REVIEW: DIFFERENT TECHNOLOGY FOR CHARGING OF ELECTRIC VEHICLE

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ABSTRACT

Electric vehicles (EV) are growing in popularity as a credible alternative to conventional-powered vehicles. These vehicles require their batteries to be "fueled up" for operation. While EV charging has traditionally been grid-based, use of solar powered chargers has emerged as an interesting opportunity. These chargers provide clean electricity to electric-powered cars that are themselves pollution free resulting in positive environmental effects. EV charging strategies to reduce the impact on the power system. However, they do not consider grid-isolated solar-powered charging stations in a car-share scenario.

In this paper presents the different approaches and techniques for electric vehicle charging methods. In thus paper review the techniques are fast charging station with integration of solar pv system, predictive controllers based charging station, PV-assisted EV fast charging stations, MPPT Algorithms for Solar PV based Charging Station and Multiport Converter based EV Charging Station. This paper will be useful for future research scholar and students those interested for working in the field of solar pv based fast charging station for electric vehicle design.

Keyword: - *EV, Fast charging, solar pv array*.

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1. INTRODUCTION

Practices in EV charging are dependent on the location and time of charging. According to a report on EVs by (Accenture 2011), 48% of individuals stated the ability to charge at workplace or public charging as one of the factors to be considered before buying an electric vehicle. Some of the big auto companies, such as Nissan and Tesla, are in the process of installing DC fast charging infrastructure. This fast charging infrastructure helps to charge an EV much more quickly than a regular charger and is a good way of reducing the "range anxiety" of EV owners. Range anxiety in the case of an EV is the constant fear of the battery running out of charge while driving, and thus stranding the vehicle (Blanco 2010). There are business owners who are installing charging stations with free charging options close to their showrooms or retail outlets in order to draw a larger customer base. Tesla is one of the EV manufacturers which is making remarkable efforts in this direction.

This company is making a network of supercharging stations which would deliver power at 120kW, almost twice as fast as a regular charger, and will be able to charge an EV in around 30 minutes (Schwartz 2012). They are also planning to have a network of chargers extending across the entire United States (Tesla Motors 2014). The only shortcoming of this undertaking is that these charging stations could only be used for Tesla vehicles. Estonia has become the first country in the world where an EV can be driven without range anxiety, as they have a nationwide coverage of EV charging stations. The network consists of 165 fast charging stations installed along highways at a minimum distance of 40-60 km. The cost of a single charge is 2.5 to 5 Euros in total (Estonian World 2013). A similar experiment called the West Coast Electric Highway has shown promise in the US: public charging stations have been installed at 25-mile intervals on a stretch of Interstate 5 in Oregon extending from Ashland in the south to Cottage Grove. This project has installed level 3 DC fast charging and level 2 chargers (Motavalli 2012). The opponents of public charging infrastructure argue that it would actually not contribute significantly as the majority of EV owners do not access public charging infrastructure because they drive only short distances in urban areas and for not more than an hour each day. These opponents also cite the argument that under-utilized public charging stations would be a waste of taxpayer's money As per K. Parks (2007), there can be four different scenarios for charging of EVs.

Uncontrolled Charging or the end-of-travel charging. This is the typical charging scenario for an EV parked in a residence. It requires no smart control equipment to tell how and when charging occurs. Also, it does not give any data about consumer behavior or incentives such as time of use rates (ToU). The assumption for this case is a constant charging rate of 1.4 kilo Watt (kW) based on a common household 110/120 volt 20 Ampere circuit with a continuous rating of 1.8-2.0 kW. Even with this considerably low charging rate, the usual charge time for a completely discharged battery is around six hours. Delayed Charging. This is similar to end-of-travel charging except that it initiates charging only after 10pm. In this case, a timer is needed either in the vehicle or in the charger to regulate power use. With a modest increase in infrastructure, use of ToU is accessible. This scenario is more likely preferred by utility companies because of the already existing incentives for off-peak energy use. A large number of utility companies like Xcel Energy offer ToU rates to residential customers. The charging rate here is 1.4 kW, which is similar to the above case of uncontrolled charging. Off-Peak Charging.
In this scenario, all charging occurs in residential areas during overnight hours, and it aims to provide the most optimal, low-cost charging as the vehicle charging can be controlled directly or indirectly by a local utility company. In the case of indirect control, the vehicle would be responding intelligently to a real time price signal. In the case of off-peak charging, the charge rate is increased to 3.2kW for maximum system optimization. This is greater than the continuous charge rate of a common household circuit and assumes that 20 percent of all charging is done using 240 V/40Ampere level 2 chargers. The charge time would be around six hours. Continuous Charging or Publicly-available electricity charging. This scenario is similar to the end-of-travel charging except that it assumes that the electric vehicle is being charged at a public charging station. Although charging during off-peak hours is encouraged, vehicles are charged whenever they are stationary for more than an hour. This is also a case of uncontrolled charging. This type of charging profile has two peaks of use - generally during the morning and evening hours.

2. DIFFERENT TECHNIQUES FOR EV CHARGING

Currently, electric vehicles (EV) are going through an important emergence, nevertheless, the technology associated to them is still under development. Author [1] presents a fast charging station (FCS) for EVs supplied by renewable energy with a novel decentralized control of the system. The fast CS is composed of a photovoltaic (PV) system, an energy storage system (ESS), and a connection with the local grid. Thanks to this configuration, the FCS is able to work as a stand-alone system most of the time, with occasional grid support. The proposed control is based on the voltage control of the common medium voltage DC (MVDC) bus, to which all the energy sources are connected. Thus, depending on its voltage, the PV system, the ESS or the grid are used to supply the energy demanded by the EVs. To show the viability of this control, the charging of two EVs is simulated under different operating conditions.

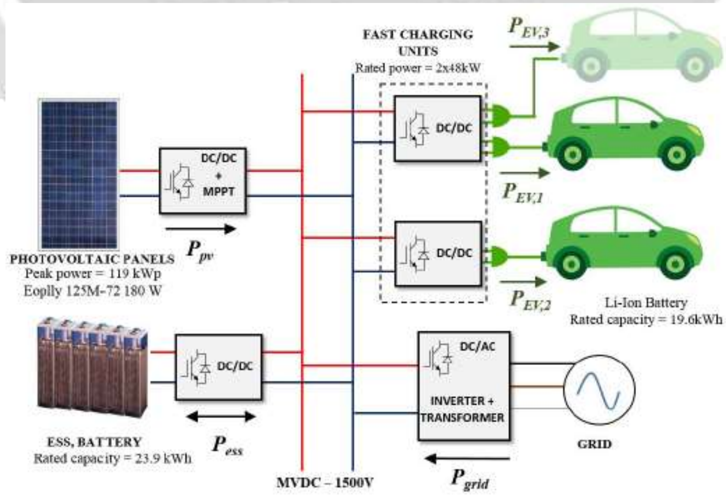

Fig.1: Configuration of the EV FCS under study [1]

The novel decentralized control depends mainly on the level of the MVDC bus voltage. The PV system, the ESS or the local grid could control the MVDV voltage. Thereby, three control modes were defined (ESS mode, PV system mode and grid mode). The performance of the decentralized EMS was analyzed by simulation of 1400 seconds, under different conditions of sun irradiance and the charging of three EV.

The obtained results showed the viability of this technology for EV charging and the proper operation of the control under the case study. The EMS was able to control the MVDC and the ESS SOC without a communication interface connecting the components of the system. Apart from that, other areas of research can be developed from this work as areas of further investigation such as stability and robustness of this kind of system during DC fault or AC fault in the external grid.

The use of distributed charging stations based on renewable energy sources for electric vehicles has increased in recent years. Combining photovoltaic solar energy and batteries as energy storage system, directly tied into a medium voltage direct current bus, and with the grid support, results to be an interesting option for improving the operation and efficiency of electric vehicle charging stations. An author presented [2], an electric vehicle charging station supplied by photovoltaic solar panels, batteries and with grid connection is analyzed and evaluated. A decentralized energy management system is developed for regulating the energy flow among the photovoltaic system, the battery and the grid in order to achieve the efficient charging of electric vehicles. The medium voltage direct current bus voltage is the key parameter for controlling the system. The battery is controlled by a model predictive controller in order to keep the bus voltage at its reference value. Depending on the state-of-charge of the battery and the bus voltage, the photovoltaic system can work at maximum power point tracking mode or at bus voltage sustaining mode, or even the grid support can be needed.

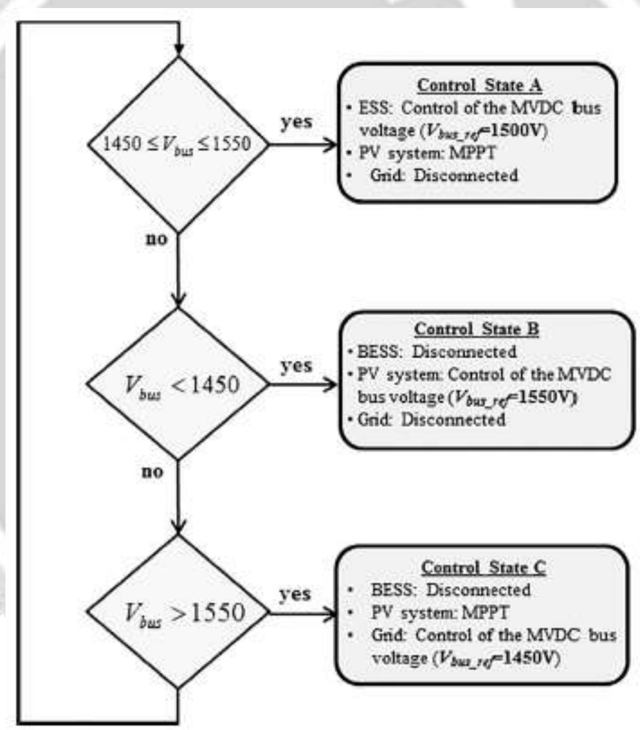

Fig.2: Flowchart of the proposed decentralized EMS [2]

In the decentralized control scheme applied to the EVCS system, each energy source worked independently from the rest of them, and the management of the energy flow among the energy sources was performed without the need for communication interface among the energy sources or between an energy source and the supervisory energy system. It makes easier the enlargement of the EVCS and MVDC network by integrating new elements (new EV chargers, ESS or RES), since a new communication system is not necessary and the EMS does not need to be modified. Another novelty presented was the way of carrying out the coordinated transitions among the operation modes of the different elements of the system based on the MVDC bus voltage and its increase or decrease resulting from energy excess or shortage, respectively. With this configuration and control scheme, the EVCS was able to work as a stand-alone system most of the time and with occasional grid support.

As expected, MPC achieved better results in sustaining the MVDC bus voltage than PI controllers, since MPC control is superior to PI control in case of control of plants with output constraints as well as MIMO (Multiple Input Multiple Output) systems – as in the case studied.
The main limitation of this work is that the validation of the proposed EMS was done by means of models and simulations, which is a standard practice in the scientific community at the first design stages, to emulate the components of the system and simulate its behavior against real conditions to check its performance.
In fact, this work is of interest for studying and evaluating different configurations and control schemes of EVCS through the use of models and simulations. As future works, it is expected to conduct new studies integrating other elements (other kinds of loads, RES, ESS and interaction with the utility grid) and controllers in order to find out the most appropriate configuration and control scheme for EVSC and MVDC networks supplied by RES, ESS and interacting with the utility grid.
The development of high-power electric vehicle (EV) fast charging stations (EVFCSs) that are directly tied to the medium-voltage (MV) grid is a promising solution to shorten the charging time for EVs. The cascaded-high-frequency-link (CHFL) system-based charging station provides an isolated power electronic interface between the low voltage (LV) DC bus (inside the station) and the three-phase MV AC power network.
The CHFL system uses a high/medium frequency transformer to provide isolation and high stepping-up ratio. The main disadvantage of this system is the large number of active switches. Author presented [3], a new design for the CHFL system based on cascaded half-bridge direct matrix converters is proposed. The proposed design reduce the active switch count by more than 40% as compared with topologies recently proposed in the literature. A simplified multilevel hysteresis current controller (MLHCC) for the system is also presented. The proposed architecture for EVFCS is assisted by a photovoltaic (PV) system to decrease the dependency on the power grid. A bidirectional power flow controller is adopted to inject the excess in the generated PV power to the grid, and withdraw power from the grid when the PV power is less than the demand of the station.

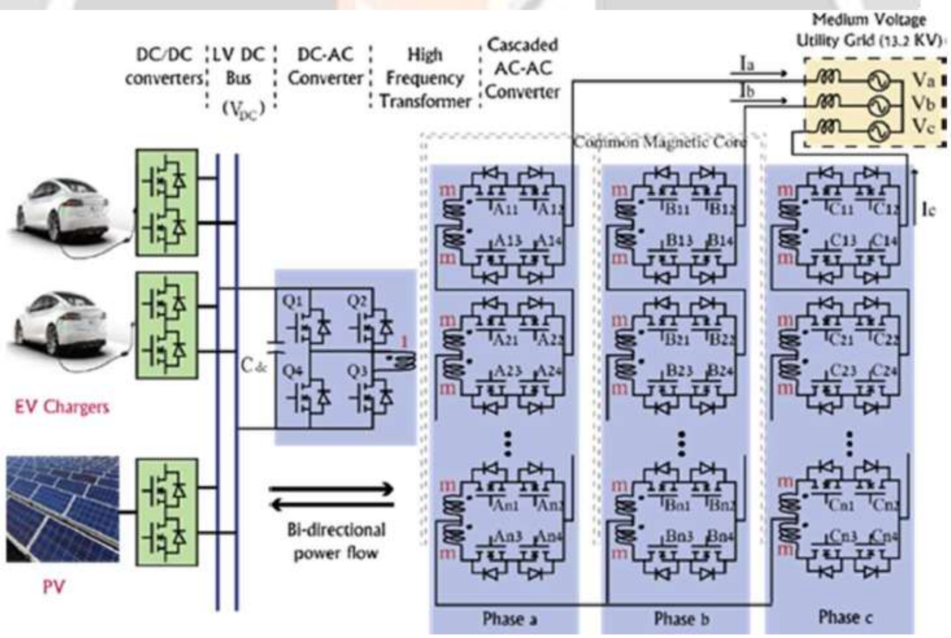

Fig.3: The proposed EVFCS with the CHFACL system [3]

Author presented [4] a new architecture for EV fast charging stations based on the CHFACL system that uses half the number of switches as compared with CHFACL systems currently available. A multilevel hysteresis current controller (MLHCC) for the system was developed, which eliminates the need for the clamping circuits used with matrix converters. The developed controller utilizes reactive power to compensate for the fluctuations in the voltage at PCC under changing injected PV power to the grid. A bidirectional power flow controller is adopted to inject any excess in PV power generation to the grid and allow the grid to support the station when the EV chargers demand exceeds the PV generation. An example of a 5-MW system was implemented and the results show superior features of the developed converter in managing the power between the MV grid and a PV-assisted EV charging station with high power quality.

This work focuses on a smart algorithm to optimize energy of electric vehicles charging station while considering numerous constraints as the instability of renewable energy sources and the potential limited power given by the grid. The PV array is considered as a basic source of energy to feed the charging station system, directly tied into a voltage DC bus, thus the lithium-ion battery is implemented in this platform to complete the power flow of each potential charging scenario. Moreover, the management algorithm is taking into account the fluctuant power state of both the DC and the AC bus link, and it treats also the state of charge of the batteries in the energy management approach.

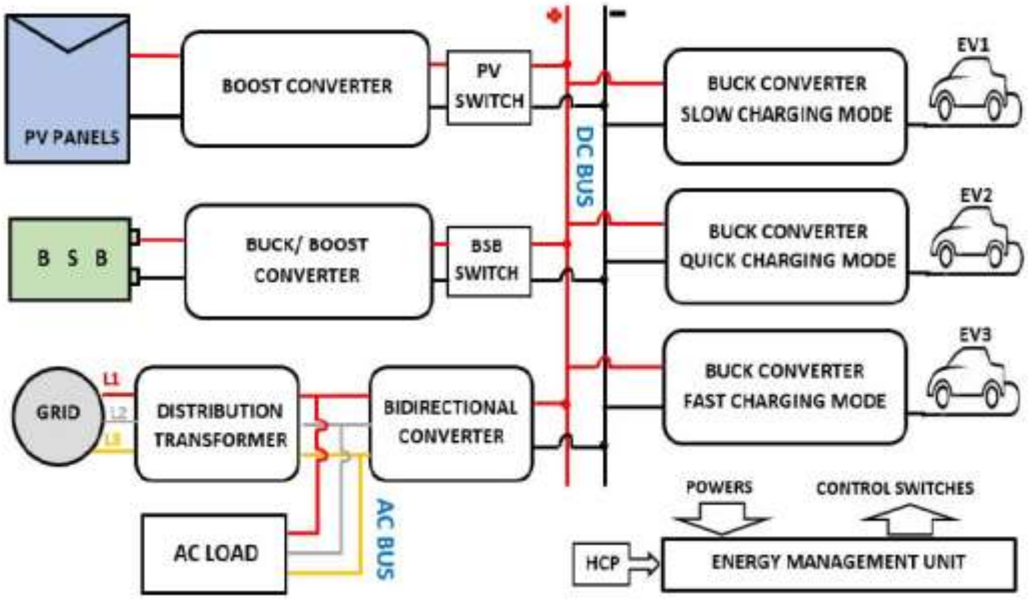

Fig. 4: Block diagram of different block of CS for EV [4]

This work presents a smart topology to load a lithium-ion battery in EVCS through multiple optimization algorithms. In this regard, the efficiency of the system is tested using modes of operation, which have been validated by simulation results. Moreover, the reaction of the battery is stable even under higher recharge rate. In fact, this case is based on database of a project with full specifications e.g. the meteorological data to emulate the PV array and the daily load of the EV battery, simulation interpretation shows repeated reactions to the input climatic scenario as the temperature and the irradiance. This methodology aimed to establish a balance between the three different sources of energy including the contribution of the grid, besides, the technical purpose is to test the validity of the EVCS topology through various charging scenarios to feed an EV battery.

Maximum Power Point Tracking (MPPT) algorithms is conferred in this method used in photovoltaic (PV) systems for changing temperature and irradiance conditions. The MPPT control is always combined with a DC-DC power converter to produce maximal power under differing metrological conditions. The boost converter is used along with the Maximum Power Point Tracking control system. Perturb and Observe (P&O) and Incremental Conductance algorithm (INC) are the two widely used algorithms for drawing maximal power from the photovoltaic source. Direct duty ratio control technique is used for both the algorithms. The system is modeled using MATLAB Simulink software.

The Perturb and Observe (P&O) method is simple to implement. It has slow response during changing atmospheric conditions due to fixed step size and has a tendency of drifting the operating point towards the wrong side. These issues are addressed by using Incremental conductance method (INC) which has a better performance over Perturb and Observe algorithm. It has a faster response and is more efficient in tracking when the irradiance values are changing continuously. The steady-state performance of the photovoltaic control system is improved by using the MPPT algorithms.

An author present, [5] a solar fed isolated unidirectional dual bridge (IUDB) dc-dc converter is proposed for fast charging of batteries of electrical vehicles (EVs). A dc-dc power electronic circuit is required to extract maximum power from the solar PV out of its nonlinear power characteristics. An interleaved boost converter (IBC) is used to extract the maximum power from the solar PV array. The Interleaved boost converter has more current handling capability and produces high quality DC output from the solar PV system. It consists of less number of active switches with one active full bridge and other uncontrolled diode bridge leading to lower cost and less complexity The proposed unidirectional isolated dual bridge has the capability of power transfer according to the battery requirement with better control of various charging modes. In this method [6] the converter operation and principle are analyzed.

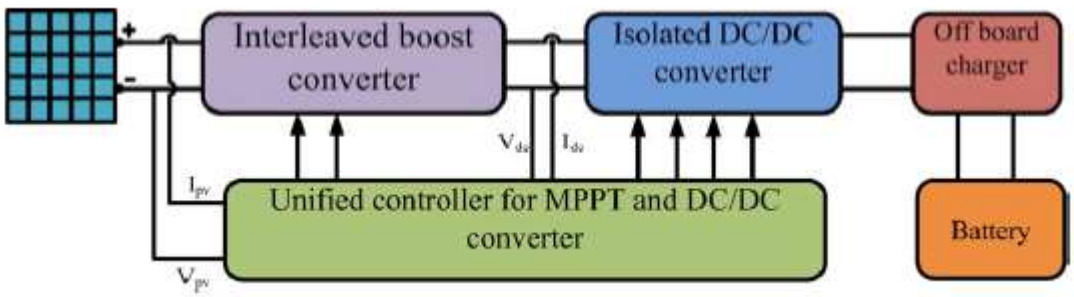

Fig. 5: Proposed solar PV based isolated unidirectional charger circuit [6]

This method [6] presents the solar PV fed isolated unidirectional fast battery charging circuit for electrical vehicles useful for remote locations. A 50 kW solar PV generation system is considered. A parallel two leg interleaved boost converter is used to extract the maximum power from nonlinear characteristics of 50 kW solar PV array. The IBC gives high quality input and output characteristics. A high frequency isolated unidirectional dual bridge converter is proposed as a fast charger circuit for EVs.

The IUDB employed with the IGBT full bridge on HVDC bus side and a diode bridge on battery side. The HVDC bus is controlled by the static energy storage device connected to it by charging with the surplus power from the solar PV system. The simulations are performed using PSCAD simulation tool to verify the control strategies. The results are observed in high charge rate and low charge rate modes.

As already happens with the electric vehicles (EVs) expansion, technology associated with their charge also must be improved. An author presents [7] a novel decentralized control method for charging stations based on a medium-voltage direct-current (MVDC) bus. This kind of charging stations is integrated in a microgrid with a PV system, a battery energy storage system, a local grid connection and two units of fast charge. The main contribution of this work resides in the cited decentralized control method based on fuzzy logic that includes the state of charge of the battery energy storage system as a control variable. This control contains two independent fuzzy logic systems (one for the battery energy storage system and other for the grid), whose function is to maintain the MVDC voltage and the battery energy storage system state-of-charge within proper thresholds and to keep the power balance stable among the units of fast charge and the rest of the charging station components. The new control method was tested in a considerable number of operating situations (two hundred cases studied) under different conditions of sun irradiance, initial state-of-charge of battery energy storage system and number of EVs connected to the charging station with the objective of showing its correct performance in all the considered scenarios.

Generally, in the field of the renewable hybrid systems, fuzzy logic has been used for the management of the energy among their components or as controller in the power electronic converters. Author has presented [7], as main contribution, a novel decentralized control combining both uses of the fuzzy logic for a CS with renewable energy and energy storage, in which fuzzy logic controllers were used as a decentralized EMS to control the converters of two components of the system separately and achieve a coordinated performance operation of the following system parameters: power flow, MVDC voltage and BESS SOC. Another novelty was to include the SOC of the BESS as a control variable for a decentralized EMS (that is very common for centralized approaches but, as the literature review showed, not for decentralized ones). Moreover, the different power converters were modelled as average models that result in simulations that represent more reliably the CS dynamics improving the approaches followed before in this area (based on quasi dynamic simulations and neglecting power converters). Finally, the novel decentralized control was evaluated and analyzed in a considerable number of operating situations by Monte Carlo simulations, in contrast to the previous works published on this topic, in order to perform a sensitivity and stability analysis of the proposed control technique and show how the elements of the system interact.

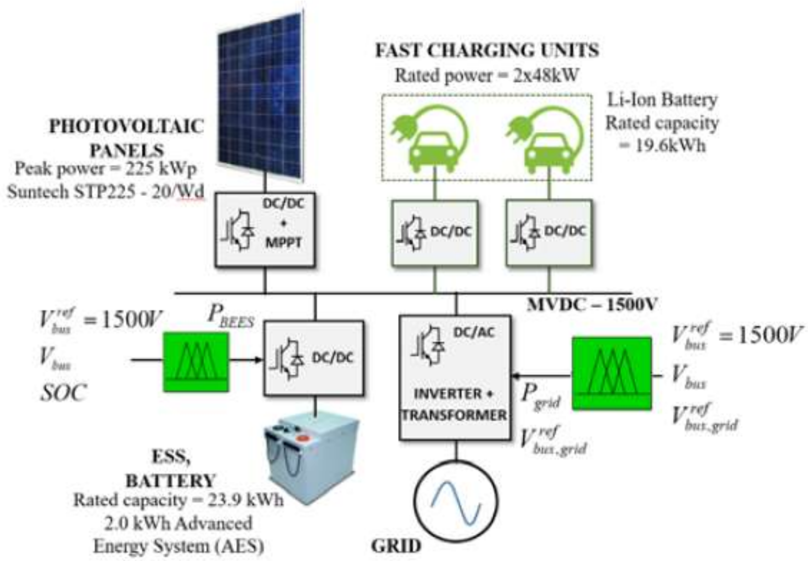

Fig. 6: Microgrid for the EVCS under study [7]

The considered CS was composed of a PV system, a battery as ESS, a connection with the local grid and two units of fast charging for EVs. Two fuzzy logic systems (one for the BESS and other for the grid connection) were implemented as controllers for the control of MVDC voltage and the BESS SOC and for the management of the input and output powers among all the components, meanwhile the PV system was working in the MPPT.

The fuzzy logic systems implemented in this work (F-DCM) were able to control the MVDC and the power flow among the components of the fast CS without the need of communication. The fuzzy logic systems worked independently of each other and they adjusted the MVDC bus voltage depending on the BESS SOC.

The proposed fuzzy logic DCM was compared to a reference DCM (R-DCM) also based on a decentralized typology but with the need of using PI controllers, hysteresis cycles and heuristic rules. In addition to the advantages of a decentralized control, such as, the facility to integrate (BESS, EV charges…) without communication system among them, the fuzzy logic DCM presented several advantages respect to the reference DCM, some of them due to the combination of uses of the fuzzy logic. With the new DCM, the fast CS was able to work in a stand-alone mode longer, so problems related with the grid connection can be reduced and the use of the BESS was improved.

The Monte Carlo simulations, in which the input parameters of the control system were modified randomly, showed that, in all the considered scenarios (two hundred cases studied), the system was kept stable, the DC bus voltage was controlled at the desired value according to the BESS SOC (1500V with normal SOC, 1400V with a low SOC and 1600V with a high SOC), and the components of the CS interact successfully knowing only the voltage level of the MVDC bus.

The results demonstrated that the fuzzy logic DCM achieved better results in the controlled variables and in the response of the whole system under study, while smoothing the operation transition of the CS components (the connection and disconnection of the components to the MVDC bus) with regard to classical controllers.

This method introduces [8] a demonstration of an islanded DC microgrid for electrical vehicles (EVs) wireless charging. The DC microgrid includes photovoltaic panels (PV), small wind turbine (WT), battery units (BUs) and a wireless charger. The planning, control strategy, laboratory system and the demonstration of the microgird are presented. Firstly, the system capacity, configuration and topology are designed and the voltage level is analyzed by using the energy balance and power balance method. Meanwhile, the electricity of the secondary system is planned and an uninterruptible power supply (UPS) is designed to supply them reliably. Secondly, the control methods of the DC microgrid composed of PV, WT, BU, UPS and wireless charger is investigated. The master-slave control strategy is used.

The battery bidirectional DC/DC converter is responsible to stabilize DC bus voltage. The challenge is the fast response of the wireless charger as a power electronic loads in an islanded microgrid. Both PV and WT are controlled using maximum power point tracking (MPPT). Then wireless charger and electromagnetic shielding device is designed and the EV charging device is reformed.

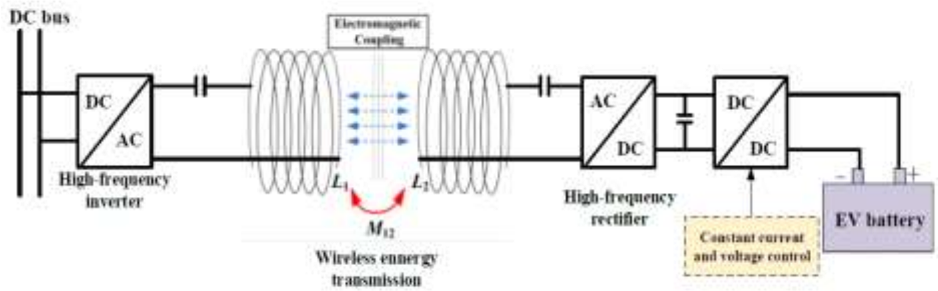

Fig.7: Topology of wireless charging station [8]

The demonstration of the WT/PV/BU DC microgrid for EVs wireless charging is implemented. The system achieves the following functionalities. The islanded microgrid is a DC system and its energy conversion efficiency is high due to its less power converters. The master-slave control is used and the system can charge the EVs wirelessly. The BU DC/DC converter can maintain the DC bus voltage stable when the EVs charging power quickly change from 0 to the rated value, and the PV and WT converter uses MPPT control to get the maximum renewable energy. Microgrid SCADA and EMS can automatically achieve real-time and remote monitoring and protect the battery.

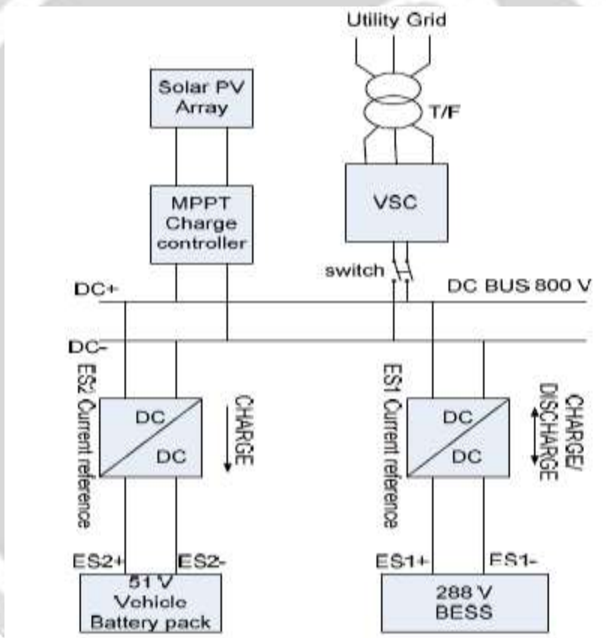

Fig.8: Representation of the system [9]

Author presented [8] the energy management in a solar PV based charging station integrated with battery energy storage system (BESS). The provision of optional exchange of power by the DC grid with the utility grid has been created here. Power flow through the utility grid is controlled using a voltage source converter (VSC). The loads considered are the Electric Vehicles (EVs) batteries. Load demand was met by the maximum power obtained from the solar PV (Photo Voltaic) using Maximum Power Point Tracking (MPPT) controller. An automated control of energy flow among solar PV, BESS and load battery is proposed using DC-DC converters. The dip in DC microgrid voltage, because of excess load demand beyond the available combined maximum power from solar PV and BESS, is compensated by delivering deficient power from utility grid.

The charging station formed by using solar PV as source integrated with BESS can charge the EVs with a specified rate. When the combined capacity of PV and BESS is less than demand then the ac grid comes to support and delivers deficient power and in turn maintains microgrid voltage which was decreased due to increased demand. The exchange in power is fully automated using the controllers associated with solar PV DC-DC converters, Battery DC-DC converters and VSC in the connecting path of ac grid. The different cases with different load demands and

variable SOC levels of storage battery were considered to validate the automation during the power exchange in the charging station.
Author presented [9] a stand-alone dc-bus Electric Vehicle (EV) charging station system using a photovoltaic (PV) source. The proposed topology includes a PV panel, an energy storage unit (ESU), and two EVs. Each unit is controlled independently; a voltage regulation scheme is implemented within the ESU converter to ensure the dc bus voltage is maintained at the nominal level under varying operating conditions. Two different operating scenarios are studied, and the results confirm that the algorithm developed allows regulating the dc bus voltage either with varying solar irradiance or when EVs are connected and disconnected from the dc grid. The proposed design offers lower energy conversion losses compared to the ac configuration and reduces energy demand on the existing ac distribution grid. It also finds applications in remote areas where parking facilities are provided for recreational purpose.

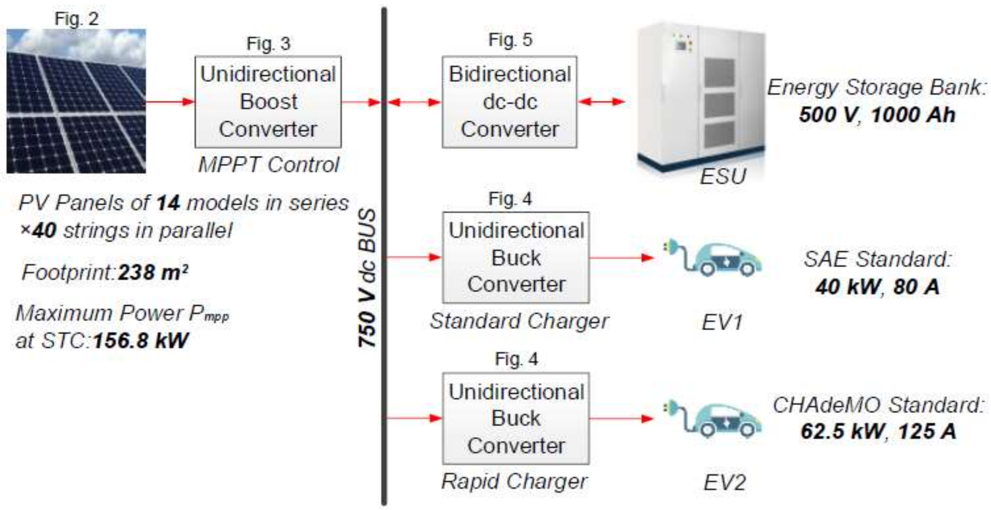

Fig. 9: The architecture of the proposed PV-fed dc-bus charging station [10]

A PV-fed EV charging station has been proposed in one of the technique [9] to provide high reliable charging power in a standalone dc system. The charging station includes both slow and fast charging standards employed in commonly used EVs. An ESU control scheme was implemented to regulate the bus voltage under variable solar irradiance and when the power required by EVs exceeds the power generated by the PV panel. The simulation results show that the ESU can react fast to either storing PV generated power or providing energy for EV charging, as well as maintaining dc bus voltage close to the nominal value. Without the proposed controller, fluctuations in solar irradiance or connecting and disconnecting of EVs may result in unacceptable operating conditions, that will cause malfunctioning or damage of the equipment connected to the dc bus. The next steps of the analysis will be to design a larger grid with multiple PV units and EVs.
The proposed scheme finds applications in areas where the distribution system is congested and cannot support large numbers of EVs. It can also be implemented in remote locations with lack of infrastructure, where EV charging facilities can be provided for tourists or long-distance travelers.
As an environmental friendly vehicle, the increasing number of electrical vehicles (EVs) leads to a pressing need of widely distributed charging stations, especially due to the limited on-board battery capacity. However, fast charging stations, especially super-fast charging stations may stress power grid with potential overload at peaking time, sudden power gap and voltage sag. Author discussed [10] the detailed modeling of a multiport converter based EV charging station integrated with PV power generation, and battery energy storage system, by using ANSYS Twin Builder. In this method [10], the control scheme and combination of PV power generation, EV charging station, and battery energy storage (BES) provides improved stabilization including power gap balancing, peak shaving and valley filling, and voltage sag compensation. As a result, the influence on power grid is reduced due to the matching between daily charging demand and adequate daytime PV generation. Simulation results are presented to confirm the benefits at different modes of this proposed multiport EV charging circuits with the PV-BES configuration. Furthermore, SiC devices are employed to the EV charging station to further improve the efficiency. For different modes and functions, power losses and efficiency are investigated and compared in simulation with conventional Si devices based charging circuits.

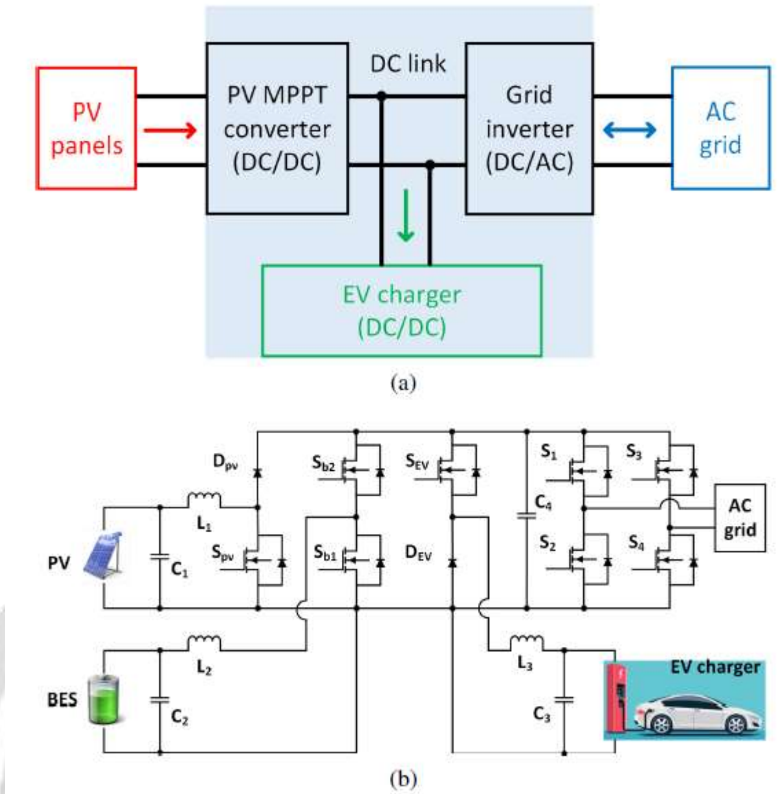

Fig.10: Multiport converter architectures, (a) the conventional architecture of EV charging stations integrated with PV, and (b) the proposed multiport converter based EV charging station architecture integrated with PV and BES [11]

Author present [11], a multiport converter based EV charging station with PV and BES is proposed. A BES controller is developed to regulate the voltage sag, and balance the power gap between PV generation and EV charging demand. With the proposed control design, BES starts to discharge when PV is insufficient for local EV charging, and starts to charge when PV generation is surplus or power grid is at valley demand, such as during nighttime. As a result, the combination of EV charging, PV generation, and BES enhances the stability and reliability of the power grid. Different operating modes and their benefits are investigated and then, simulation and thermal models of the multiport converter based EV charging stations and the proposed SiC counterpart are developed in ANSYS TwinBuilder. Simulation results show that the efficiency can be improved by 5.67%, 4.46%, and 6.00%, respectively, for PV-to-EV mode, PV-to-BES, and BES-to-EV mode at nominal operating condition, compared to Si based EV charging stations under the same operating conditions.

Renewable energy sources powered charging station (CS) is necessary for the sustainability of electric vehicle (EV). Therefore, one of techniques [12] uses photovoltaic (PV) array and wind energy conversion system (WECS) as main energy sources for the EV charging station. Moreover, diesel generator (DG) set and grid power are also used as back-up power providing the continuous power to the EV. The charging station, has the provision to power the local house hold loads using PV array and WECS energy in islanded and grid or DG set connected modes.

While charging EV and feeding household loads, the charging station compensates for the local reactive power and harmonics current demand for achieving unity power factor (UPF) operation of the grid or a DG set. In addition, various other complementary features of the charging station such as a vehicle to home, vehicle to grid, harmonics elimination, vehicle to grid reactive power compensation, and synchronization capability are considered in this work.

The PV array and WECS are used together to make an EV charging station and the operation of CS is validated on` developed prototype in the laboratory. Moreover, the test results in islanded condition, grid connected mode and DG set connected mode have verified that the CS capability to continuously charge the EV and feed the household load, irrespective of the disturbance in WECS and PV array.

Moreover, test results have shown the performance of MPP technique irrespective of PV power and WECS power perturbations. The controller of the CS have ensured the optimum loading of the DG set to achieve the maximum fuel efficiency. Moreover, the IEEE 519 complied operation of the charging station is also verified by test results. Various presented results have also verified the other complementary features of the charging station such as a vehicle to home, vehicle to grid, harmonics elimination, vehicle to grid reactive power compensation, and synchronization capability.

3. CONCLUSION

This paper presented a comprehensive review on EVs in terms of charging technology, various EV impacts and optimal CS placement and sizing. Charging technology plays an important role in energy transfer for an EV battery. To provide enhanced understanding about this technology, this study presented different energy transfer modes, charging levels, and techniques in addition to the standards currently being utilized for EV charging worldwide.
In this paper presents the different approaches and techniques for electric vehicle charging methods. In thus paper review the techniques are fast charging station with integration of solar pv system, predictive controllers based charging station, PV-assisted EV fast charging stations, MPPT Algorithms for Solar PV based Charging Station and Multiport Converter based EV Charging Station. This paper will be useful for future research scholar and students those interested for working in the field of solar pv based fast charging station for electric vehicle design.
Therefore, this work will help provide most relevant and significant information about existing studies. It will also provide an opportunity to research further on battery performance optimization and intelligence systems related to the integration of multipower sources, stability, reliability analysis of distribution networks, and location and sizing optimization of CSs in consideration of power quality issues.

4. REFERENCES

[1] García-Triviño, Pablo, et al. "Control of electric vehicles fast charging station supplied by PV/energy storage system/grid." 2016 IEEE International Energy Conference (ENERGYCON). IEEE, 2016.

[2] Torreglosa, Juan P., et al. "Decentralized energy management strategy based on predictive controllers for a medium voltage direct current photovoltaic electric vehicle charging station." Energy Conversion and Management 108 (2016): 1-13.

[3] Elsayad, Nour, and Osama A. Mohammed. "A cascaded high frequency AC link system for large-scale PV-assisted EV fast charging stations." 2017 IEEE Transportation Electrification Conference and Expo (ITEC). IEEE, 2017.

[4] Hassoune, A., et al. "Smart topology of EVs in a PV-grid system based charging station." 2017 International Conference on Electrical and Information Technologies (ICEIT). IEEE, 2017.

[5] Nadkarni, Sushmita S., Sachin Angadi, and A. B. Raju. "Simulation and Analysis of MPPT Algorithms for Solar PV based Charging Station." 2018 International Conference on Computational Techniques, Electronics and Mechanical Systems (CTEMS). IEEE, 2018.

[6] Goud, Pandla Chinna Dastagiri, Anurag Sharma, and Rajesh Gupta. "Solar PV Fed Fast Charging Converter with Isolated Unidirectional Dual-Bridge Topology." 2018 8th IEEE India International Conference on Power Electronics (IICPE). IEEE, 2018.

[7] García-Triviño, Pablo, et al. "Decentralized fuzzy logic control of microgrid for electric vehicle charging station." IEEE Journal of Emerging and Selected Topics in Power Electronics 6.2 (2018): 726-737.

[8] Zhaoxia, Xiao, et al. "Control of DC Microgrid for Electrical Vehicles (EV s) Wireless Charging." 2018 China International Conference on Electricity Distribution (CICED). IEEE, 2018.

[9] Srujan, D., et al. "Energy Management in Grid Assisted BESS Integrated Solar PV Based Smart Charging Station." IECON 2019-45th Annual Conference of the IEEE Industrial Electronics Society. Vol. 1. IEEE, 2019.

[10] Huang, Han, Grazia Todeschini, and Surya Santoso. "Design and Control of a Photovoltaic-Fed Dc-Bus Electric Vehicle Charging Station." IECON 2019-45th Annual Conference of the IEEE Industrial Electronics Society. Vol. 1. IEEE, 2019.

[11] Zhang, Yibin, Jiangbiao He, and Dan M. Ionel. "Modeling and Control of a Multiport Converter based EV Charging Station with PV and Battery." 2019 IEEE Transportation Electrification Conference and Expo (ITEC). IEEE, 2019.

[12] Verma, Anjeet, and Bhim Singh. "Integration of Solar PV-WECS and DG Set for EV Charging Station." 2020 IEEE International Conference on Power Electronics, Smart Grid and Renewable Energy (PESGRE2020). IEEE, 2020.