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Electric Charging Stations Infrastructure and Management

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Abstract - Technological advancements always played a major role in transforming the automobiles; From hand-pulled carts to autonomous cars. The fuel powered vehicles are one of the greatest inventions the world has ever seen, but the negative impact caused by them on the environment has laid a new path for the invention of Electric Vehicles. The electric vehicles are emission less vehicles, that are powered and run on electricity solely. Like fuel pumps, these EV's require chargin stations. This work provides infrastructure and maintenance of charing stations. Charging stations have been installed in various parts of the world till date. Level 1, Level 2 and fast EV charing stations have been installed in various places respectively. Detailed infrastructure report on installation and maintenance is required. Maintenance is required for any EV charin station to run efficiently. The various factors which effect the efficiency of charging stations are frequency of usage, climatic conditions, exposure of charring unit to atmosphere. This work provides detailed overview of various power options, technologies, energy management techniques and maintained of charing stations that are optimal for the Indian market.

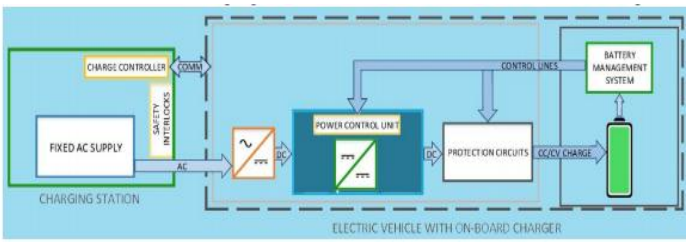
Key Words: **Electric Vehicles, Infrastructure, Maintenance, Efficiency, Charging Stations.**

1. INTRODUCTION

The government of India came up with National Electric Mobility plan in 2012. It states to manufacture 6 to 7 million HEV's and EV's by 2020 and recently in 2017 it is also announced that fuel powered vehicles should be banned by 2030. Many cities in India have extreme levels of air pollution in form of oxides of Nitoen and Carbon. Transport sector majorly contribute to the air pollution accounting for about 51% in India and this figure goes to 75--80%. The alternative fuel vehicles, EV's reduces negative impact of transport sector on environment. EVs have not gained wide acceptance among customers in the past. However, technological advancements, battery technology have made EVs attractive. EVs have started penetrating automobile market in India. However large scale deployment of EVs in India depends upon the charin infrastructure which includes slow charging stations at houses and fast charging stations in public places.

2. EV Charging Station

An EV charging station is an infrastructure which supplies the electricity for an EV to get chared. Chring stations are generally placed near public areas, shopping malls and places where density of vehicles is high. For charing at home, electric vehicles have converters on board that can plug into a standard electric outlet. Others either require or can use a chargin station that provides electrical conversion, monitoring or safety functionality.



These stations are needed when traveling too. Many support fast charging with higher voltages and currents. Public charging stations are typically om-street facilities provided by electric utility companie, retail shopping centres, restaurants and parking places, operated by a rane of private companies.

3. Types of Chargers

Rapid chargers are the fastest way to charge an EV, and predominantly cover DC charging. This can be split into two cateories, ultra-rapid and rapid. Ultra-rapid points can chare at 100+ KW, often 150KW, and upto 350 KW, and are DC only. Conventional rapid points make up the majority of the UK's rapid charging infrastructure and charge at 50 kW DC, with 43 kW AC rapid charging often also available. Fast chargers include those which provide power from 7 kW to 22 kW, which typically fully charge an EV in 3-4 hours. The most common public charge point found is a 7 kW untethered Type 2 inlet, though tethered connectors are both Type 1 and Type 2 connectors. Slow units cover chargers between 3 kW to 6 kW and are best used for overnight charging, usually taking between 8-12 hours for a pure-EV, or 2-4 hours. Typically referred to as 3 kW points, slow chargers can be rated at up to 6 kW, with 5.5 kW commonplace for lamppost-based charge points, whilst three-pin plugs often charge at 2.3 kW. EVs charge on slow devices using a cable which connects the vehicle to a three pin or Type 2 socket.

4. Power Levels

On the basis of charging power levels, charging can be classified into Level 1, Level 2, Level 3 charging level and DC fast charging. Level 1 charging is the slowest mode of charging which requires 120 V/15 A, single-phase supply and J1772 EV connector to connect with the EV port. It usually takes place at home. Level 2 charging is used for public applications. It uses dedicated supply equipment which is connected to 208 or 240 V outlet. Level 3 and fast DC charging are used for commercial applications which take place at public places like highways, city fueling points, similar to gas stations.

Table 1: Describes about charging time, charger location, voltage, power, range and usage of different charging levels

Charing type	Level 1	Level 2	DC Fast
Charging time (h)	20–22	6–8	0.2–0.5
Charger location	Onboard; 1-phase	Onboard; 1 or 3-phase	Off-board; 3-phase
Voltage	120	240	208-600
Power	1.3–1.9	Up to 19.2	50–150
Range (per hour of Charging)	2–5 miles	10–20 miles	60–80 miles
Use	Residential purpose	Public	Public

5. Onboard and Off-board topologies

EV chargers can be classified as onboard and off-board chargers, unidirectional and bidirectional power flow capabilities. On board chargers have various limitations due to placement of the charger on the vehicle, whereas off-board charges do not have such limitations.

Table 2: Charging standards

Standard	Specification
SAE-J1772	EV coupler for conductive charging
SAE-J1773	EV inductively coupled charging
SAE-J1797	Recommended practice for EV battery modules packaging
SAE-J2288	Life cycle testing of battery modules for EV
SAE-J2464	EV/HEV rechargeable energy storage system (RESS) safety and abuse testing
SAE-J2836 Part 1	Use cases for communications between PEVs and utility grid
SAE-J2836 Part 2	Use cases for communications between PEVs and supply equipment (EVSE)
SAE-J2836 Part 3	Use cases for communications between plug-in vehicles and the utility grid for reverse flow
SAE-J2894	Power quality requirements for plug-in vehicle chargers—requirements
IEC-69/156/ CD:2008	Electric vehicle conductive charging system
IEC-23H/222/ CD:2010	Plugs, socket outlets, vehicle couplers, and vehicle inlets—conductive charging of EVs
JEVS-C601:2000	Plugs and receptacles for EV charging
AIS-138 (Draft)	Electric vehicle conductive AC charging system-ARAI

6. EV Charging Infrastructure

Having a perfect charging infrastructure is very important for penetration of electric vehicles into the market. Hence, Government of India considered charging infrastructure as foremost task regarding EV's. One of the factors should be considered is additional load which is applied on the grid and the system must to be capable to bear the load. The infrastructure must be consumer convenient and should not affect the power grid. In India, very few DC charge stations are installed by manufacturers. The public AC charge points are existing in India with less than 3.3kW rating which is limited by on-board charger capacities of EV's. The availability of fast AC and DC charging points helps in providing better infrastructure for consumer. The charging infrastructure needs less investment compared to a fuel stations but still the growth of charging infrastructure in India is not up to the mark. It requires continuous support from the government, utility grid authorities and manufacturers. Currently in India, the Bharat EV AC Charger (BEVC-AC001) for AC charging with less than 3.3kW power rating & Bharat EV DC Charger (BEVC-DC001) with less than 15kW power rating are expected to notify for both 48V & 72V charging systems. Also, the Automotive Research Authority of India (ARAI) published AIS138 Part-1 (Electric Vehicle conductive charging system) for AC charging standard in May-2017.

7. Requirements for Charging Infrastructure:

Every public charging station shall have the following minimum infrastructure:

• Exclusive transformer with all related substation equipment including safety appliance.

• 33/11 KV cables with associated equipment including line termination.

• Appropriate civil works.

• Appropriate cabling and electric works for safety.

• Adequate space for entry and exit of vehicles.

• Should posses the chargers as preferred below

Table 3: Types of Chagrers

Charger Type	Charger Connectors*	Rated Voltage (V)	No. of Charging Points/No. of Connector guns (CG)
Fast	CCS (min 50 kW)	200-1000	1/1 CG
	CHAdeMO (min 50 kW)	200-1000	1/1 CG
	Type-2 AC (min 22 kW)	380-480	1/1 CG
Slow/Moderate	Bharat DC-001 (15 kW)	72-200	1/1 CG
	Bharat AC-001 (10 kW)	230	3/3 CG of 3.3 kW each

8. TATA POWER Charging Station:

Tata power is one of the leading companies adopting the EV culture. It has come up with various plans regarding the charging stations. Tata Power has announced its plans to expand its electric vehicle (EV) charging network in the country to over 700 by the end of the financial year 2021. The company said that it currently has around 170 charging stations, and now it would be investing to expand its network of smart EV charging points under the "Tata Power EZ Charge" brand name. The company said that the growth in demand for EVs is expected to overtake the demand for internal combustion (IC) based vehicles, adding that in 2019-20, EVs recorded a 20% jump in sales by volume from the previous year. The company spoke about its plans to create infrastructure for home charging, as well, while simultaneously expanding its public charging locations like metro stations, shopping malls, theatres, and highways. It said it is working with metro rail authorities and municipal corporations for this.

9. Maintenance of Charging Station:

As number of vehicles increases, the maintenance is also needed to be done greater number of times. The various maintenance issues which are observed in the charging station are as follows

• Power failures

• Shorts

• Slower than normal charge times

• Charger gun malfunction

• Power malfunctions

• Excess energy consumption or other

Accurate and quality site preparations are crucial for reliable charging stations. Preventive maintenance is required for efficient charging station. It helps in preventing equipment breakdown and results in less replacement (or) repair of equipment. Preventive maintenance consists of below aspects,

• Visual inspection

• Environmental inspection

• Mechanical inspection

• Electrical inspection

• Implementation of updates

• Reporting issues

The complete installation of charge station with all charging models will take INR 20 to 30 Lakhs according to Indian market situation.

10. Conclusion:

The charging infrastructure and maintenance in Indian market scenario is discussed with statistics. The challenges which are faced by EV's while penetrating into the Indian market is also discussed.

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