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Solar Power Electric Vehicle Charger

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***Abstract*: This report discusses about the potential need for electric vehicles (EV), charging station (CS) infrastructure and its challenges for the Indian scenario. With increase in liberalization, privatization and expansion of distributed and renewable power generation of Indian electricity market, transmission and distribution, as well as market processes related to the allocation of energy and energy mix are undergoing an evolutionary development with improved efficiency and reliability. Searching charging stations for electric vehicles is an important issue for the drivers which need the implementation of smart charging infrastructure network. Selecting the location for installing electric vehicles charging stations is important to ensure EV adoption and also to address some of the inherent risks such as battery cost and degradation, economic risks, lack of charging infrastructure, risky maintenance of EVs, problems of its integration in smart grid, range anxiety, auxiliary loads and motorist attitude**

***Keywords*: Solar, power, electric, vehicle, charger**

1. Introduction

Automobiles have made great contributions to the growth of society by satisfying many of the needs for mobility in day to day life. Development of internal combustion (IC) engine is one of the greatest achievements of modern technology. But due to usage large number of automobiles, it affects environment and human life also. Air pollution, global warming, and rapid depletion of crude oil reserves become a serious problem now. As an alternative to replace conventional vehicles, development of electric vehicles (EVs) is done in recent times. Electric vehicle is an electric motor driven transportation medium that runs with the help of electric battery. Battery supplies necessary electrical energy to run all the electrical as well as electronic applications in EV. So in electric vehicles prime source is battery. Main function of battery is to store the energy (charge) and to deliver that energy (discharge). Major three battery types are preferred for an EV are lead –acid, nickel based batteries such as nickel- metal, nickel-cadmium and lithium based batteries such as lithium-ion, lithium-polymer .Battery selection depends on specific energy which is co-related with the EV range (in km) for higher range EV, battery capacity should be more to meet the demand which increases the battery capacity. Charging of battery is most important parameter in the energy storage systems. Hence electric vehicle chargers have been introduced to charge the EV battery. Charger provides power from utility to charge.

2. Literature Survey

Charging infrastructure for electric vehicles (EV) will be the key factor for ensuring a smooth transition to e-mobility. Smart charging of EVs is expected to enable larger penetration of EVs and renewable energy, lower the charging cost and offer better utilization of the grid infrastructure.

1. In recent years, Electric vehicles (EVs) are receiving significant attention as an environmental- sustainable and cost-effective substitute of vehicles with internal combustion engine, for the solution of the dependence from fossil fuels and for the saving of Green-House Gasses emission.
2. The proposed fast charger is divided into two main sections an AC-DC converter performing a PFC function and a DC-DC converter performing a charging function. A transformer including leakage inductances was used in the AC-DC converter in order to obtain isolation and inductance. A series-connection topology was used in the DC-DC converter between the DC-bus and outlet.
3. A fast charger station can charge a vehicle battery in 5-10 minutes but it is very expensive and massive. Recent advancements in the device developments and design tools enables one to have a higher power density (power divided by volume) chargers that is equivalent to as smaller size and weight. Semiconductors based on Silicon Carbide (SIC), magnetic materials based on Nano-crystalline and modern design tools like FEM simulators are examples of these advancements.
4. An on-board charger is responsible for charging the battery pack in a plug-in hybrid electric vehicle (PHEV). The objective of the design is to achieve high efficiency, which is critical to minimize the charger size, charging time and the amount and cost of electricity drawn from the utility.

3. System Structure

- *Pv Module*- It converts sun light into DC Electricity Solar charge controller- It regulates the voltage and

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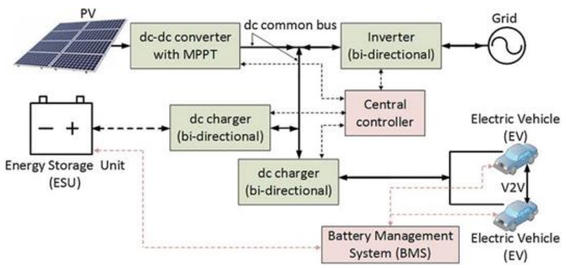
current coming from the PV panels going to, battery and prevents battery overcharging and prolongs the battery life.

- *Battery*- stores energy for supplying to electrical appliances when there is a demand.
- *Load*- is electrical appliances that connected to solar PV system such as lights, radio, TV, computer, refrigerator, etc.
- *Maximum power point tracking*- IT is a technique used commonly with wind turbines and photovoltaic (PV) solar systems to maximize power extraction under all conditions.



1) Converters/ Inverters

A Solar inverter or PV inverter, is a type of electrical converter which converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network

- Bidirectional AC/DC Converter
- Unidirectional AC/DC Converter
- Bidirectional DC/DC Converter
- Unidirectional DC/DC Converter

2) Battery management system (BMS)

A battery management system (BMS) is any electronic system that manages a rechargeable battery , such as by protecting the battery from operating outside its safe operating area monitoring its state, calculating secondary data, reporting that data, controlling its environment, authenticating it and / or balancing it.

3) Basic of EV charger

In recent years the problems of "range anxiety" associated with electric vehicles (EVs) have been alleviated by the introduction hybrids (HEVs) and plug in hybrids (PHEVs) and the development of higher energy density batteries capable of storing more energy in the same space. With the increasing popularity of electric vehicles, "range anxiety" is now being replaced by "charging anxiety"

Chargers provide a DC charging voltage from an AC source whether from a common socket outlet or more recently from a purpose built DC charging station. Most important are the methods of controlling the charge and protecting the battery from over-voltage, over-current and over-temperature. These charger functions are integrated with and unique to the battery. Chargers for electric bikes are usually low cost, separate units. To save weight they are not usually mounted on the bike and charging takes place at home. Their power handling capacity is only sufficient for charging the relatively low power bike batteries and entirely unsuitable for passenger car applications.

Chargers for passenger cars are normally mounted inside the car. This is because the vehicle may be used a long way from home, further than the range possible from a single battery charge. For this reason they have to carry the charger with them on board the vehicle. Charging can be carried out at home from a standard domestic electricity socket outlet but the available power is very low and charging takes a long time, possibly ten hours or more depending on the size of the battery. Since charging is usually carried out overnight this is not necessarily a problem, but it could be if the car is away from its home base. Such low power charging is normally used in an emergency and most cars are fitted with a higher power charging option which can be used in commercial locations or with a higher power domestic installation. In many countries this higher power facility is implemented by means of a three phase electricity supply.

Commercial electric vehicles need bigger batteries which need higher power charging stations to achieve reasonable charging times but they also have extra options. Many of them follow prescribed delivery routes within a limited range from base and return to base in the evening. In these cases off board charging is possible saving weight and space on the vehicle. Such applications can also be adapted to battery swap options. Each vehicle may have two batteries with one being charged while the other is in use. When used in long distance shuttle applications this can double the effective range of the vehicle.

The vehicle depletes the battery during each journey and picks up a fully charged battery at the terminus leaving the discharged with one being charged while the other is in use. When used in long distance shuttle applications this can double the effective range of the vehicle. The vehicle depletes the battery during each journey and picks up a fully charged battery at the terminus leaving the discharged battery to be recharged ready for the next trip. This shuttle option however needs three batteries per vehicle.

Early HEVs used Nickel Metal Hydride batteries, but they are mostly being superseded by a range of variants of Lithium ion batteries which is the technology of choice for most new EV applications since they can store more energy and deliver higher power. For this reason most EV chargers are designed to work exclusively with Lithium i battery to be recharged ready for the next trip. This shuttle option however needs three batteries per vehicle.

4) Charging Stations

Charging stations merely deliver the energy to the vehicle, usually in the form of a high voltage AC or DC supply. They don't normally have the functions of the charger which must transform the electrical energy into a form which can be applied directly to the battery. From the wide range of potential consumers noted above, it can be seen that the EV community needs several power supply options. Broadly speaking, three different power levels have been defined but within these levels a very wide range of options are available to accommodate the different existing power grid standards of the national electricity generating utilities.

- *Level 1* refers to Single Phase Alternating Current (AC) using grounded receptacles as used in domestic applications. In North America this typically means 16 Amps at 120 Volts delivering 1.9 kW of power. In Europe it may be 13 or 16 Amps at 240 Volts delivering 3 kW of power. The EV may incorporate a standard domestic power cord to connect the vehicle to a domestic socket outlet or a Level 1 charging station.
- *Level 2* delivers up to 20 kW of power from either Single or Three Phase Alternating Current (AC) sources of 208-240V at up to 80Amps. In North America, the J1772 standard has been defined by the Society of Automotive Engineers - SAE to cover the connector and charging cable used in Level II applications. These cables are permanently fixed to the Level II charging station rather than the vehicle with the male connector being mounted in the vehicle itself. The connector is also commonly called a "coupler". Individuals can install a level 2 charging station at home, while businesses and local government can also provide level 2 charging for a fee or free if they wish.
- *Level 3* refers to Direct Current DC charging, or “fast charging.” To achieve very short charging times, Level 3 chargers supply very high currents of up to 400 Amps at voltages up to 600Volts DC delivering a maximum power of 240kW. Within this definition there are several competing industry / commercial standards including an SAE J1772 Hybrid coupler, the so called Jumbo, and the Japanese CHAdeMO. The J1772 combo coupler for example allows charging from either a conventional, 15-amp AC wall outlet or a DC connection of up to 90 kilowatts. These systems are being proposed for public fast charging stations. Examples of J1772 and CHAdeMO couplers are shown below.

5) Home Charging

The home private chargers are generally used with 230V/15A single phase plug which can deliver a maximum of up to about 2.5KW of power. Thus, the vehicles can be charged only up to this rate. The billing for the power is part of home-metering. This will be continued till a policy evolves to charge the home users differently for EV use. Also Bharat EV Specs recommends using the IEC 60309 Industrial connector from both ends.

6) Public Charging

For charging outside the home premises, Bharat EV standards recommends that the electric power needs to be billed and payment needs to be collected. The power utilities may also want to manage power drawn by these chargers from time to time.

7) AC "Slow" Charging

Slow AC charging is the most common method of charging electric vehicles. An EVSE supplies AC current to the vehicle’s onboard charger which in turn converts the AC power to DC allowing the battery to be charged. So when you charge your Mahindra e2o or the e2o plus electric car or a Lithium-Ion based e-Scooter using a 15 Amp socket or a smart charger, then you are charging you are - AC charging your EV.

Under AC Charging there are 2 categories of charging

8) Normal AC charging

As mentioned above, electric 2-wheelers, 3-wheelers and 4-wheeler vehicles in India has on-board charger that charge at rate of around 2.5kW to 3kW. These AC 2.5KW or 3KW Chargers could fast charge a 2-wheeler (for a battery with an energy density of 2KWh) in an hour’s time; 4-wheeler or larger vehicles with batteries of 12 KWh or more will be charged in five to six hours.

9) Fast AC charging

Global electric cars like the Nissan Leaf or the Tesla have on board chargers with higher power ratings. This enables AC charging at a faster rate, from 7.7 kW to 22 kW.

10) AC Plug Connectors

Indian electric cars use the IEC 60309 Industrial Blue connectors and Bharat EV specifications recommend using this plug.

Global EV's use the IEC 62196 Type 2 connector (commonly referred to as Mennekes). This plug was selected by the European Commission as official charging plug within the European Union. It has since been adopted as the recommended connector in countries outside of Europe.

IEC 60309 Industrial Socket used by Indian e-Rickshaws, Mahindra e2o, Mahindra e2o Plus P6

11) This is the Bharat EV standard

IEC 62196 Type 2 connector used by Indian and Global EV's electric cars, Mahindra e2o Plus 8, Nissan Leaf, and Renault Zoe etc.

Simple 3 pin connector coupled with a 15 Amp plug used in Indian e-Scooters

12) DC Fast Charging

As per Bharat DC Charging Specifications, Power rating of fast chargers are

- 10kW/15kW/30kW/50kW or even higher capacity. Voltage rating at which fast charging has to be carried out
- 48V/72V for Indian electric cars like the Mahindra e2o Plus P8, Mahindra e-Verito and upcoming Tata electric cars
- Up to 750V or even higher used by global electric cars like Nissan Leaf and others.

13) Level 1 DC Chargers

Public DC Chargers at output voltage of 48V / 72V, with power outputs of 10 kW / 15 kW with maximum current of up to 200A. As per the Bharat EV specs, these will be called Level 1 DC Chargers.

14) Level 2 DC Chargers

Public DC Chargers at output voltage up to 1000V, with power outputs of 30 kW / 150 kW. These will be called Level 2 DC Chargers.

15) DC Plug Connectors

There are four or so DC Fast Charging connectors currently being used by electric car manufacturers all over the world. *CHAdeMO* – Nissan and other Japanese companies like Mitsubishi

- SAE Combo Charging System (CCS) – (BMW, GM, VW, and other carmakers)
- Supercharger – Tesla standard connector
- GB/T - BYD among other Chinese companies use this. Mahindra and Tata electric cars also use this standard
- Bharat EV Charger DC-001 specifications recommend the China based GB/T connector standard. Also Indian electric cars and electric buses use the GB/T port on the vehicles for DC fast charging.

We feel costs could be a major factor in India opting for GB/T compared to CHAdeMO or CCS. Also because car companies are looking to the Chinese and Asian market to increase car sales, it's possible that whatever fast charging standard China chooses, will, by weight of numbers, become the world standard

16) DC Plug Connectors

CHAdeMO connector

GB/T connector

CCS connector

17) Solar PV system sizing

Determine power consumption demands

- Calculate total Watt-hours per day for each appliance used
- Calculate total Watt-hours per day needed from the PV modules

18) Size the PV modules

- Calculate the total Watt-peak rating needed for PV modules
- Calculate the number of PV panels for the system

1. Inverter sizing
2. Battery sizing
3. Solar charge controller sizing

4. Conclusion

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. EV charging is considered as a big load to the utility. The worst case if all EVs are charged at the same time. However, this scenario will be unlikely to happen because of many factors. One of the factors is that the number of charging station is limited. As for the impact of EV battery chargers on the power supply system, it depends on the technology of the chargers. Older version of chargers is based on full-wave rectification using diodes and progressively thyristors are used. Later designs use microprocessor-controlled charging technologies with several algorithms being implemented for parameter monitoring and control.

Today, smart battery chargers are available which can interactively communicate with the utility system in order to receive and send information about the state of charge, energy availability, tariffs and management data in general. Such designs have resulted in reduction of harmonic distortion and power factor improvement. A survey of battery charger manufacturers from 1993 to 1995 shows that the average total harmonic distortion decreases from 50.1 to 6.12% (Gomez and Morcos, 2003).The degree of impact on power system depends on how much the EV penetrates the market. This penetration will depends on the battery cost, gasoline prices, charging infrastructure, competition from other vehicles and government policy. When referring to impact of EV to power grid, the regional or local penetration is of importance to utilities. Some parts of the region will be more severely impacted by the presence of EVs than others. Even within the same region, only certain part will need significant focus. The distribution of these EV will depend on promotional policies, incentives and the deployment of charging infrastructures

References

[1] Gautham Ram Chandra Mouli, Prasanth Venugopal, Pavol Bauer, " Future Of Vehicle Charging " , 19th International Symposium POWER ELECTRONICS Ee2017, October 19-21, 2017, Novi Sad, Serbia ,2017

[2] Sreejakumar Nair, Narendar Rao, Shantanu Mishra, Anand Patil, " India's Charging Infrastructure - Biggest Single Point Impediment In EV Adaptation In India" ,IEEE Transportation Electrification Conference (ITEC India) ,2017

[3] Maria Carmen Falvo, Danilo Sbordone I. Safak Bayram, Michael Devetsikiotis, "EV Charging Stations and Modes: International Standards", International Symposium on Power Electronics, Electrical Drives, Automation and Motion, 2014

[4] Janamejaya Channegowda, Vamsi Krishna Pathipati, Sheldon S. Williamson, "Comprehensive Review and Comparison of DC Fast Charging Converter Topologies: Improving Electric Vehicle Plug-to-Wheels Efficiency ", IEEE ,2015

[5] Deepak Gautam, Fariborz Musavi, Murray Edington Wilson Eberle, William G. Dunford, "An Automotive On Board 3.3 kW Battery Chargerfor PHEV Application", U.S. Department of Energy - Vehicle Technologies Program, 2008.

[6] Deb, S. Kalita, K. & Mahanta, P. (2017, December). Review of impact of electric vehicle charging station on the power grid. In 2017 International Conference on Technological Advancements in Power and Energy (TAP Energy). IEEE.

[7] Deb, S., Tammi, K., Kalita, K., & Mahanta, P. (2018). Impact of Electric Vehicle Charging Station Load on Distribution Network. Energies, 11(1), 178.

[8] Liu, Z. F., Zhang, W., Ji, X., & Li, K. (2012, May). Optimal planning of charging station for electric vehicle based on particle swarm optimization. In Innovative Smart Grid Technologies-Asia (ISGT Asia), 2012 IEEE (pp. 1-5). IEEE

[9] Feizi M, Beiranvand R (2020) Simulation of a high power self-equalized battery charger using voltage multiplier and phase-shifted full bridge converter for lithium-ion batteries. In: 2020 11th Power Electronics, Drive Systems, and Technologies Conference (PEDSTC), Tehran, Iran, 2020, pp. 1–6.

[10] Ota Y, Taniguchi H, Suzuki H, Nakajima T, Baba J, Yokoyama A (2012) Implementation of grid-friendly charging scheme to electric vehicle off-board charger for V2G. In: 2012 3rd IEEE PES Innovative Smart Grid Technologies Europe (ISGT Europe), Berlin, 2012, pp. 1–6

[11] Afida ayob et al "Review on Electric Vehicle, Battery Charger, Charging Station and Standards." Research Journal of Applied Sciences, Engineering and Technology. January 2014.

[12] Adam Junid et al "A Study of Electric Vehicle Charging Station Installation Progress in Malaysia." Research Journal of Applied Sciences, Engineering and Technology. January 2016.

[13] Praveen Kumar et al. "Potential Need for Electric Vehicles, Charging Station Infrastructure and its Challenges for the Indian Market." Research India Publications. Number 4 (2013).

[14] Kara M. kockelman et al, "optimal locations of U.S. fast charging stations for long distance trips by battery electric vehicles." Journal of Cleaner Production. 2018.

[15] Somudeep Bhattacharjee et al "Investigating Electric Vehicle (EV) Charging Station Locations for Agartala, India." 2nd International Conference of Multidisciplinary Approaches on UN Sustainable Development Goals. December 2017.

[16] Shaohua Cui et al. "Locating Multiple Size and Multiple Type of Charging Station for Battery Electricity Vehicles." Licensee MDPI, Basel, Switzerland, 13 September 2018.

[17] Doug Kettles et al. "Electric Vehicle Charging Technology Analysis And Standards." U.S. Department of Transportation's University Transportation Centers Program, February 2015.

[18] Yu Miao et al. "Current Li-Ion Battery Technologies in Electric Vehicles and Opportunities for Advancements." Licensee MDPI, Basel, Switzerland, 20 March 2019.

[19] Henry Lee et al "Charging the Future: Challenges and Opportunities for Electric Vehicle Adoption." Faculty Research Working Paper Series, September 2018.

[20] Gautham Ram Chandra Mouli et al "Future of electric vehicle charging" International Symposium on Power Electronics, 2017.

[21] Mingsheng Zhang et al. "Location Planning of Electric Vehicle Charging Station." IOP Conference Series: Materials Science and Engineering, 2018.

[22] Li Zhang, Tim Brown, "Evaluation of charging infrastructure requirements and operating costs for plug-in electric vehicles." Journal of Power sources 240, 2013.

[23] http://solutions.3m.com/wps/portal/3M/en_US/electronics/home/productsandservices/pro ducts/chemicals/BatteryElectrolytes/.

[24] http://www.cleanfleetreport.com/clean-fleet-articles/google-energy-v2g/.

[25] https://www.jetir.org/view?paper=JETIR2004477

[26] https://www.researchgate.net/publication/334689540_Charging_Statio_Placement_for_Electric_Vehicles_A_Case_Study_of_Guwahati_City_India

[27] http://www.leonics.com/support/article2_12j/articles2_12j_en.php

[28] https://www.qualcomm.com/news/onq/2017/05/18/wireless-dynamic-ev-charging-evolution-qualcomm-halo

[29] https://www.youtube.com/watch?v=h6jKvZgkSFE

[30] https://insights.globalspec.com/article/13768/dynamic-wireless-charging-success-in-long-haul-ev-truck-test.