particular time like at night, and let's say the wind turbine has surplus power. If the produced excess energy is not used or sold to a neighboring country, the only option is to shut down the turbines to maintain nominal frequency and avoid instability in the network. However, if there are several vehicles with a bidirectional connection, the wind turbine can be saved from the shutdown by charging the cars at this particular time and push back to the grid during peak-hours . From this, the significance and benefits of the bidirectional charger over the traditional charger motivate to investigate it. This section presents the step by step modeling of the bidirectional Battery electric vehicle charger in MATLAB/Simulink, the simulation result, and its discussion.

A bidirectional DC-DC converter is applicable for efficient electrical power transfer and battery charging. The DC-DC converter part of the full two-stage bidirectional charging station is presented here in this subsection. As shown in Fig.no. 5. a non-isolated half-bridge buck-boost converter connected with the battery, and VDC is connected with the DC side of the Rectifier in the complete model. As the name indicates, the converter operates in both buck and boost ways.

The non-isolated bidirectional half-bridge converter operates in both buck and boost way, which is developed by the combination of separate buck and boost Rectifiers from Fig.no. 3.8. The MOSFET internal on resistance and internal resistance of the anti-parallel diode is set to the default values in the half-bridge DC-DC converter.

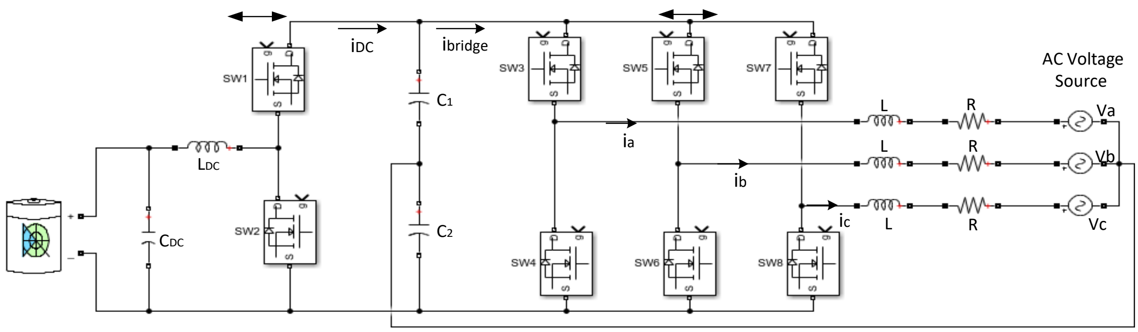

Fig.no. 4: The two-stage bidirectional Battery electric vehicle charger without galvanic division.

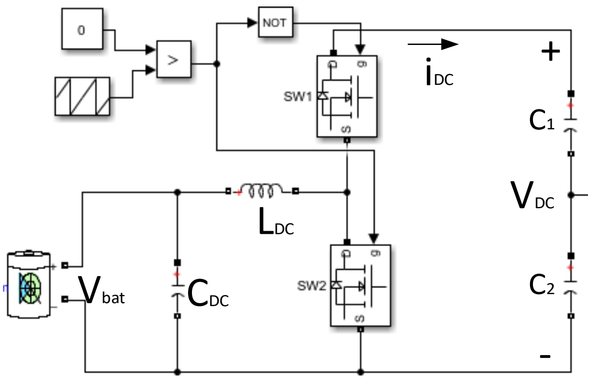

Fig.no. 5. Bidirectional DC-DC converter.

IV. Result

The phase angle AC sine wave in SPWM controls the operation mode of the converter. This helps to controls the direction of power flow. zero phase angle means no power transfer between the AC and the DC side because of zero current flow, as shown in Fig.no.6., the The power transfer can be controlled by changing the phase angle.

Fig.no. 7 and Fig.no. 8 presents, respectively the simulation result for both the mode like rectifier and inverter for the converter.

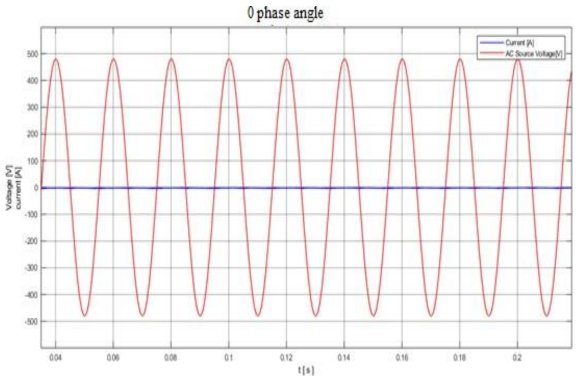

Fig.no. 6 When the phase shift is 0° in a sine wave, no current flow.

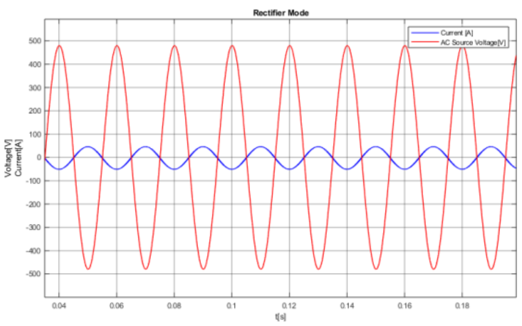

Fig.no. 7: AC voltage and current under rectifier mode with a 1° phase angle.

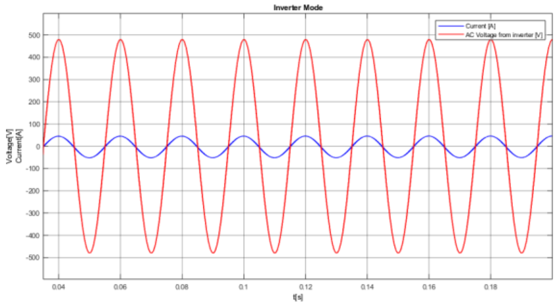

Fig.no. 8: AC voltage and current under inverter mode with a 1° phase angle.

As the phase angle and current have proportional relation,

Fig.no. 9 presents the amplitude of current doubled as we increase the more phase angle. Fig.no. 10 presents the simulation result for rectifier and inverter mode together. The voltages in both operations have the same amplitude, in phase, and completely overlapping.Therefore, it is clear from the fig.no. that the power transfer reverses when the current flow reverses.

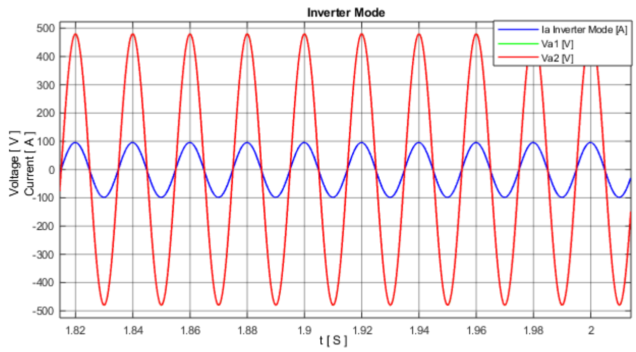

Fig.no. 9: AC voltage and current under inverter mode with a 2° phase angle.

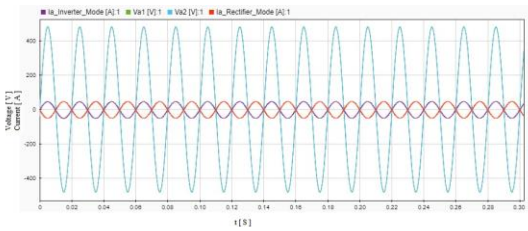

Fig.no. 10: AC voltage and current for both rectifier and inverter mode.

V. Conclusion

As In this presentation , the different way of charging of Electric battery vehicle form energy sources and converter technology for bidirectional power transfer is discussed. The currently available standard Electric battery vehicle bidirectional charger is also discussed. The two-stage model of bidirectional Battery electric vehicle charging station is designed and simulated separately with & without galvanic separation techniques . The two-stage converter techniques is selected because this helps in regulating the voltage in power system.

It is very important to finding a new way for charging of Electric battery vehicles, which is free from harmful gas discharge,.

Charging stations powered only from renewable energy is also the best way .

converter technology for bidirectional transfer of energy between the Electric battery vehicle batteries and the grid was presented with there advantages and disadvantages. The idea of vehicle-to-grid is very powerful for the new development in grid and the Electric battery vehicle for solving the problem of supply in a power system.

few companies are working on developing the updated bidirectional charging, and trying to complete the target till 2025.

Lastly, the bidirectional Battery electric vehicle charging station is modeled and simulated to work on EV charging and send power back to the grid. The charging station are developed with a bidirectional three-phase AC-DC and DC-DC converter, in both mode isolated and non-isolated. Here in this work, the bidirectional Battery electric vehicle charger model is implemented separately with and without galvanic division. The simulation results of both models are better satisfactory, and this result make the possibility of bidirectional power transfer with developed models is realized.

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