INDIA'S EVOLVING CHARGING INFRASTRUCTURE: TRENDS AND INSIGHTS

1. INTRODUCTION

As the world increasingly struggles from a global climate change crisis, the push towards adoption of sustainable modes of transportation, especially the electric vehicles ("**EV**"), over traditional modes of transportation, has been a significant driver in the global fight against climate change. In the Indian context, the adoption of EVs has witnessed remarkable momentum, strengthened by the government's ambitious plans to achieve a substantial transition to EVs.

The successful switch from internal combustion engine vehicles to EVs relies heavily on the development of a robust and accessible EV charging infrastructure and network in India. As per Government of India ("**GoI**") data, currently there exist only about 6500 public charging stations[1] ("**PCS**") to cater to over 2.8 million EVs in the country.[2] Thus, one can argue that infrastructure development to support the growing number of EVs may be on a different trajectory.

This lack of adequate charging infrastructure in India, may be a good reason for consumer scepticism owing to range anxiety and concerns regarding charging accessibility. Therefore, it can be said that comparable development of an efficient and widespread charging infrastructure holds the key to overcoming concerns relating to EVs, ultimately encouraging mass adoption of EVs across urban and rural areas alike.

In this article, we delve into the legal landscape surrounding the EV charging infrastructure in India including a brief overview of the emerging business models, current trends and key stakeholders. Further, in this endeavour we aim to provide a comprehensive analysis of the various consents and authorisations required for establishing and operating a PCS, including the standards to be followed. We also undertake a comparative analysis of the EV charging infrastructure industry in India vis-à-vis the industry in China, Japan, Norway and United States of America. Thereafter, we finally aim to shed light on the potential hurdles in realising an adequate EV charging infrastructure in India, and possible solutions to the same.

2. OVERVIEW OF EV CHARGING INFRASTRUCTURE MARKET IN INDIA

To understand the legal structure surrounding the EV charging infrastructure industry (the **"EV Charging Industry**"), it is crucial to understand the market dynamics around it. This section identifies the key stakeholders driving its growth and examines the evolving business models within the EV Charging Industry.

[1] Please refer https://pib.gov.in/PressReleasePage.aspx?PRID=1910392
[2] Please refer https://vahan.parivahan.gov.in/vahan4dashboard/

2.1 Key Stakeholders

The following table provides a depiction of the key stakeholders in the EV Charging Industry, highlighting the various interactions within the ecosystem:

Stakeholder	Role
Site-owners	Site-owners refer to the owner of the real estate on which the PCS is built.
Charge point operators	A charge point operator installs, manages, maintains, and operates PCSs.
Power distribution companies ("**DISCOMs**")	DISCOMs are utility companies that typically purchase power from electricity generation companies and sell it to consumers (in this case, to charge point operators).
Network service providers	Network service providers' act as service providers whose primary responsibility is to help EV drivers find PCSs by offering mobile apps with labelled maps, assist connectivity with the PCS, as well as billing and payment functionalities.
Charging management software companies	Charging management software companies assist charging stations in providing back-end services such as energy management, hardware and load monitoring, payment processing, fleet management, etc.
EV manufacturers	EV manufacturers collaborate and partner with charge point operators to ensure the availability and accessibility of PCSs for their EV customers
Governmental ministries	The government assists the EV Charging Industry in developing and implementing policies, regulations, and incentives that support the growth, accessibility, and sustainability of EV charging infrastructure.
End consumers	End consumers are the primary users of EV charging infrastructure by utilising PCSs, providing feedback for improvement, and influencing demand through their choices and preferences.

It is important to note that these stakeholders may be interconnected and interdependent. Charge point operators rely on collaboration with site owners to gain access to suitable locations for PCSs. Site owners, on the other hand, rely on charge point operators to provide the necessary expertise. These stakeholders may also coincide with one another, such as when an EV manufacturer owns its PCSs as well as the real estate it is on. Ultimately, it is the consumer who benefits from these efforts and utilises them. These interactions give growth to diverse business models within the sector. We have discussed these interactions in detail further below.

2.2 Business Models

The EV Charging Industry encompasses a diverse range of business models, each offering unique value propositions from the varied perspectives of key stakeholders. From the perspective of a charge point operator, several interactions take place within the EV Charging Industry, including with site-owners, end consumers, and utility companies, among others. We have highlighted some common business models in the EV Charging Industry relevant to each of these interactions from the point of view of a charge point operator –

Interaction	Model	Description
Interactions with site-owners	Owned and operated	The charge point operator owns the real estate on which it sets up a PCS.
	Renting and leasing	The charge point operator rents or leases real estate from the site-owner to set up a PCS.
	Revenue Sharing	The charge point operator collaborates with a site-owner for installing PCSs at commercial establishments, wherein the revenue is shared between the charge point operator and the site-owner.
Interactions with end consumers	Parking-based	Where the charge point operator is also a site-owner, it may offer a combination of charging and parking facilities to attract more customers. For example, a mall may offer bundled EV charging with its parking facility to attract more footfall.
	Subscription services	Charge point operators offer its users the option to pay a recurring fee for access to charging. They may often bundle other benefits such as discounted charging rates, priority access, or faster charging speeds.
	Pay-per-use	Charge point operators charge their users on the basis of amount of electricity consumed or the duration of their charging on a per-session basis.
	Bundled charging	Some charge point operators are empanelled with EV manufacturers such as Audi and BMW, to offer free bundled charging for a fixed period.
Interactions with utility companies	DISCOM connections	In India, power distribution is carried out mostly through public-sector DISCOMs and is a highly regulated activity. Charge point operators generally have to apply for electricity connections with DISCOMs for their electricity needs.
	Open Access Energy	Charge point operators may obtain electricity through open access from any power generation company directly.
Interactions with other industry stakeholders	Partnership revenue model	Charge point operators often partner with EV manufacturers to offer charging solutions for the EV manufacturer's customers. For example, Mahindra has tied up with Jio-bp to offer charging solutions by using Mahindra's channel locations to set up Jio-bp Mobility Stations.[3]
	Franchise model	Charge point operators such as Statiq offer franchisee opportunities to set up an EV PCS. This allows the market entrant to take advantage of a unified charging app and brand name, while strengthening the franchiser's PCS network.

Other stakeholders in the EV Charging Industry such as fleet operators, cab aggregators, manufacturers of charging infrastructure, or software companies may interact with the ecosystem through other business models. Some examples of these are highlighted below –

[3] Please refer https://www.mahindra.com/node/3435

(a) Mobility-as-a-Service

Mobility as a service ("**MaaS**") refers to services which enable users to plan, book, and pay for multiple types of mobility services, typically characterised by a shift from personally-owned modes of transportation. MaaS companies can take many forms including cab aggregators like Uber and Ola, monthly car subscriptions such as those offered by Revv, and bicycle-sharing systems such as Santander cycles. Charge point operators typically interact with these companies by offering charging solutions on a B2B basis dedicated to their operation.

(b) Micro-mobility

Micro-mobility entails the use of low-speed, small vehicles such as cycles, scooters, skateboards, etc. for travelling short distances, typically for first-mile and last-mile connectivity. Micro-mobility generally goes hand-in-hand with the growth of public transit, since public transit typically doesn't offer last-mile connectivity. Companies such as Bounce and Yulu are operating in this space in India. Charge point operators' solutions to these small vehicles requires a combination of public charging and battery swapping (and consequent charging of these swapped batteries).

(c) E-roaming services

Apart from charging management software and network service providers, charge point operators are now also subscribing to e-roaming services. E-roaming services connect several charge point operators and their networks over a single digital platform. This allows consumers to charge their EVs at any PCS, irrespective of the network service provider they are subscribed to or enrolled with. Essentially, e-roaming services promise a "charge-anywhere" experience. Companies such as Numocity and Deepfleet are currently operating in this space in India.

(d) Battery Swapping Stations

Battery swapping technology allows EVs to quickly exchange a discharged battery pack for a fully charged new one, as an alternative to recharging the vehicle via a charging station. Battery swapping is generally used for E2Ws and E3Ws. Companies operating in this space such as Sun Mobility also use a "battery-as-a-service" model, allowing customers to subscribe to batteries, such that they do not have to purchase the battery upfront along with the EV.
We have previously analysed India's draft battery swapping policy in an article titled 'Battery Swapping: A Promising Future for Electric Vehicles' accessible here.

In addition to those discussed above, we have described several pioneering business models in the EV industry such as infrastructure-as-a-service and virtual power plants in a previous report titled 'Electric Mobility in India' accessible here.

3. CONSIDERATIONS FOR SETTING UP A PCS

The establishment of a PCS involves a multitude of considerations, encompassing both business and legal aspects. Broadly, these cover considerations relating to real estate selection and acquisition, electricity

procurement, standards relating to PCSs, safety and reporting compliances, and labour and environmental compliances, which have been covered in brief in this section.

3.1 Business considerations

There are several business considerations that a PCS operator must undertake that are specific to the EV Charging Industry. These include the geographical location of the PCS, selection of charging hardware and types, as well as software solutions for the end consumer. The same are described below in greater detail:

(a) Geographical location

The geographical location of a PCS is a pivotal factor in its profitability and long-term viability. Considerations which come into play while selecting the real estate, include the quality of the local grid infrastructure, the frequency of power cuts, the level of competition in the vicinity, the proximity to commercial and residential areas, and the adoption rate of EVs in the region. PCSs may also be set up at commercial establishments such as malls and shopping complexes, through arrangements such as revenue sharing agreements with the site-owner, as described above.

Another important factor that affects site-selection is the availability of sufficient transformer capacity in the area. In the event that there is insufficient transformer capacity in the area to support the PCS, a charge point operator may be required to install a transformer at their own expense, which may be a costly affair.

It is vital to ensure that there are no encumbrances on the proposed real estate to be used for setting up the PCS business and all real estate related approvals from various authorities are in place. It is also pertinent to note that agricultural lands cannot be used for setting up such PCSs as these would fall within the commercial use category unless the land use pattern is changed as per the prescribed process. Notably, land is a state subject under the Constitution of India. Thus, laws regarding acquisition and payable duties may differ from state to state.

(b) Charging hardware and type

Selection of charging hardware and type is an important decision that should align with market preferences and demand. Market players in the EV Charging Industry should ensure that the charging hardware they select is suitable for widespread adoption today and is future-proof as well. For example, India currently allows for six different types of charger standards (as discussed further below on page 9), based on the power output and the category of vehicle. In areas with higher density of E2Ws or E3Ws, PCSs with connectors specific to these vehicles may be more suitable. Simultaneously, it's important for companies to make sure that the choices they make continue to make sense in the long term since establishing PCSs requires a significant upfront financial commitment. Additionally, it's crucial to consider the adequacy of power infrastructure that can support more powerful chargers down the line.

In places with poor grid reliability, addition of batteries or solar power generation may be useful. New technologies such as a PCS with integrated battery storage, like the one developed by Freewire, enables use of charging points even in situations of low voltage supply.[4]

(c) Software solutions

Software solutions play a significant role in ensuring a seamless user experience and effective management of the PCS. These software solutions may be customer facing or business facing.
In terms of customer facing solutions, software systems, inter alia, enable EV owners to easily locate PCSs, make reservations, conduct secure payments and allow roaming capabilities and compatibility.

On the other hand, businesses may benefit from software solutions such as charging management systems that allow charge point operators to understand the load of their PCS, ensure charger stability, and detect faults and issues with chargers.

For fleet operators with their dedicated charging stations, a battery management system is also important for monitoring the health of the battery, ensuring optimal charging temperatures, and battery status reporting.

3.2 Regulatory considerations

In India, the Ministry of Power is responsible for the development and promotion of the EV charging ecosystem. The first guidelines regarding charging infrastructure were issued by the Ministry of Power in 2018, which stated that setting up of PCSs shall be a delicensed activity in India and any individual is free to set up PCSs.[5] These guidelines were revised in 2022 and the Revised Consolidated Policy and Standards for Charging Infrastructure for EVs were notified on January 14, 2022 ("**Charging Infrastructure Guidelines**"),[6] aiming to provide a structured and comprehensive framework for the development and deployment of EV charging infrastructure across the country.

Apart from the Charging Infrastructure Guidelines, businesses must also ensure compliance with several safety regulations issued by the Central Electricity Authority ("**CEA**") such as the CEA (Technical Standards for Connectivity of the Distributed Generated Resources) Regulations, 2013 and the CEA (Measures Relating to Safety and Electric Supply) Regulations, 2023, as well as compliances under various labour laws in India –

[4] Please refer https://electrek.co/2023/04/06/freewires-game-changing-ev-charging-solutions-expand-outside-the-us-into-the-eu/
[5] Ministry of Power, Notification No. 12/2/2018-EV dated 14 December 2018 available at https://www.icimod.org/policies-on-energy/india/Charging%20Infrastructure%20for%20Electric%20Vehicles%20-%20Guidelines%20and%20Standards%20-reg..pdf
[6] Ministry of Power, Notification No. 12/2/2018-EV (Comp. No. 244347) dated 14 January 2022 available at https://powermin.gov.in/sites/default/files/webform/notices/Final_Consolidated_EVCI_Guidelines_January_2022_with_ANNEXURES.pdf

(a) Regulatory considerations under the Charging Infrastructure Guidelines

The Charging Infrastructure Guidelines provide largely for five aspects of a PCS – electricity connections, safety equipment and appliances, network service provider tie-ups, tariffs, and service charges. Some key compliances relating to each of these are outlined below –

(i) Electricity connections

To commence operations, PCSs need to apply for an electricity connection to the DISCOM operating in their area. Post the submission of a complete application, DISCOMs are required to transmit electricity within a period of 7 days in metro cities, 15 days in other municipal areas, and 30 days in rural areas.[7]

Alternatively, rather than procuring electricity through DISCOMs, the Charging Infrastructure Guidelines also provide that PCSs may procure electricity via open access, i.e., by purchase of electricity directly from power generation companies.[8] Recently, the GoI has notified the Electricity (Promoting Renewable Energy Through Green Energy Open Access) Rules, 2022, that allows consumers to buy green energy through open access where their sanctioned load exceeds 100 kW.[9]

In cases where a business is intending to set-up large multi-vehicle PCSs, a separate exclusive transformer including related substation equipment may be required to be set up, if required by the state-specific electricity supply codes. For example, in Kerala, a separate transformer is required above loads of 50 kVA.[10] Such a transformer may also be required if the existing transformer in the area does not have adequate capacity to support the PCS, as mentioned above.

(ii) Compliances for safety and user protection

The Charging Infrastructure Guidelines provide that PCSs are required to ensure appropriate civil, cabling and electrical works, appropriate fire protection equipment, as well as adequate space for charging and entry/exit of vehicles.

Apart from this, there are rules and regulations issued by the CEA. This includes the CEA (Technical Standards for Connectivity of the Distributed Generated Resources) Regulations, 2013 and the CEA (Measures Relating to Safety and Electric Supply) Regulations, 2023. We have discussed these rules and regulations further below (on page 8).

(iii) Network Service Provider

The Charging Infrastructure Guidelines require every PCS to tie up with at least one online network service provider to enable users to book charging slots and to check information regarding

[7] Electricity (Rights of Consumers) Rules, 2020
[8] Paragraph 2.2 of the Charging Infrastructure Guidelines
[9] Please refer https://pib.gov.in/PressReleasePage.aspx?PRID=1842737
[10] Clause 4(1) of the Terms and Conditions of Supply, 2005, Kerala State Electricity Board available at http://ceikerala.gov.in/images/pdf/ActsRules/TCSupply-kseb.pdf

location, types, and number of chargers available, etc.[11] Notably, this requirement relating to network service provider tie-up would not have to be complied with where a company is using the PCS for 100% internal use.[12] For example, electric golf carts owned/leased by a golf course are free to use their own non-standard chargers and charging stations.

(iv) *Tariff Rates*

Under the Charging Infrastructure Guidelines, maximum tariff rates at which a DISCOM can provide electricity to the PCS are prescribed, which are determined in accordance with different times of the day ('time-of-day tariffs'), being higher during nighttime hours and lower during daytime hours.[13] These tariffs are to be single part tariffs, i.e., charged at a uniform rate, based on the cost of supply. A separate metering arrangement exists for PCSs to take benefit for special tariffs.[14]

(v) *Service Charges*

The Charging Infrastructure Guidelines have mandated prepaid collection of service charges by the PCS. The maximum service charge allowed to be levied by PCS would be fixed by state governments, determined on the basis of charging speeds and time of the day.[15]

(b) Safety and user protection regulations

As mentioned previously, compliance with the CEA (Technical Standards for Connectivity of the Distributed Generated Resources) Regulations, 2013 and the CEA (Measures Relating to Safety and Electric Supply) Regulations, 2023 is vital for PCSs.

The CEA (Technical Standards for Connectivity of the Distributed Generated Resources) Regulations, 2013 provides for standards and codes of practice to all power generating companies, charging stations, prosumers, etc. Some key compliances include –

(i) Ensuring reliable fault protection systems,
(ii) Carry out stability studies,
(iii) Installation of power quality meters
(iv) Registration with the CEA to obtain a Unique Registration Number.

Additionally, the CEA (Measures Relating to Safety and Electric Supply) Regulations, 2023, provide for specific compliances relating to electrical installations for all persons engaged in generation, transmission, distribution, trading, or supply of electricity. Some key compliances under these regulations include –

(i) Ensuring sufficient rating for power and insulation

[11] *Ibid,* paragraph 3.1(viii)
[12] *Ibid,* paragraph 3.4
[13] *Ibid*, paragraph 7
[14] *Ibid,* paragraph 7
[15] *Ibid*, paragraph 8

(ii) Precautions for leakages,
(iii) Precautions for the safe custody of equipment,
(iv) Danger notices,
(v) Protective equipment,
(vi) Maintaining records of the relevant test certificates, inspections, and periodic assessments for a period of at least 7 years.

Particularly for PCSs, there exist separate requirements such as minimum distance between charging point and connection on EV, voltage parameters, earthing protections, and fire prevention standards.[16]

(c) Labour law compliances

Depending upon the size and form of business, the PCS operator may have to obtain registrations and ensure compliance with various labour law legislations such as the Industrial Disputes Act, 1947; Employees' Provident Fund and Miscellaneous Provisions Act, 1952; Employees' State Insurance Act, 1948; etc. We have briefly covered compliances under these in a previous article titled Legal Landscape Governing Manufacturing of Electric Vehicles and Batteries accessible here.

In addition to this, all Indian states have notified their respective Shops and Establishment Acts, which are applicable to all commercial establishments. Thus, every PCS is required to obtain a Shops and Establishment registration. Generally, the relevant Shops and Establishment Act of the state covers matters such as hours of work, payment of wages and compensation, record keeping for details of employees and employers, leave and holiday provisions, etc. In most states, it is mandatory to apply for a Shops and Establishment registration within 30 days of commencing the business.

4. STANDARDS AND SPECIFICATIONS

In addition to the aforementioned, it is necessary for the PCSs to meet the charging standards specified under the Charging Infrastructure Guidelines. These standards are as follows –

Charger Type	Charger Standard	Minimum Rated Power	Rated Output Voltage	Target Vehicle Type
Fast	Combined Charging System (CCS)	50kW	200V - 750V or higher	E4W
	CHAdeMO	50kW	200V - 500V or higher	E4W
	Type-2 AC	22kW	380V - 415V	E4W, E3W, E2W
Slow / Moderate	Bharat DC-001	15kW	48V	E4W, E3W, E2W

[16] Chapter XI of the CEA (Measures Relating to Safety and Electric Supply) Regulations, 2023.

Charger Type	Charger Standard	Minimum Rated Power	Rated Output Voltage	Target Vehicle Type
	Bharat DC-001	15kW	72V or higher	E4W
	Bharat AC-001	10kW	230V	E4W, E3W, E2W

The Bureau of Indian Standards, the national standards body of India, is responsible for formulating the standards relating to the aforementioned chargers, connectors and respective communication protocols. Some of the standards approved are as follows[17] –

(i) *AC Charging*

IS-17017 is the key EV charging standard in India comprising three parts and six sections. IS-17017 Part-1 provides the basic features of all EV charging systems. An AC charger must adhere to this standard, and the specific AC connector standard in the IS-17017 Part-2. Both AC and DC chargers need to conform to the technical standards IS-17017 Parts 21 & 22. Additional Indian standards for AC chargers have been approved in the form of low-cost charging points for use in parking areas.

(ii) *DC Charging*

IS-17017 Part-23 describes the requirements for DC charging stations, with power output of 50kW to 200kW. Beyond this, high power charging standards are required to cater to buses and other heavy vehicles. Recently, the BIS has finalized the IS-17017 Part-25, which is specifically for providing low DC power of less than 7 kW for light EVs. Data communication standards are specified in IS-17017 Part 24. When the Combined Charging System (CCS) standard is deployed, communications will be as per the IS-15118 series.

5. GOVERNMENT INCENTIVES AND SCHEMES

To accelerate the transition to EVs, the government has introduced several forward-thinking schemes and initiatives aimed at incentivizing the adoption of EVs and strengthening the charging infrastructure network.

For example, the Ministry of Heavy Industries has been running its Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles ("**FAME**") since 2015 in two phases ("**FAME-I**" and "**FAME-II**"), which focuses on providing incentives for purchasing EVs and for installation of charging infrastructure. Recently, the GoI has provided approximately USD 100 million as subsidies to oil companies in India under the FAME-II for installation of PCSs across the country. We have recently analysed challenges faced under FAME-II and the future of the scheme in an article titled 'Evaluating FAME-II: Insights and Road Ahead' accessible here.

[17] Please refer https://e-amrit.niti.gov.in/bis-standard

The process for installation of PCSs and incentives offered differ for every state. In Delhi, the government has prepared a single-window processes through online portals for people to install PCSs at their premises, provided through empanelled vendors that assist through the entire installation process.[18] Similarly, Maharashtra has a dedicated website for disbursement of PCS incentives.[19] Several states also offer incentives such as capital subsidies for setting up PCSs, such as in Gujarat, Tamil Nadu, and Andhra Pradesh. We have previously undertaken a detailed analysis of the various incentives provided by different states under their respective EV policies in a report titled 'Electric Mobility in India' accessible here.

However, while these incentives are appreciated, to understand how well the country is faring in terms of EV adoption, it is important to analyse comparable and high-achieving countries in this sector to allow a holistic picture of the global landscape.

[18] Please refer https://ev.delhi.gov.in/charging_station
[19] Please refer https://evincentive.mahadiscom.in/EVCS/

6. COMPARATIVE ANALYSIS

We have undertaken a brief analysis of the four largest automobile manufacturing countries in the world– China, USA, India and Japan, as well as Norway which is often considered the EV capital of the world.

Particulars	India	China	U.S.A.	Japan	Norway
EV Penetration (share of EVs to total vehicles)[20]	0.2%	4.9%	1.3%	0.6%	27.73%
Public vs. Private Sector Contribution	The GoI is the largest player in the EV Charging Industry in India, with state-run companies such as Bharat Petroleum Corporation Limited, National Thermal Power Corporation and Energy Efficiency Services Limited operating the majority of EV PCS in the country. There are few private companies with nationwide PCS coverage, with the exception of Tata Power, the largest	The Chinese government's involvement in the EV Charging Industry is significant as it plays the foremost role in promoting the growth of the EV sector, through incentives such as subsidies to companies for setting up PCSs, as well as through direct involvement through state-run corporations. The largest EV manufacturer in China and the seventh largest in the world, SAIC Motor is a state-run corporation.[21]	The federal government of the United States adheres to a largely non-interventionist approach with regards to EVs and their charging infrastructure. Private companies such as Ford, Tesla and General Motors have driven EV growth with some support from the federal government in the form of tax rebates. The EV Charging Industry is driven by private companies such as Tesla and Electrify America. Recently, owing to lack of standardisation, market alliances between	The Japanese EV Charging Industry is characterised by private sector participation largely, supported by government incentives and minimal direct participation. The Japanese automobile industry is one of the oldest and largest in the world, and includes private companies such as Toyota, Honda, Nissan and Mitsubishi. For charging infrastructure, the Tokyo Electric Power Company (a public sector enterprise which	Norwegian EV Charging Industry has been shaped by efforts of foreign private companies supported through government incentives. While Norway does not have any domestic EV manufacturers, the EV Charging Industry has many domestic companies such as Recharge and Statkraft. The government supports the building of EV charging infrastructure through financial

[20] Please refer https://www.iea.org/reports/global-ev-outlook-2023/trends-in-charging-infrastructure

[21] Please refer https://www.news18.com/news/auto/saic-motor-corporation-registers-6-8-growth-finishes-2017-at-6-93-million-car-sales-1675045.html

Particulars	India	China	U.S.A.	Japan	Norway
	private operator in the country.	Teld New Energy, a private company, has the highest number of EV PCS in China, followed closely by the State Grid Corporation of China.[22]	private companies are growing, such as the North American Charging Standard alliance.	was nationalised in 2012 following the Fukushima Nuclear Disaster), is the largest company in the industry. Other private players include ABB Ltd., Tesla, and Orix.	support provided by Enova SF, a state-owned corporation.[23]
Government Incentives	So far, the only incentives available for EV PCS setting up by the GoI are within the FAME-II scheme. Most of these funds have been provided to state-run oil companies to set up EV PCS at various gas stations across the country.[24] Apart from this, local governments offer incentives in the form of concessional land rates (such as in	The Guidelines for the Development of Electric Vehicle Charging Infrastructure, 2015, set a target for the construction of 4.8 million PCSs by 2020, to meet the demands of 5 million EVs, ensuring a vehicle-to-charger ratio of 1:1. While the target has not been met, the current ratio of 2.5:1 is one of the best globally.[25] The primary policy of the Chinese government involves setting up PCSs	The U.S Code 30C Alternative Fuel Infrastructure Tax Credit gives qualifying businesses a 30% tax credit, up to USD 100,000, for all alternative fuel infrastructure installed and placed in service from January 1, 2023, through December 31, 2032. For personal use, the U.S. Federal Tax Credit gives individuals 30% off a home charging station plus installation costs up to USD 1,000.[27]	From 2021, the Japanese government has earmarked about USD 550 million for new EV PCSs.[29] Similarly, local governments offer their own incentives. For example, Tokyo's metropolitan government set a subsidy programme in 2018 to accelerate the installation of charging stations for EVs at residences.[30]	The Norwegian government provided incentives in 2017 and achieved its target to install two multi-standard fast PCSs every 50km on all main roads in the country.[31] Norwegian local governments offer a wide range of incentives as well. The cornerstone of these incentives is financial assistance to housing associations for installation of

[22] Please refer https://www.statista.com/statistics/1309829/china-public-electric-vehicle-charging-company-by-station/
[23] Please refer https://www.duo.uio.no/bitstream/handle/10852/95091/8/Master-thesis-Guangyuan.pdf
[24] Please refer https://pib.gov.in/PressReleasePage.aspx?PRID=1911394
[25] Please refer https://www.china-briefing.com/news/electrifying-the-road-ahead-unlocking-chinas-ev-charger-industry-potential
[27] Please refer https://afdc.energy.gov/laws/10513
[29] Please refer https://asia.nikkei.com/Business/Automobiles/Japan-to-double-EV-subsidies-to-match-U.S.-and-Europe
[30] Please refer https://www.iea.org/policies/6649-evse-support-tokyo
[31] Please refer https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/norway/incentives-legislations

Particulars	India	China	U.S.A.	Japan	Norway
	Delhi), capital subsidies (such as in Tamil Nadu), property tax rebates (such as in Maharashtra) and exemption from electricity duties (such as in Gujarat).	through state-owned enterprises, such as through the State Grid Corporation of China. Some provinces offer incentives in the form of capital subsidies based on the wattage of the chargers, such as in Shenzhen. Further, mandates are also made in terms of minimum parking spaces for the installation of charging facilities.[26]	Recently, the federal government has also announced the National Electric Vehicle Infrastructure Formula Program, providing states with USD 5 billion funding over 5 years to deploy EV PCS.[28]		chargers. For example, the Asker municipality provides up to 50% of investment costs.[32] Electric cars also pay lesser parking fees in municipality parking lots, where charging may also be free.[33]

[26] Please refer http://fgw.sz.gov.cn/zwgk/qt/tzgg/content/post_4599411.html
[28] Please refer https://www.energy.gov/articles/president-biden-doe-and-dot-announce-5-billion-over-five-years-national-ev-charging
[32] Please refer https://www.asker.kommune.no/klima-og-miljo/tilskudd-til-lading-for-elbiler-i-boligselskap/
[33] Please refer https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/norway/incentives-legislations

7. CHALLENGES AND WAY FORWARD

The rapid growth of EV infrastructure in India presents itself as a lucrative investment opportunity for the host of stakeholders in the EV Charging Industry. However, there are challenges and barriers that limit the EV charging infrastructure in India. Some of the biggest challenges remain in grid infrastructure and power outages, as well as high upfront costs on investment. We have highlighted challenges presently being faced in the industry, our suggestions for solving these challenges, and ongoing initiatives taken by governments in India in the EV Charging Industry presently:

S. No.	Challenge Faced	Ongoing Initiatives	Proposed Course of Action
1.	**Insufficient GoI incentives to privately owned PCS** The GoI has allocated a significant budget of approximately USD 120 million as incentives for PCSs under the FAME-II, which are largely being disbursed through public sector undertakings ("**PSUs**"). However, privately-owned PCSs have not received benefits of FAME-II for charging infrastructure to the same extent.[34] Inequitable disbursal of incentives to private companies may lead to an uneven playing field and hinder the growth of private companies in this sector.	**State governments' incentives** Most states have policies that are conducive to the charging infrastructure requirements, such as capital subsidies in Gujarat and special tariffs in Uttar Pradesh – all of which are intended towards private users. Delhi has also taken several steps, including directing all existing commercial and institutional buildings with a parking capacity of 100 or more vehicles to reserve 5% of their parking space for EVs with suitable EV chargers. In addition, as per Delhi Development Authority's amended United Building Bye Laws (2016), 20% of parking capacity in all new constructions, must be provided with charging infrastructure for EVs.	**Incentives and mandates for privately owned charging infrastructure** The GoI should ensure that disbursal of benefits is equitable and unbiased towards public and private entities alike. Apart from incentives, measures that drive demand may be examined. For example, State Governments may mandate minimum EV charging infrastructure in parking areas to escalate demand. Similarly, incentives may be focused on real estate developers for achieving green standards such as LEED certifications that include EV charging. Such measures may allow competition between public and private entities, without requiring high budgetary investments.

[34] Please refer https://pib.gov.in/PressReleasePage.aspx?PRID=1911394

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2.	**High real estate leasing costs** Leasing often becomes one of the largest expenses for setting up PCSs. Since EVs are more prevalent in urban areas where real estate is scarce and expensive, businesses face heavy costs in attempting to capture the largest markets. Private entities are also often unable to compete with PSUs in bidding for PCSs to be set up on highways, since such PSUs already own pieces of real estate adjoining highways. For example, under FAME-II, while proposals were invited from both public and private entities, only public entities were sanctioned incentives.[35]	**Leasing out of public real estate** In several areas, government-owned real estate such as those at public parking spaces are provided to set up PCSs. For example, in 2020, the Noida Metro Rail Corporation floated a tender to set up PCSs in parking lots of metro stations. Tenders have also been floated in the past by companies such as CESL that partner with other government agencies to procure lease rights, which are further provided to selected beneficiaries. Some states such as Bihar also offer incentives in the form of reimbursements of stamp duty and registration fees for lease agreements relating to EV PCSs.	**Innovative incentive solutions** Especially in urban areas, incentives for real estate costs are imperative. Leasing of public real estate may be expanded to offset the cost of leasing. At the same time, creative solutions are required that simultaneously interact with the real estate and EV Charging Industry. One example is performance-linked incentives that reward charge point operators for meeting usage and availability targets. Public-private partnerships may be incentivised as well. For example, the Uttar Pradesh government offers government real estate on a revenue sharing model for a period of 10 years, at the rate of INR 1 / kwH.[36]
3.	**Obstacles in grid infrastructure** India experiences frequent power cuts due to high demand and overload on the grid infrastructure, especially during the summer months. To allow for dependability of chargers, it is imperative to alleviate concerns of grid	**Time-of-day tariffs and open access** The GoI has recently introduced new concepts that are expected to improve the performance and efficient use of the grid. One of such concepts is the use of time-of-day tariffs. With the use of such tariffs, rates	**Modernising electricity infrastructure** Enhancing EV public charging infrastructure is closely linked to the maturity of the electricity distribution industry in India. Embracing models such as net metering, and ideas such as peer-to-peer

[35] Please refer https://pib.gov.in/Pressreleaseshare.aspx?PRID=1808115
[36] Please refer https://invest.up.gov.in/uttar-pradesh-electric-vehicle-manufacturing-policy-2022/

S. No.	Challenge Faced	Ongoing Initiatives	Proposed Course of Action
	unreliability and overloads, especially in rural areas. Additionally, several newer innovations in the electricity infrastructure space have not gained traction in India yet. These include net metering, which allows selling privately produced electricity (such as through solar panels) back to the grid, as well as vehicle-grid connectivity, which optimises EV charging based on grid load and tariffs.[37]	during solar hours of the day shall be 10%-20% less than the normal tariff, while the tariff during peak hours will be 10 to 20 percent higher, which would incentivise people to consume energy efficiently. Recently, the GoI has also allowed the purchase of green energy through open access to allow consumers to purchase renewable energy.	energy trading are gaining traction in the world but are disallowed in India. Other important steps which the GoI can consider include providing real-time data on grid capacity and load, implementing time-of-day tariffs and employing vehicle-grid connectivity. For businesses, the rise of new technologies such as vehicle-grid communication are giving birth to new software solutions in the EV Charging Industry. For example, companies such as Driivz provide B2B solutions for smart EV charging management software.
4.	**Structural issues in DISCOMs** DISCOMs are predominantly owned by the state governments in India. Private DISCOMs are also operational in India but are limited to a few cities like Delhi and Mumbai. Regions with private DISCOMs are generally seen to be more consumer friendly and offering fewer power cuts by allowing competition in the industry, allowing ease of doing business. On the other hand, where public sector DISCOMs are prevalent, receiving electricity	**Attempts to foster competition** The GoI has recently introduced the Electricity (Amendment) Bill, 2022, which allows multiple licensees to operate in the same area of supply, which may allow competition to foster in the industry. Some states such as Odisha have attempted privatisation of DISCOMs multiple times, with varying levels of success. Particularly in Delhi, privatisation has been a success and DISCOMs have been able to	**DISCOM Reform** Reform in the DISCOM industry, while complex and nuanced, is vital for the growth of reliable EV charging infrastructure. Past lessons have shown us that competition between DISCOMs will lead to efficiency in operations and allow consumer choice by fostering competition. At the same time, it is important that the share of renewable energy generation grows alongside EV growth, to ensure end-to-end sustainability.

[37] Vehicle-to-grid, or V2G for short, is a technology that enables energy to be pushed back to the power grid from the battery of an EV, potentially assisting in decentralised battery storage across the country.

S. No.	Challenge Faced	Ongoing Initiatives	Proposed Course of Action
	connections is often delayed and power cuts are seen to be more common. At the same time, these DISCOMs are facing heavy losses as well, due to issues of theft and network inefficiencies. These structural issues point to a clear need for reform in the sector.	reduce their losses, through a combination of management and technological reforms.	Modernising electricity infrastructure (*as discussed above*) such as through deployment of smart meters would also help limit losses faced in the sector.
5.	**Multiplicity of standards** While standards have been prescribed for EV charging infrastructure by the Ministry of Power, the issue of different types of chargers for different types of vehicles leads to confusion for the consumer, who is unsure whether a particular PCS is compatible with their EV. For charging station operators, this leads to increased costs, since they may be installing multiple types of chargers at the same PCS, to cater to different types of customers. In the event that any particular charging standard is no longer popular, it may lead to inefficiency and underutilisation of chargers. While the Ministry of Power has issued comprehensive guidelines for standardisation, challenges continue to persist in terms of inconsistent PCS	**Use of Network Service Providers** So far, the GoI has mandated the use of network service providers for charge point operators that enable advance online booking of charging slots and provide information regarding location, types and numbers of chargers available, service charges, etc.	**Open Protocols and Partnerships** The issue of multiplicity of standards can be resolved through the use of open protocols and standards. For example, the Open Charge Point Protocol, allows any compliant PCS to communicate with a compliant network service provider. We have seen the success of creating interoperable software protocols on which apps can be built, such as the Unified Payments Interface. On the consumer end, we understand that the GoI is in the process of developing a master app to promote uptake of EVs in the country with features such as EV charging slots shown nearby on a map.[38] In the absence of standardisation, partnerships are the key to offer better charging solutions for customers. Recently, American companies Ford, and General

[38] Please refer https://economictimes.indiatimes.com/industry/renewables/master-app-in-the-works-to-ease-electric-vehicle-charging/articleshow/100923942.cms

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	compatibility, multiple network service providers and subscription services.		Motors, made headlines by adopting the North American Charging Standard, previously known as the 'Tesla Charging Connector' until the standard was opened. Other manufacturers such as Mercedes-Benz, Polestar, Rivian, and Volvo have also announced similar plans.[39] Businesses may also consider associating with alliances such as the Open Charge Alliance, a global consortium of public and private EV companies that advocate for, and promote, open and shared protocols and standards in the industry.
6.	**Unreliability of chargers** While electric chargers offer the advantage of hassle-free maintenance and minimal operational costs compared to traditional petrol pumps, unreliability and broken chargers have been troubling the infrastructure across the world. Issues like networking problems and screen or cable damage can impact their availability. The situation is prevalent in India as well, as about 60% of PCSs operated by Bharat Petroleum Corporation Limited, the second	**Standards and periodic checks** The BIS has specified standards for PCSs that a charge point operator is required to comply with in order to set up a PCS, which includes requirements for several reliability related concerns including sufficient insulation, temperature monitoring, load balancing, etc. Officials are also empowered to carry out periodic checks of the electricity equipment under the CEA (Measures Relating to Safety and Electric Supply) Regulations, 2023.	**Auditing and minimum requirements** Swift malfunction detection and rectification are necessary to establish the same level of dependability as petrol pumps. While grid uptime is of utmost importance, reliability can also be ensured by creating a regular inspection and auditing system, which is currently not in place. The GoI can also mandate the use of service level agreements that specify minimum uptime, response time for maintenance, etc. Penalties may be considered for operators who fail to comply with reliability standards.

[39] Please refer https://www.forbes.com/sites/brianbushard/2023/07/07/mercedes-benz-latest-to-adopt-teslas-charging-standards-as-ev-competition-soars-here-are-the-others/?sh=1b0183756201

S. No.	Challenge Faced	Ongoing Initiatives	Proposed Course of Action
	largest chain of PCSs in India, were not functional in May 2023.[40]		

[40] Please refer https://the-ken.com/oil-giants-dead-ev-chargers-haunt-indias-highways/

8. CONCLUSION

In conclusion, addressing the challenge of inadequate EV charging infrastructure in India necessitates a comprehensive approach that amalgamates various strategies. Valuable insights drawn from leading nations such as China and Norway underscore the pivotal role that governmental intervention plays in this sector and the aforementioned comparative analysis reveals significant considerations in this regard.

Apart from these global lessons, enhancing incentives for privately-owned charging infrastructure, especially by subsidising cost of real estate, could stimulate private sector participation, fostering a robust charging network and expediting broader EV adoption. Modernizing the electrical infrastructure is equally important; the implementation of features like net metering and peer-to-peer energy trading can optimize charging operations, enhancing cost-effectiveness for consumers. Furthermore, embracing open protocols and interoperability standards fosters seamless communication among charging stations, fostering innovation while ensuring cross-network compatibility.

Lastly, reliability remains paramount in instilling confidence among EV owners. The GoI can orchestrate this by instituting regular inspections, establishing a rigorous auditing framework, and enforcing service level agreements to maintain elevated operational standards. By assimilating insights from successful international endeavours, India can gather valuable lessons in experimenting with ultra-fast charging technology, dynamic charging lanes, and intelligent grid integration – all pivotal in enhancing the charging experience and driving widespread EV adoption.

Embracing these solutions collectively, the GoI can pave the way for a sustainable and thriving EV ecosystem, advancing the nation's transition towards a greener and cleaner future.

Authors: Saurav Kumar | Swathi Sreenath | Ritvika Thakur | Kajal Kashyap | Suyash Bajpai

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Practice Areas: Mergers & Acquisitions, Corporate and Commercial, Automotive