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A REVIEW CHARGING STATIONS FOR ELECTRIC VEHICLE

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ABSTRACT: As a measure to tackle the ever increasing energy demand as well as climate change 21st century has witnessed the concept of e mobility and a prototype shift from conventional vehicles to Electric Vehicles (EVs). But the increasing number of EVs is a major threat to the power distribution network. The increase in the demand of power required for charging EVs may hamper the smooth performance of the power distribution network. In order to ensure secure and steady performance of the power distribution network it is essential to analyze the impact of EV charging stations on the power grid. In the past few years there is extensive research on the effect of EV charging stations on power distribution network. In this particular review study the literature bearing on the impact of EV charging stations on the power distribution network are considered. Electric vehicles are a new and upcoming technology in the transportation and power sector that have many benefits in terms of economic and environmental.

KEYWORDS: *Electric vehicles, mobility, distribution network, EV charging stations, power distribution.*

I. INTRODUCTION

For economic development of any nation, the population depends strongly on fossil fuels, particularly for transportation and electricity generation. Since the number of Vehicles increases every day, the air Quality becomes a serious problem in urban area due to the big amount of the burning of fossil fuels that are greatly responsible for global warming. In light of high energy usage, environmental pollution and rising fossil fuel prices, current dependent on Internal Combustion Engine (ICE) technology must be reduced and alternative fuel which has the potential to solve environmental pollution; global warming and energy sustainability concerns must be explored. It is suggested that electricity is the most suitable energy carrier for transportation in the next 30 years when considering risk, emissions, availability, maintainability, efficiency and reliability (Chan and Chau, 2001). The invention of automobiles with ICE began in the late 19th century and the automotive industry ever since has seen only incremental changes. ICE remains the prime mover for automobiles with fossil fuel as the main fuel. The paradigm shift towards electrification drives the development of new types of propulsion systems based on electric. Figure 1 shows the paradigm shift from ICE vehicle to advanced electric-drive vehicles (Emadi, 2011). Transportation 1.0 and Car 1.0 refer to a stage or time in which transportation and cars employ fossil fuels as the main fuels, while Transportation 2.0 and Car 2.0 refer to paradigm-shifted stage in which increasing electrification in vehicles is foreseen. Electric drive vehicles are very attractive due to low road emissions, can potentially strengthen the power system by providing ancillary services; have a lower operating cost compared to fossil fuels and are more energy efficient. Advanced electric drive vehicles can be categorized into Hybrid Electric Vehicles (HEVs), plug-in Hybrid Electric Vehicles (PHEVs) and all-electric vehicles (EVs). HEVs can be generally classified as series, parallel and series-parallel (combined hybrid) (Maggetto and Van Mierlo, 2000) as respectively. In a series HEV, traction power is delivered by the electric motor while the ICE drives an electric generator that produces power for charging the batteries and driving the electric motor as a parallel HEV in which the engine and electric motor are coupled to drive the vehicle which allows simultaneous operation of ICE and motor high speeds. a series parallel configuration in which two electric machines are used to provide both parallel and series paths for the power. This means that ICE can be used to drive the vehicle together with the motor, or used for generating electricity to be stored in the battery, depending on the operating conditions and setup. HEVs can be further divided into micro hybrids, mild hybrids, power hybrids and energy hybrids depending on the hybridizationfactor. Hybridization factor is defined as the ratio of the peak of vehicle electrical power to that of total electrical and mechanical power (Zeraoulia et al., 2006). Micro hybrids have a hybridization factor of 5- 10%; mild hybrids, 10-25% and power hybrids have much higher factor. An energy hybrid has an energy In the last few years there has been considerable interest in Electric Vehicles (EVs) and Plug-in Hybrid Electric Vehicles (PHEV), which could play an important role in reducing greenhouse gas (GHG) emissions from the transport sector, and have potential as a future alternative to internal combustion (IC) vehicles. However, meaningful GHG emissions reductions with EVs are conditional on low-carbon on their source of electric energy. According to reference [1], the life cycle GHG emissions from PHEVs are assessed and find that they reduce GHG emissions by 32% compared to conventional vehicles. In this paper, the term of "electric vehicle" refers to all kind of transportation that contains rechargeable batteries; namely Cars, buses, velocipedes motorcycles and trucks. The augmentation in EV numbers brings a new issue that is the high electricity demand from the grid. One efficient solution to overcome the impact is to decentralize the power generation such as integrating renewable energy local sources into charging infrastructure. To address this challenge, Liu et al. [2] report the interaction between renewable energy and EVs charging problem in the presence of smart grid technologies. PV power technology is expected to go through a substantial development in future, due to increased environmental awareness, the cost reduction and rise in efficiency of the PV modules. P. J. Tulpule et. al. [3] has cited several economic and environmental profits of the PV powered charging station in workplace parking. Furthermore, the charging operation is made during the daytime, which means the power generation is in its maximum point. Therefore a considerable cost saving is guaranteed. The installed PV modules on working parking garage's roof gives also free shelters in bad weather conditions [4]. Because of these advantages, the PV-grid based system is more preferred than other renewable energy based systems. All electrically power assisted vehicles need to be recharged via charging systems, and the stations that use photovoltaic module as a source of electric energy for the battery recharging are called photovoltaic- charging stations (PVCS). The PVCS is divided into two mandatory types, which are PV-grid charging system and Standalone charging systems. In this paper, we will investigate this topic by comparing the features of the two architectures and giving the actual technological status of charging system. For this reason, we present every part of the PV charging infrastructure to give an updated literature to engineers and researchers. This paper is organized as follows: The second section gives an overview of the chargers standards. The third section analyses the general architecture of the PVC_S. In the fourth section, there is three main organizations that work to standardize electrical characteristics of EV charging stations in the world: the worldwide leader of the electric carmakers, Tesla motors develops its own standards for its model S, Model X and Roadster electric cars. Every organization cited above, offers a range of charger norms that work on both AC and another dedicated to DC voltage. In this paper we investigate only the data belong to DC range. For instance, the SAE has been working on standard J1772, which organizes EV chargers into 3 main categories [5]: Level 1, Level 2 and Level 3. i) Level 1: the charger is on- board and provides DC voltage with maximum current of 80 A, and maximum power of 40 kW. ii) Level 2: the charger provides DC voltage with maximum current of 200 A, maximum power of 90 kW. iii) Level 3: charger is off- board. The charging station provides DC voltage directly to the battery via a DC connector, with a maximum power of 240 kW. All chargers from level 3 are considered as fast chargers.

II. PROPOSED METHOD

Photovoltaic Charging station topologies The PV-EV charging stations are divided into two categories, which are PV-grid charging system and PV-standalone charging systems. This section reviews the two architectures and gives a technical comparison between them.

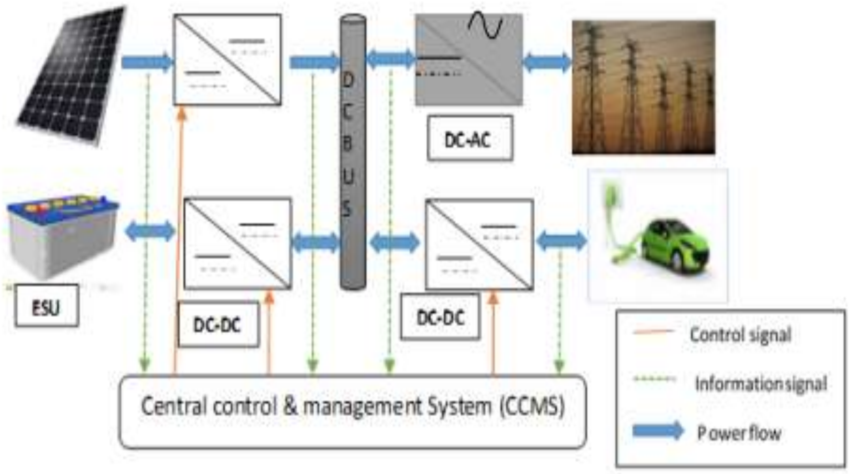

Fig.1: A block diagram of a PV-grid charging system.

The showed charging architecture in figure 1, which is studied from different points of view in various published paper[6], [7], is characterized by two conversion stages obtained through AC/DC and DC/DC converters. Furthermore, the dc bus has a high importance, because it is proposed to interface the PV array, the ESU and the EV battery pack combining other dc powered electronics. In this architecture, the batteries or energy storage unit (ESU) could be optional since the station is directly connected to the grid. Nevertheless, it would be a substantial part in case of willing reduces the dependence to the grid. In [8] the authors investigate the convivial topologies for integrated PV-grid charger.

Standalone PV charging system

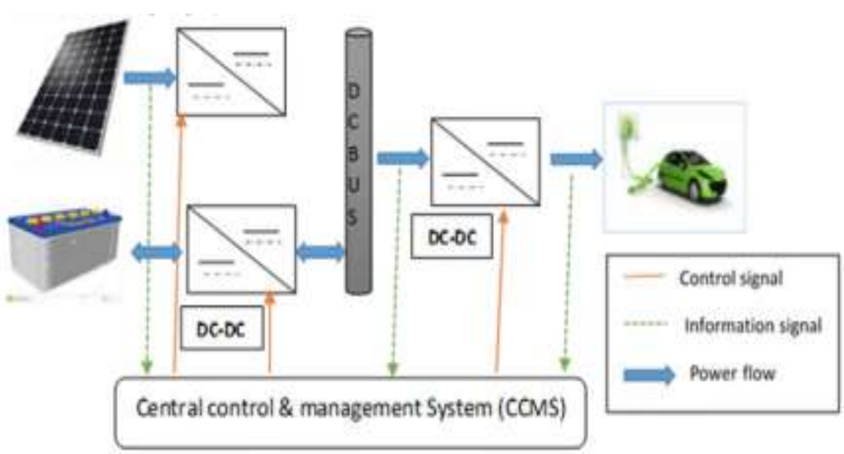

Fig.2: Standalone PVC$_S$

In contrast with PV-EV charging station connected to grid, the standalone or off-grid station could provide energy to EV's batteries without any connection to the power grid. To this end, the charging system is necessarily equipped with an Energy storage unit (ESU) in order to be able to deliver continuously the power to the EV battery during night or when the PV modules cannot produce the sufficient energy [9]. For instance, In [10] authors proposed a standalone photovoltaic vehicle charge using second life lithium batteries as ESU.

Bidirectional DC Charger

The mandatory function of a dc charger in PVCS is to allow an effective control during the charging process by interfacing the dc bus voltage to the EV battery. In literature, charger systems for electric vehicles are classified into off-board and on-board types with unidirectional or bi-directional power type adopts the Vehicle to grid (V2G) concept, since it has not only the capability to charge the EV in one effective way from the grid or the ESU, but also it supports also the power flow in the other direction back to the grid Hence, it gives the grid the opportunity to benefit from the energy stored in the EV battery during shortage energy time. Beside this, V2G technology requires advanced communication components to guarantee a safe operation and a smart grid to accept the power injection. The impact of the V2G on the EV battery pack is evaluated and discussed more deeply in concerning the power converter configuration used; we find essentially two structures, namely nonisolated and isolated converters. This latter type ensures the galvanic isolation, by contrast, it presents some drawbacks such as high cost realization due to adding transformers. In the other side, the nonisolated bidirectional dc chargers are considered the most appropriate to serve as DC chargers because of their compactness and higher reliability. In authors reviewed the topologies of non-isolated bidirectional DC-DC chargers and proposed application of a rapid charging station at municipal parking decks. In an on-board bidirectional soft-switched battery charger is proposed. Serving the same purpose, The Interleaved design of Bidirectional converter and a half bridge topology are studied in with the aim to minimize the inductor size and increase the efficiency using soft-switching control. On-board chargers are usually used to increase the charge availability for all kind of rechargeable vehicles. However, some constraints must be taken in consideration such as weight; size and power rate since this type is usually used for slow charging during nights or embedded on the vehicle. Therefore there will be an outlook for PV charging stations to move from slow onboard chargers to high-power off-board fast chargers in the future. The dissimilarities between the On-board and OFF board Dc charger are summarized.

III. CONCLUSION

This paper briefly reviews works recently conducted in the area of photovoltaic DC charging stations for EVs. A discussion and a comparative study between different components of the charging stations are done. To summarize, the benefits of PV-EV chargers that adopt V2G technology will receive an increased attention and more investments from grid operators and carmakers in the future. As conclusion, The Photovoltaic charging structure is becoming more complex with several functions integrated into the system, which require intelligent controls in each block and real time management for the whole station. Electric vehicles are expected to enter the world market such that by 2030, 10% of the vehicles will be of EV type. To have a better understanding on EV technology, this study outlines the various types of EV, battery chargers and charging stations. A comprehensive review has also been made on the standards currently adopted for charging EV worldwide. For better understanding on the state of the art EV technology, a comparison is made on the commercial and prototype electric vehicles in terms of electric range, battery size, charger power and charging time.

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