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A Review on Recent Advancement of Electric Vehicle Chargers

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ABSTRACT: *The Ministry of Power (MOP), Government of India released the guidelines on EV charging infrastructure on December 14, 2018, which addresses the need for adequate availability of charging stations. These guidelines were revised and updated on October 1, 2019. Sales of EVs are projected to reach around 10.5 million for the four wheeler segment by 2030 as per NITI Aayog. The accessibility of public charging framework is a urgent factor in expanding the appropriation of PHEVs, on the grounds that significant distance trips can't be accomplished with PEVs' restricted Electric Range (ER). Fast Charging Stations (FCSs) will ultimately be scattered in the organization. The energy utilization of charging organization which EV charging offices framed will be exceptionally enormous. EVs are becoming highly remarkable and nominal and, as they achieve popularity, the technology for them is elaborating and becoming more attainable. It is usual to see EV chargers at businesses, public areas, and homes, and knowing the difference between the different types of EV chargers can help you make the best decision for your electric car. The types of EV chargers are divided by levels that indicate how rapid and competent they are.*

KEYWORDS – *Electric Vehicle(EV), Ministry of Power, NITI Aayog, Electric Range(ER), Fast Charging Stations (FCSs), Plug-in Hybrid Electric Vehicles (PHEVs)*

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I. INTRODUCTION

The Ministry of Power, Government of India issued a clarification on EV charging in April, 2019, namely that charging of an EV battery by a charging station is a service consisting of electricity consumption and hence should earn revenue for this specific service. The value of the electricity is realized through a charging station operator, and hence is distinct from a typical sale of electricity. As such, EV charging does not fall under the purview of the Electricity Act of 2003 and is not subject to the other conditions of electricity retail distribution; this clarification has paved the way for participation of private players. The guidelines and standards aim to enable faster adoption of EVs in India by ensuring safe, reliable, accessible, and affordable charging infrastructure along with affordable tariffs, creating standard guidelines for EV charging businesses, and encouraging utilities and other parties to be prepared for EV adoption. India has perhaps the most quickly developing auto business sectors on the planet and has seen a yearly development of 16% in the vehicle enlistment for as far back as decade. At current level, almost 50,000 new engine vehicles (2-, 3-, and 4-wheelers) get enlisted each day. The vehicle area contributes around 10% of these GHG discharges, while street transport represents 88% of transport GHGs. Transport area is the biggest shopper of oil based goods, representing 98% of the absolute petroleum utilization and 70% of complete diesel utilization. India presently depends on imports to meet over 80% of its oil needs. It positions third on the planet for raw petroleum imports both as far as volume just as worth. Its oil imports represent USD 91.43 billion, comprising 27% of its absolute spending on imports in 2017.

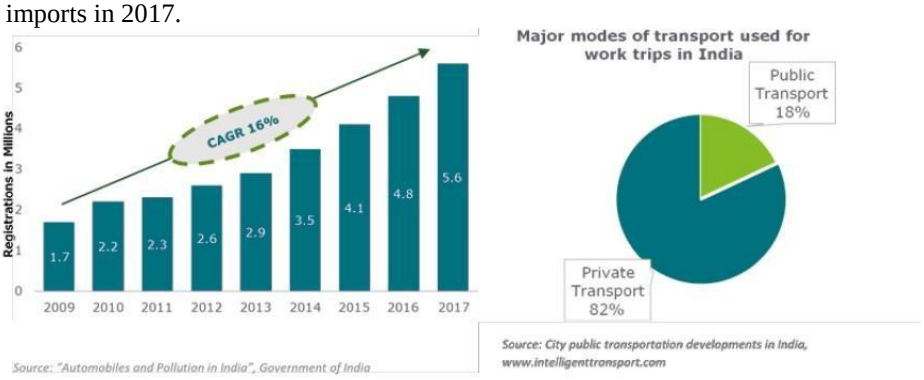

Fig 1:- Vehicle registration in India and major transport mode

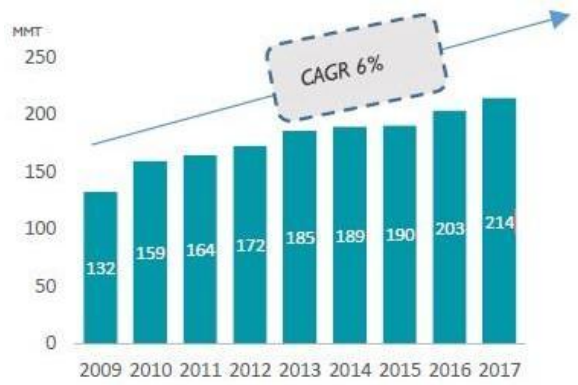

Fig 2:- India's Oil imports (FY 2009- FY 2017

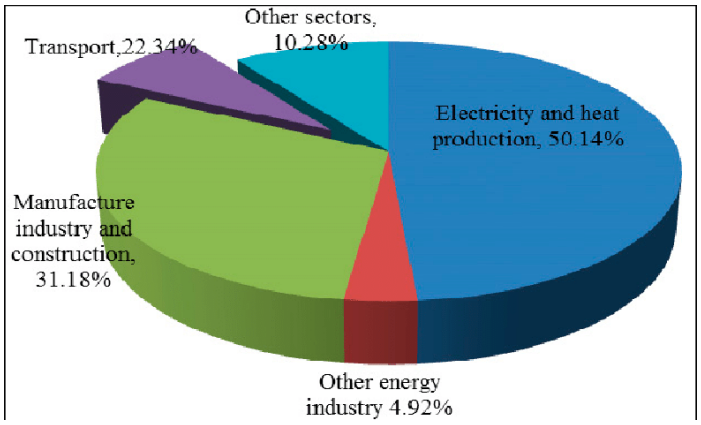

Fig3:-Sector wise CO2 emission in India

The arranging approach for carrying out charging foundation ought to be finished so as to address clients' and providers' issues. PEV clients expect admittance to FCSs at whatever point they need them, went with an excellent of administration. Along these lines, an absence of charging offices because of sitting FCSs improperly or not in the slightest degree will adversely affect drivers' comfort. The arranging model ought to likewise improve PEV drivers' availability to charging focuses by ideally picking those focuses from competitor destinations to cover the arranging organization. In addition, putting resources into untimely innovation is viewed as high-hazard. Financial backers want a productive business that guarantees greatest benefits and a protected venture, so giving a public charging administration must be assessed with the thought, all things considered, and boundaries influencing that business. Determining the future interest for PEVs will improve speculation security and enable leaders and financial backers to assess their ventures as time goes on, just as giving electrical utilities information on the normal PEV request that should be canvassed in their update plans.

1.2 Electric market in India

The Government of India has identified electric mobility as one of the key focus areas for development. Sales of EVs are projected to reach around 10.5 million for the four wheeler segment by 2030 as per NITI Aayog and RMI. Projected sales of various EV vehicles in India for 2020, 2025 and 2030 are shown in Figure below:-

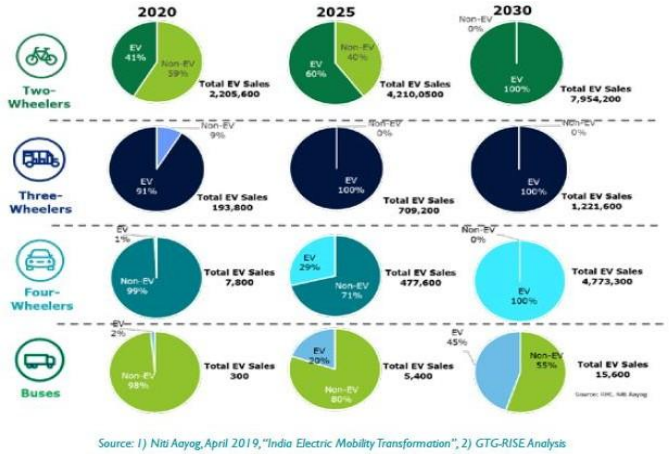

Fig 4:- EV sales projections till 2030

Over the course of the following decade RMI and NITI Aayog hope to see considerable development in electric two-, three-, and four-wheel vehicles, just as electric transports. Fragment astute, the infiltration of EVs in new vehicle deals is 30% for private vehicles, 70% for business vehicles, 40% for transports by 2030, and 80% for two and three-wheelers by 2030.

The gauge appropriation situation appeared beneath depicts a traditionalist pathway where the reception of EVs doesn't speed up at the normal rate as trusted under FAME II because of reasons like slacks in the arrangement of EV biological systems including charging stations, lower than anticipated presentation of EV vehicle models on the lookout, delay in approach execution, absence of purchaser mindfulness, and so on This situation expects a weighted normal EV deals infiltration of 35% in 2030 across all vehicle portions.

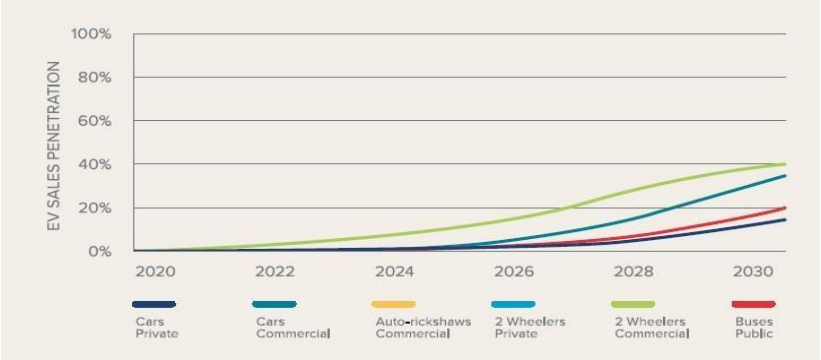

Fig5:- Electric vehicle sales penetration—baseline scenario

II. EV CHARGING SYSTEMS IN INDIA

Charger Type	Charger connector	Rated Voltage	No of charging point/No of charging gun
Fast	CCS (min 50kW)	200-750 or higher	1 CG
	CHAdeMO (min 50kW)	200-750 or higher	1 CG
	Type-2 AC (min 22kW)	380-415	1 CG
Slow/Moderate	Bharat DC-001 (15kW)	48 72 or higher	1 CG
	Bharat AC-001(10kW)	230	3 CG of 3.3 kW Each

Table1:- Guidelines for EV Charging Systems in India

Source:- *Ministry of Power, 2019, "Charging Infrastructure for Electric Vehicles – Revised Guidelines and Standards"*

Other requirements are specified below:
• An exclusive transformer and related substation equipment, 33/11 kV lines, appropriate civil works, space for charging and entry / exit of vehicles, etc.
• Charging stations are required to tie up with at least one online Network Service Provider (NSP) to enable advance remote/online booking of charging slots by EV owners.
• EVSE shall be type tested by an agency/lab accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL) periodically.
The guidelines do not specify load flow studies or other forms of analysis for locating PCSs. However the guidelines provide a rule of thumb: one PCS on a grid of 3km x 3 km, one fast charging station every 100 km on highways, which can serve as a framework for discoms in identifying necessary network upgrades.
Following is a review of international charging standards as prevalent in various select
Countries:-

	Conventional	Slow		Fast	
Level	Level 1	Level 2		Level 3	
Current	AC	AC		AC, tri phase	DC
Power	<= 3.7 Kw	<=22 kW	<=22kW	<=43.5 kW	< 200 kW
US	SAE J1772	SAE J1772	Tesla	SAE J3068	CCS Combo 1 / Chademo
China	Type 1	GB/T 20234 AC	Tesla		GB/T 20234 DC
Germany	Type C/F/G	IEC 62196-2 Type 2 Tesla	CCS Combo 2 (IEC 62196-3) 62196-3)	CCS Combo 2 (IEC 62196-3) 62196-3)	Tesla and CHAdeMO (IEC 62196-3 Type 4)

Table2:- International Charging Standards in Select Countries

The Ministry of Housing and Urban Affairs introduced the Model Building Bye-Laws for EV charging infrastructure in February, 2019. Key provisions are highlighted below:

Particulars	**Details**			
Parking Bays of EV charging	Residential and commercial buildings to allot about 20% of their parking space for EV charging infrastructure.			
Power load of EV charging	Building premises should have additional power load equivalent to the power required for all charging points to be operated simultaneously with a safety factor of 1.25.			
No of Slow and fast charger	4W	3W	2W	PV(Buses)
	One slow charger for 3 EVs One fast charger for 10 EVs	One slow charger for 2 EVs	One slow charger for 2 EVs	One fast charger for 10 EVs

Table3:- Amendments to Model Building Bye-Laws, MoHUA

Isolated and free consultative panels have been shaped under the Automotive Research Association of India (ARAI), Central Electricity Authority (CEA) and ETD-51 (under BIS) which are assessing charging and EV testing principles. The goal of these different panels is to help set up India's own EV charging guidelines. Key features of the report distributed by the Bureau of Energy Efficiency (BEE) are: The Bureau of Indian Standards (BIS) and the Department of Science and Technology (DST) have been chipping away at a native charging standard for India. BIS has distributed BIS:170175 (got from IEC 61851) which covers general prerequisites and wellbeing for EVSE.. The norms perceive DHI upheld Bharat Chargers (AC-001 and DC-001) for low voltage EVs (under 120 V). For higher voltage levels, the standard backings CCS-2 and CHAdeMO. Late alterations in the charging rules permit any AC or DC charger that consents to Standards AIS 138 – 1, and AIS 138 – 2 separately. In this way, it is normal that CHAdeMO, CCS-2, Type 2 AC and the Bharat Chargers

will all coincide in India. There are extra two diverse working gatherings in BIS to settle on connectors and correspondence conventions, which will be significant from an interoperability viewpoint. Until working gatherings have recognized these conventions, the current charging guidelines (Bharat Chargers, CCS-2 and CHAdeMO) and their references to connectors and correspondence conventions will be followed.
Based on stakeholder consultations conducted by BEE, the following specifications for charging options were identified:

Type	Standard	Power Level	Typical charging time			
			2W	3W	4W	PV(Buses)
			1.25KWh	3Kwh	15Kwh	100Kwh
Slow AC	Bharat Charger AC-001	3.3	1-5 hour	1-5 hour	5-8 hour	NA
Fast AC	Type-2 AC	Min 22	NA	NA	35Min	NA
Fast AC	Type-2 AC	Min 22	NA	NA	~35 min	NA
Slow DC	Bharat Charger DC-001	15	0,5-1 hour	~45 mins	~50 min	NA
Fast DC	CCS-2/ CHAdeMO	Min 50	NA	NA	~15 min	
High Power Fast DC	CCS-2/ CHAdeMO	Min 100	NA	NA	NA	NA

Table4:- Charging options

Slow AC charging

Slow AC charging is the most basic form of charging in India today and refers simply to plugging a car or two-wheeler into a standard three-pin 5 amp (type D) or 15 amp (type M) wall outlet without communication function to the on-board charger of the EV. These basic forms of charging are not enabled with managed charging capabilities and deliver about 5–15 km of range per hour, depending on plug and vehicle type. Although this is the most common form of charging today, we expect moderate and fast AC charging to quickly become the default mode of charging in India as the market develops over the next few years.

Moderate AC charging

Moderate AC charging requires the installation of dedicated EV charger to a 15 amp single-phase circuit and is available with (and without) managed charging capabilities. Charging rates start at 2.5 kW and can go up to 20 kW depending on the type of EVSE installed and the car model connected. Charging stations above 3kW require branch circuits with higher amperages and in some cases require two-phase or three-phase connections. Indian cars are currently limited to 3 kW and the majority of global OEM vehicles are limited at 7.7kW. Some vehicles charge at 20 kW and draw more than 80 amps. Charging rates between 3 to 7.7 kW deliver between 25 to 65 km of range per hour charging for cars and between 60 and 150 for two-wheelers, respectively.
The below points apply to moderate AC charging in India today:

- Most Indian electric cars and motorcycles can be charged directly using the IEC 60309 connector.
- Most global OEMs use an IEC 62196 Type 2 connector that requires an adaptor to connect with IEC 60309 charging stations.
- Most electric two-wheelers sold in India have three-pin home charger that is used along with the IEC 60309 to 15 amp adaptor.
- Many electric two-wheelers are designed with a removable battery to enable the charging to take place in the home or workplace and do not always require a curbside charging system.

DC fast charging

DC quick charging is commonly utilized when the vehicle requires a quick charge and the client/proprietor will pay a premium for the quicker charge. DC quick charging stations are quite often business tasks possessed or potentially worked by a charge network administrator. DC Fast charging requires devoted lattice foundation and some degree of discom commitment in the arranging and configuration stage. At any rate DC quick charging stations require the establishment of committed three-stage power supply gear that that draws essentially higher amperage than AC charging choices.

Quick charging, here and there called speedy charging in India, is altogether more costly to introduce and work. It is once in a while utilized as the essential method of private vehicle charging and never utilized as a devoted charger for an individual vehicle.

Data management

EVs and EV chargers are consistently producing significant information on the condition of charge of the battery, the pace of charge of the battery, the kilowatt-hours (kWh) utilized in charging, value signals from a utility, request reaction signals from an interest oversee framework, and different snippets of data that the organization administrator or client may discover helpful.

Charging the board programming is intended to oversee and control charging stations and their organizations. Organization programming advances the speedy arrangement and design of EV charging stations and works with a two-path stream of information between the charging station and its organization control focus. This usefulness permits administrators to distantly design, oversee, and update programming; set and control driver admittance to charging; set estimating; oversee charging; and run utilization reports.

Programming applications likewise permit drivers to find and hold accessible charging stations. Programming devices can be arranged to send warnings to administrators and drivers.

III. CONCLUSION

As the usability of electrical vehicles is increasing day nowadays so the charging methods must be robust and reliable so that one can make the use of electric vehicles without any trouble. The paper presents DC AC charging protocols for charging the plug in hybrid electric vehicles (PHEV). In this paper theory of conductive charging is presented and complete study of the charger is done. This paper shows how one can use conductive charging system as per Electric Market in India. Electric vehicle charging stations not just need to add energy to electric vehicles, just as act electric vehicles and framework interface .So the electric vehicle charging station development is the way in to the flow industrialization of electric vehicles.

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