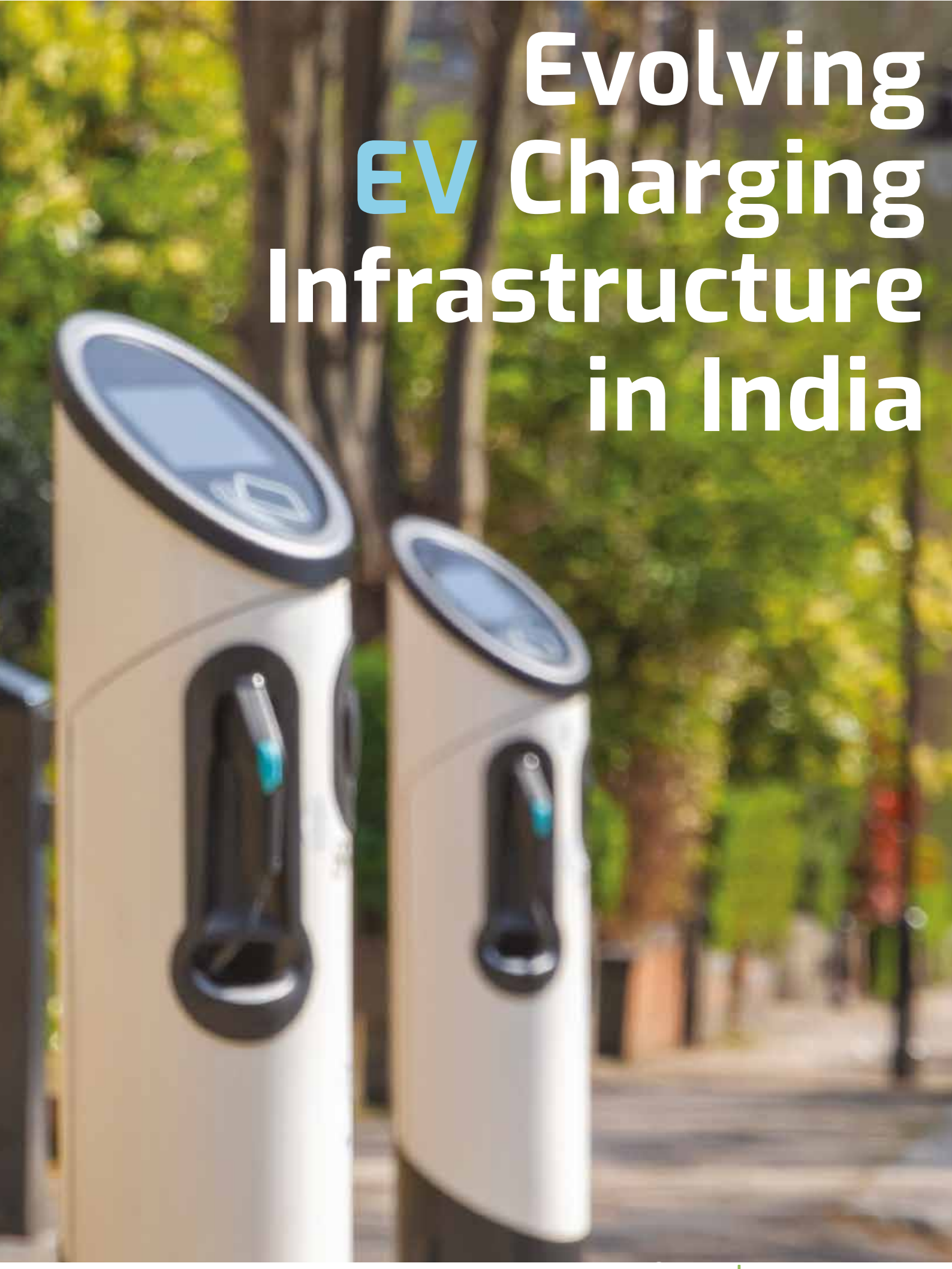

Evolving EV Charging Infrastructure in India

JMK Research & Analytics

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JMK Research & Analytics is a boutique consultancy for all kinds of research and advisory services for Indian and international clients focusing on Renewables, Electric mobility and Battery Storage segments. We employ our interdisciplinary team, strong industry network, vast project experience in the Indian Energy sector to create substantive business value for our clients. Our subscribers include, equipment suppliers, investment agencies, multi-lateral and bilateral agencies, project developers, government authorities.

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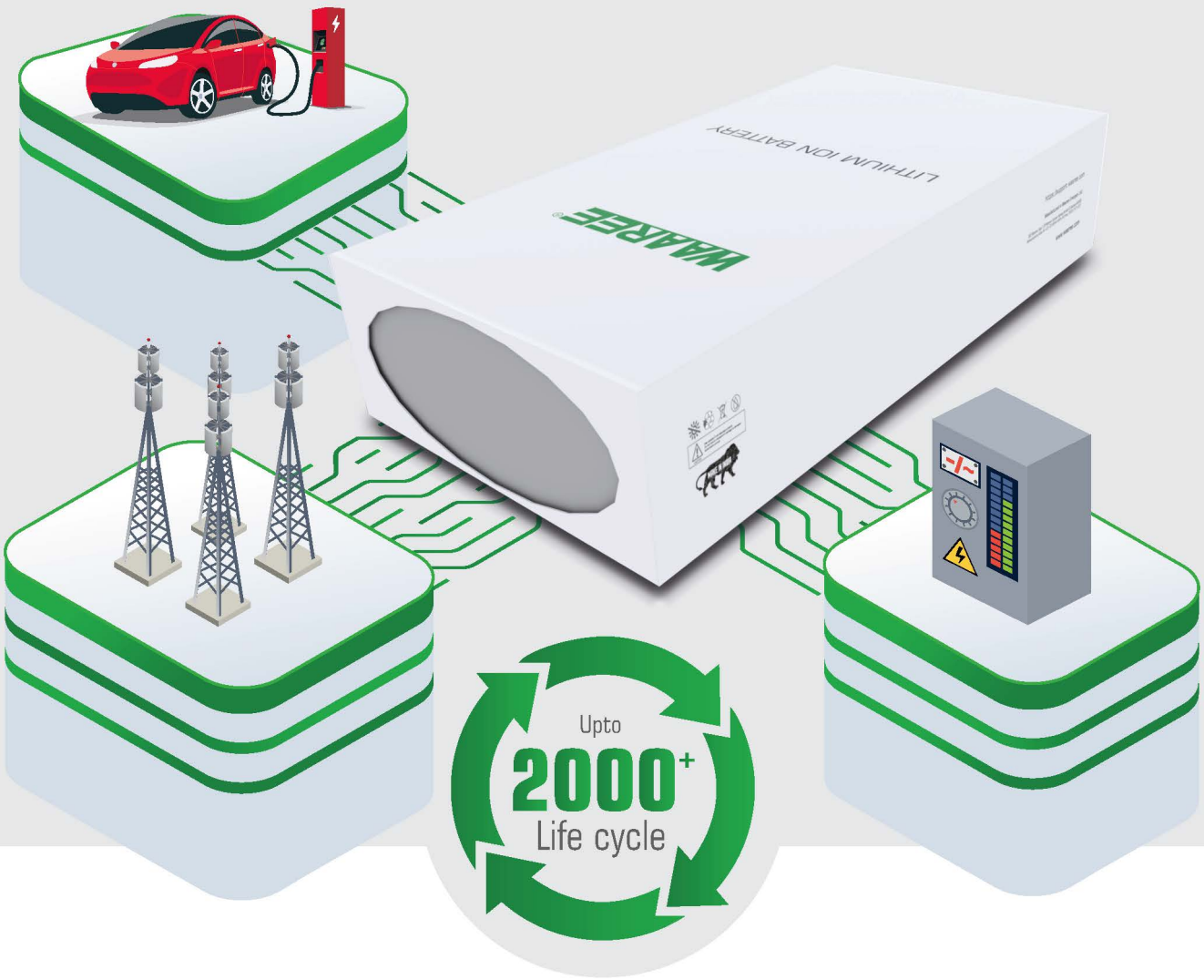

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Contents

Introduction

The electric mobility (e-mobility) sector in India is categorized by availability of Electric Vehicles (EVs) on the supply side and adoption trends on the demand side. Adequate charging infrastructure is the key prerequisite that will define the adoption trends of EVs in India. EVs carry limited on-board energy in the battery packs which need charging from time-to-time depending upon the battery pack, size, and capacity. Charging systems are therefore essential for sustainable operation of EVs.

The charging requirement depends not only on the kind of vehicle (two-wheeler, three-wheeler, four-wheeler, and bus) but also on the utility purpose i.e. passenger or commercial.

The Government of India has set a target to electrify 70% of all commercial vehicles, 30% of private cars, 40% of buses, and 80% of two wheeler and three wheeler sales by 2030. This target entails simultaneous penetration of charging stations across India.

The Government of India has been supporting the EV industry through schemes such as FAME1 and FAME2 with a major focus on charging infrastructure. The industry players too have been quite optimistic and shown an active interest in the overall EV Charging ecosystem. While EVs are being worked upon by major OEMs, an ecosystem for the development of chargers, charging stations, and other services is steadily being built.

The charging infrastructure is the backbone of electric mobility but is also one of the key perceived barriers to EV adoption in India given its limited availability and long charging times. India is picking up the pace in setting up the charging infra but not as much as is there in other regions like European Union (EU), USA or China. High operating cost, Discom load and the uncertainty related to utilization rates of charging stations are holding back the charge operators from expanding their current reach.

In India, there is a lack of government approved standards for electric two-wheeler and three-wheeler categories. One of the reasons for this could be the end-user's preference for battery swapping and fixed rate of charge. Since the public charging stations (PCS) cannot offer a fixed rate of charge, such users favour home charging. Similarly, fleet operators like the state-run intra-city bus services have a totally different charging infrastructure requirement. It therefore becomes necessary that the charging infrastructure strategy be all inclusive for all vehicle types.

Components of EV Charging Infra

Setting up of charging infrastructure i.e charging station requires

- Hardware (charger/EVSE)
- Software (Central Management System/mobile app)
- Service (maintenance of charging stations and other hardware/software)

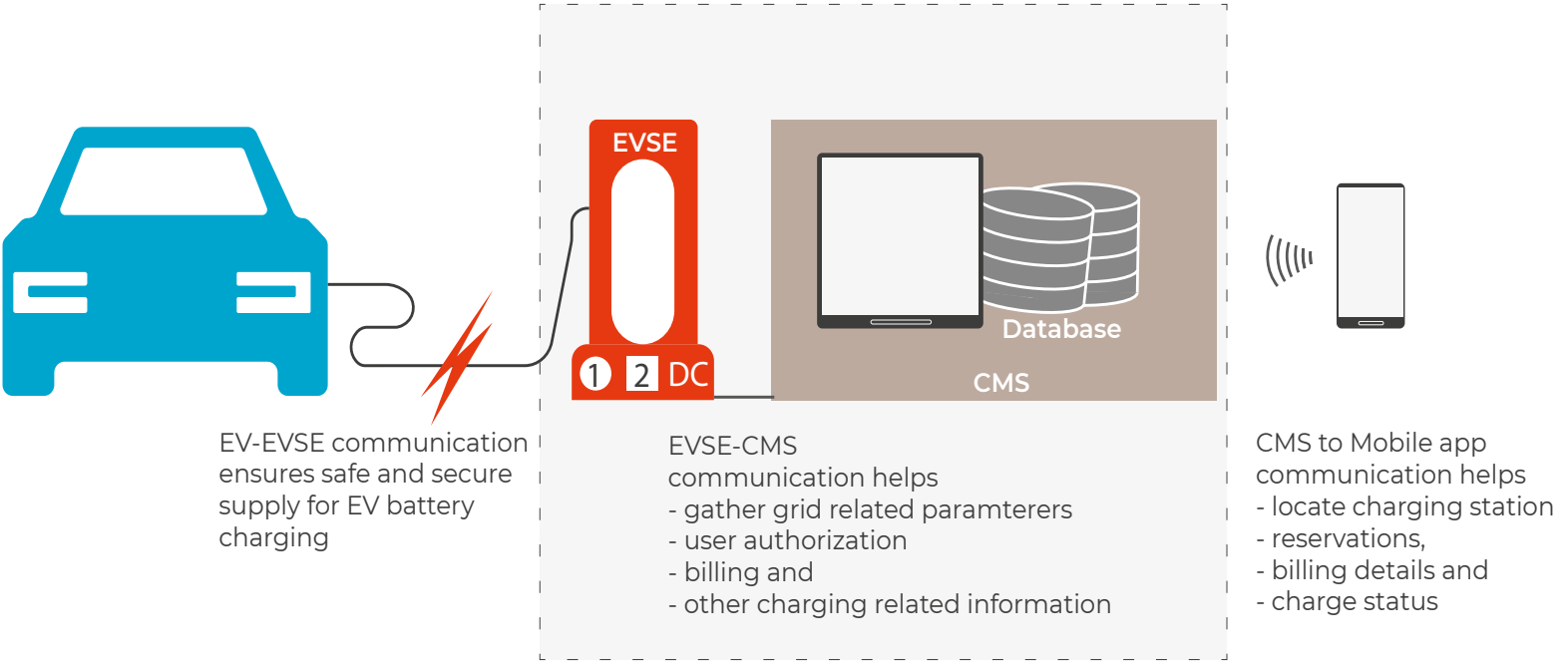
An EV Charging Infrastructure, in essence, includes the following:

- Charging station that contains several EVSE (Electric Vehicle Supply Equipment)/charge points. So, a charge point can be considered as equivalent to a refueling hose of a gas station/petrol pump. A charge point in turn contains several connectors/outlets however, per charge point, not more than one connector can be active at a time. This connector, through which the electricity is delivered, can be a socket or even a cable. A charger is then connected to one of these connectors basis requirement which then goes directly to the vehicle's socket.
- Central Management System (CMS) is a cloud-based backend system managed by the company operating the charging station. The CMS manages user authorization,

billing, and rate of charging.

- Mobile Application enables end-users in finding nearest charging stations, reserving a charging slot, and paying. Digital infrastructure availability in the form of charging location finders, IoT infrastructure for multiple cars, online charging reservation platforms, and online payment platforms completes the value chain of charging infrastructure efficiently.

Architecture of EV Charging Infrastructure



Source: DHI – Committee Report on Standardization of Public EV Chargers

Market Overview

The Charge Point Operators (CPOs) currently have the ownership of the charging infrastructure they operate, and they follow a Pay per Use model with different variants for revenue-realization. Online mapping of these PCOs through smart-phones makes it convenient for EV owners make digital payments along with checking location, availability of chargers along with their type.

Segmentation

For scaling up EV adoption, a clear understanding of the necessary EV charging infrastructure is required as One-size-fits-all approach will not be the way forward.

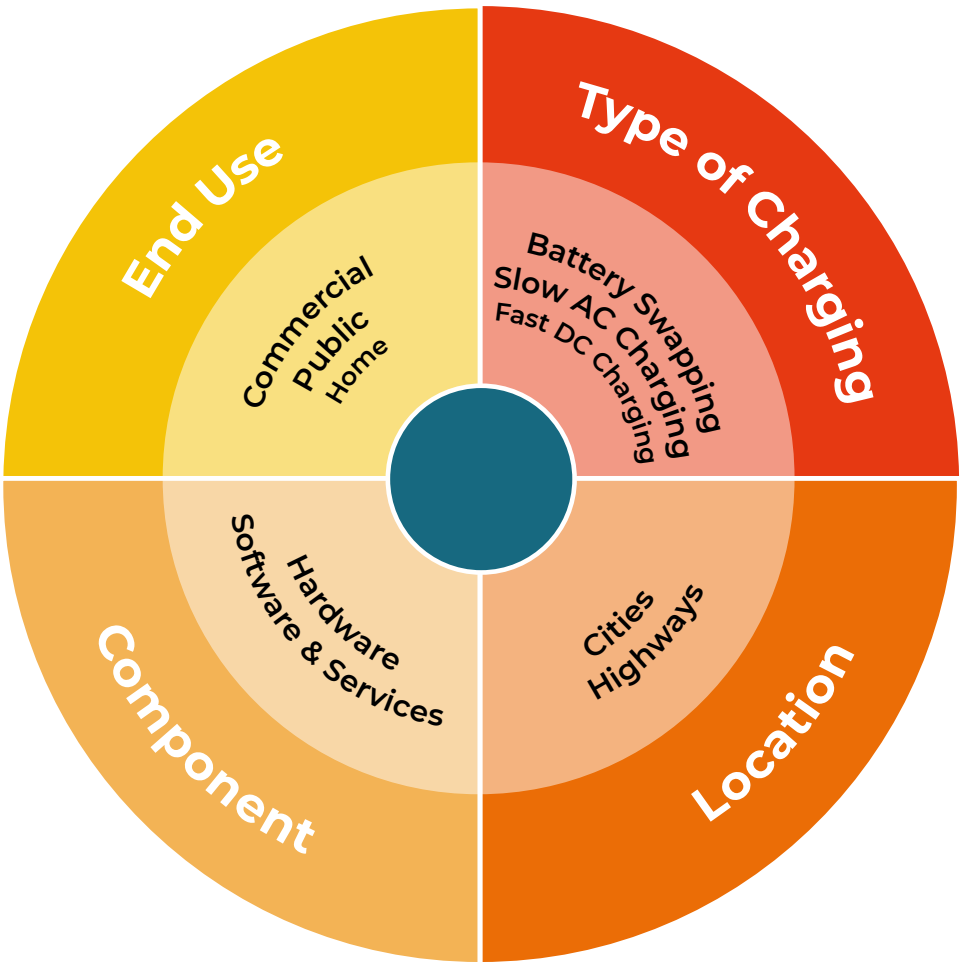
The charging requirement for a commercial e-4W that covers more kilometers per day than a private vehicle is higher. So, while it is anticipated that the bulk of private e-4W charging would be from home chargers, the commercial e-4W would prefer public charging. Even the operation of commercial e-4W fleet varies significantly based on the type of load they carry, i.e. passengers or goods. The passenger fleet can further be of two types: on-demand cab and staff transport. So, other than public charging facilities, the on-demand cab fleet may prefer captive charging while the staff transport fleet might prefer charging facility within the office premises.

Setting up en-route public charging facilities however is not preferred by a charging service provider owing to the difficulty in finding space, along with the high expected cost of land rental in a city.

In case of 2W and 3W, battery configuration of fixed vs. detachable decides if the charging option will be through plug-in charging or battery swapping, respectively. Although, battery swapping

options are popular for e-2W and e-3W, setting up a charging facility for its own brand of vehicles is beneficial for a four-wheeled EV manufacturer. Ather and Battre are exceptions here as despite being e-2w manufacturers, they are setting up their own public charging facilities.

Segmentation of EV Charging Infrastructure



Source: JMK Research

Types of charging

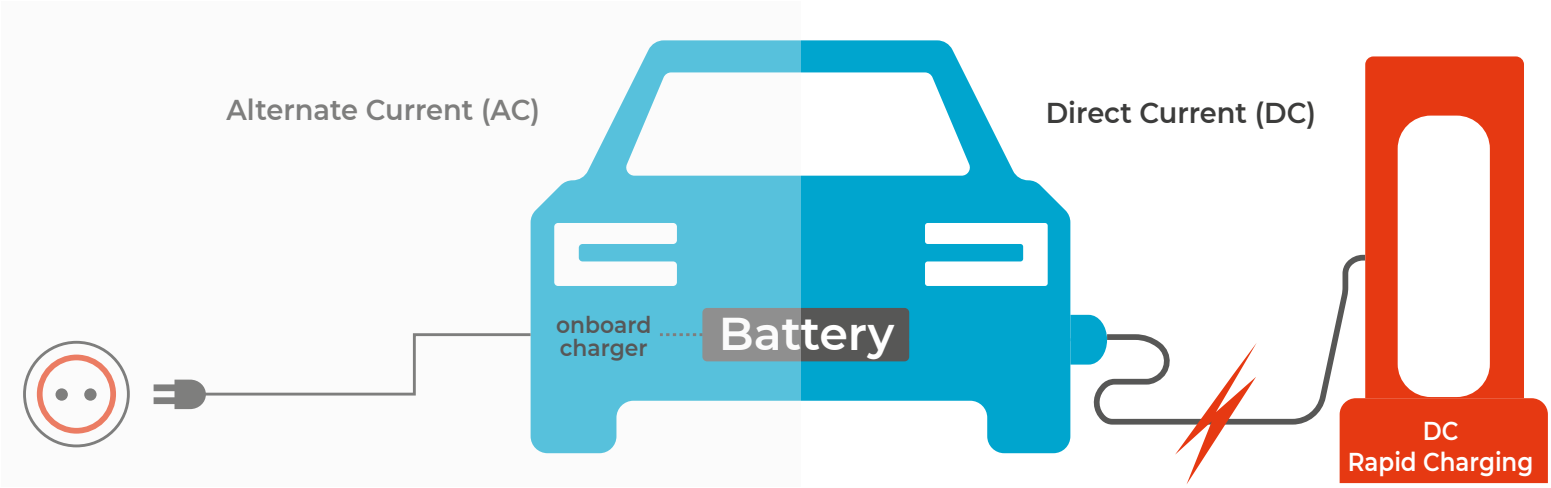
The EV charging infrastructure market in India, basis the type of charging, is segmented into battery swapping and direct charging which is further segmented into AC/slow charging and DC/ fast charging. The power that comes from the grid is always AC (Alternating Current). Vehicle batteries are however always charged by DC (Direct Current).

The battery swapping option allows a vehicle's discharged battery or battery pack to be immediately swapped for a fully charged one, thereby eliminating the delay involved in waiting for the vehicle's battery to charge. This option is suitable for e-2W and e-3W in India.

- **AC/Slow Charging**: The power received from the grid is AC power. When charging portable electronic devices (e.g. mobile phones, EVs), the power needs to be converted from AC to DC. This is done by a converter. In the case ofEVs, this converter/ onboard charger is inside the car. Here, AC is supplied to the onboard charger of the vehicle that converts AC into DC that ultimately charges the vehicle battery. This charging method is most suitable for parking spots where the car will stay parked for 20 minutes or longer. The slow charging methods include Bharat AC-001, a low voltage charging technology which is the most economical of all the standards, and Type 2 AC with 7.4 kW of power output. Type 2 AC is faster than AC-001. Though upto 22 kW of power output can be considered but no vehicle for this power output is available in India. However, OEMs like Volvo and BMW have plans to launch 22 kW compatible EVs by the end of 2021.

- **DC Charging**: Fast chargers for EVs make use of DC charging. They convert the power before it enters the vehicle. After conversion, the power goes directly into the car battery, bypassing the car's converter, an onboard charger. The electric 4-wheeler (4W) vehicles in India however do not have an on-board charger beyond 7.5kW. This is to save or minimize costs in vehicle. Hence most of them use AC chargers. A DC installation requires a lot of power from the grid (around 125 A). This makes its costs (production, installation as well as operation) quite high, resulting in higher tariffs for charging. However, it is the preferred charging method to quickly recharge during long-distance trips as it usually allows for much faster charging. This type of charging is mostly found along highways rather than at business locations or homes. The fast charging standards include Charge De Move (CHAdeMO), Bharat DC-001, and Combined Charging System (CCS). CCS (available as CCS1 with 5-pin AC connector and 2-pin DC connector and CCS2 with 7-pin AC connector and 2-pin DC connector) is majorly used by most of the US, European, and South Korean automobile manufacturers while CHAdeMO is primarily used by Japanese automobile manufacturers.

AC Charging vs. DC Charging



Source: JMK Research

Compatibility of Charging Standards with different EVs

Standard	Examples of Compatible e-Models in India
Bharat AC-001	Mahindra e2o, Mahindra e2o Plus P6, Tata Tigor (Charging Time: 6 hours)
Bharat DC-001	Mahindra e2o Plus P8, Mahindra e-Verito, Tata Tigor (Charging Time: 1.5 hours)
CHAdeMO	Hyundai Kona
CCS	Hyundai Kona, MG ZS EV, Tata Nexon EV

Source: JMK Research

- **Location**

The EV charging infrastructure market in India, basis the location type, is segmented into cities and highways. Majority of charging stations are however currently being deployed in cities with plans underway to install more charging points in major expressways and highways.

Components

The EV charging infrastructure market in India, basis the type of component, is segmented into software & services, and hardware. Software & services include platform as a service, installation and maintenance of charging units, and towing service and battery delivery service, which are in a very nascent stage in India. Hardware includes charge points, connectors, and chargers and associated equipment. The charging technologies involved in setting up a charging infrastructure are rapidly evolving. However, the equipment market is still in its nascent stage.

End-Use

The EV charging infrastructure market in India, basis end-use, is segmented into Home Charging, Commercial Charging, and Public Charging. Home charging is a type of AC Charging.

- **Home chargers** generally use a 230V/15A single-phase plug that delivers an output power of upto 2.5kW. Further, the electricity consumed is added to home-metering.
- **Public charging**, referring to outside-home charging, enables interoperability between EVs offered by different automakers and charging stations. Public Charging Stations (PCS) could be set up at petrol pumps, municipal parking lots, malls, and government office complexes. Countries with higher population density have denser public charging network measured in number of vehicles to charge point (VCP). The Netherlands (450 persons per sq. km) has a VCP of 4, China (150 persons per sq. km) has 6, and the US (36 persons per sq. km) has 79. Therefore, in country like India which has high population density and less space, public charging network is necessary. In addition, in cities like Delhi and Mumbai where 70 per cent of cars are estimated to be parked on the roads, very few city dwellers own a garage/parking space for their car. This necessitates availability of a public space that is used by multiple vehicles on a shared basis.
- **Commercial/Captive charging** The third kind of charging option is for an entity/Company's own vehicles (e.g.- MG Motors) or say for instance, for a cab aggregator's own fleet. The charging stations falling under this option are set up inside corporate premises and not in public domains. Such charging stations are optimally utilized (~80%) as stated by CPOs like Volttic.

Market Sizing

The overall market for charging infrastructure in India is fragmented and unstructured owing to segregation in terms of public vs. private players and PCS vs. commercial charging. The market size, therefore, can best be gauged through the count of charge points established by the major CPOs (public plus private) in India till date as well as the PCS established under various schemes – FAME I/FAME II as of now.

Similarly, the plans for upcoming months/years can be analysed through the outlook numbers suggested by the respective CPOs as well as the tenders/EOIs already sanctioned/announced.

Current Status

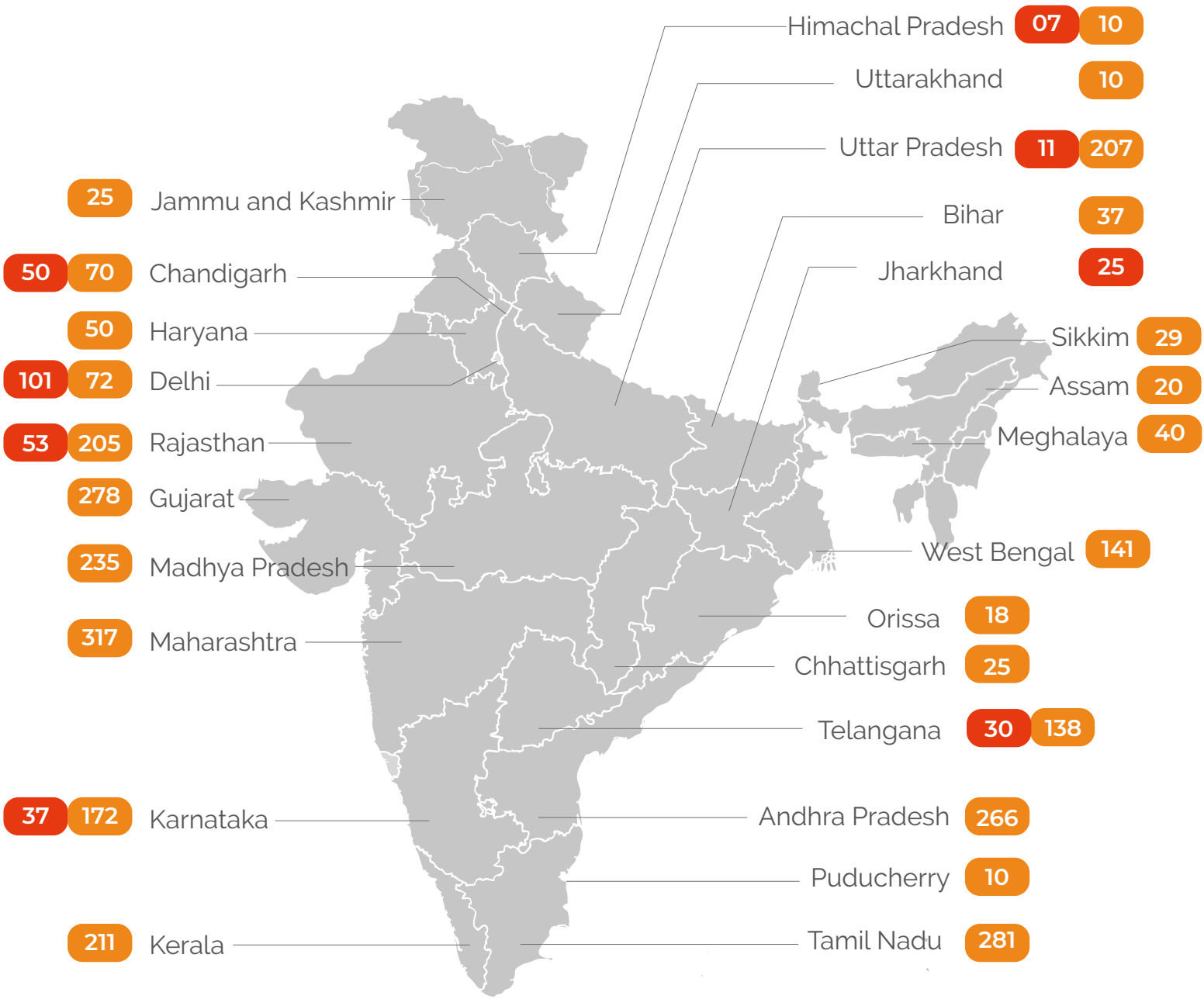
PCS

As of 15th March 2021, DHI has sanctioned 3397 charging stations under FAME scheme

Charging stations established under FAME schemes

EV Stations established as per FAME I Scheme *

EV Stations earmarked as per FAME II Scheme



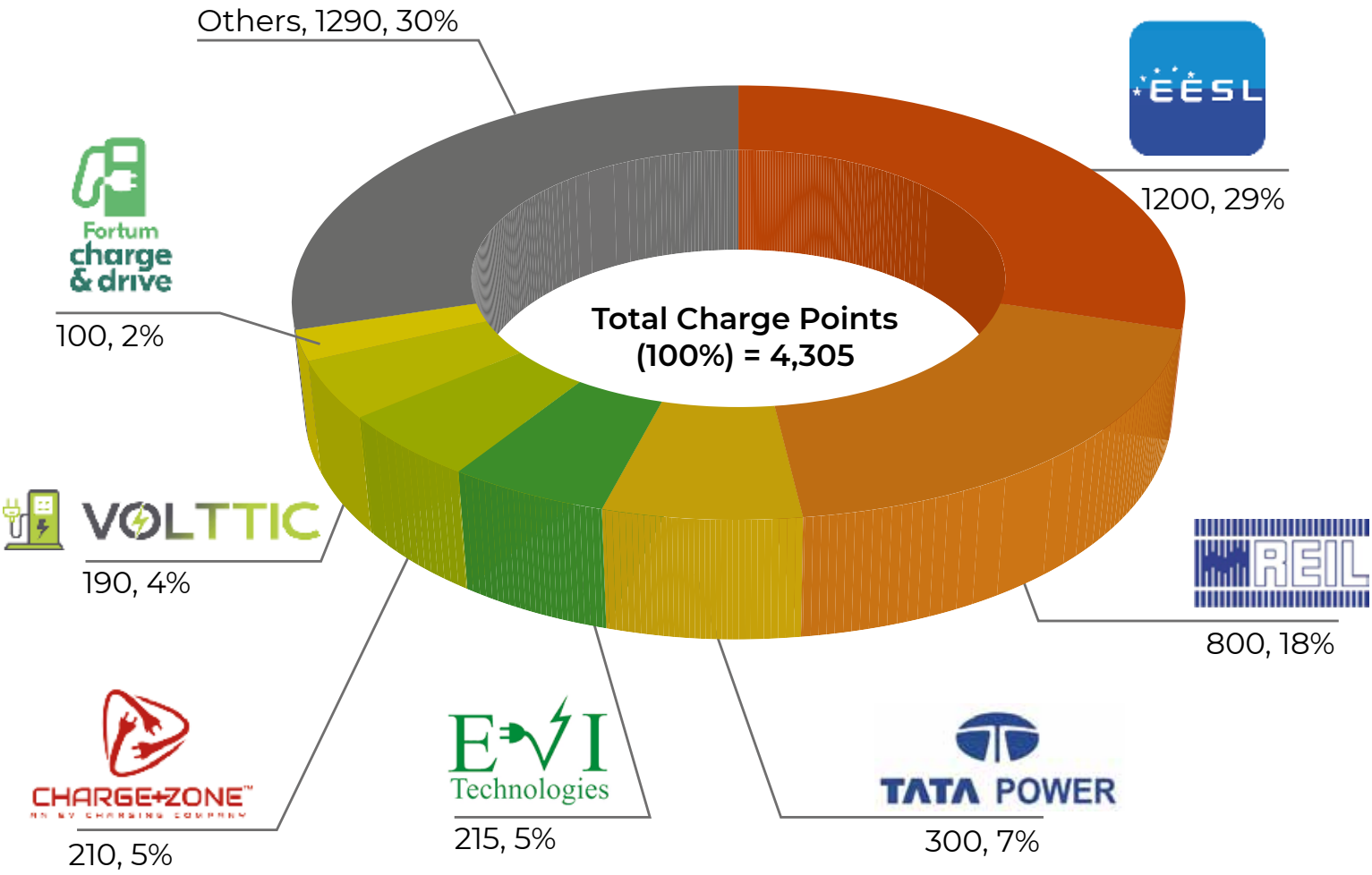
*Delhi-Chandigarh Highway: 16 ; Mumbai-Pune Highway: 15; Jaipur-Delhi-Agra: 29; Goa: 6

Source: Department of Heavy Industry, JMK Research

Charge Points

The charge points established by key CPOs, till recently, throws light on the estimated count as well as public player vs. private player segregation. While EESL stands out in the race, owing to its bagging of all the major contracts under FAME I scheme and being a public entity, private players like TATA Power are also doing exceptionally well.

Number of Charge Points of Key CPOs*



Source: JMK Research

* Data for Tata Power, EVI, and ESSL is not confirmed. Numbers published for these three players are taken from various industry news articles

Future Plans

The country is riding high on the support extended by the government through FAME I and FAME II schemes as well as the interest shown by the private players. The future therefore looks bright as can be assessed from the EOIs and tenders announced along with the plans of the industry players.

Encouraging Numbers from EOIs/Tenders

The DHI sanctioned 3,397 EV charging stations under the second phase of **Faster Adoption and Manufacturing of Electric Vehicles India** (FAME II India) scheme as on Jan 11, 2021. Out of this, the DHI approved setting up of 2,636 EV charging stations - 1,633 fast charging stations and 1,003 slow charging stations - across 62 cities in 24 states and union territories (UTs) of India in January 2020. Maharashtra was allotted the highest number (317) while Karnataka and Tamil Nadu were allotted 266 and 256 stations respectively.

The Ministry of Heavy Industries and Public Enterprises also sanctioned 241 additional charging stations in September 2020. In October 2020, the DHI extended an EoI to have atleast one charging station every 25 km on both sides of highways/roads and minimum one Long Range/Heavy Duty charging station at every 100 kms on both sides of highways/roads. The parties invited included government organizations, public sector undertakings (PSUs), state-owned distribution companies, and private companies to set up ~1,500 charging stations (nine expressways with a total length of 1,775 km will have a minimum of 174 charging stations and 16 arterial highways having a total length of 13,370 km, will have a minimum of 1,370 charging stations) on 25 expressways and highways.

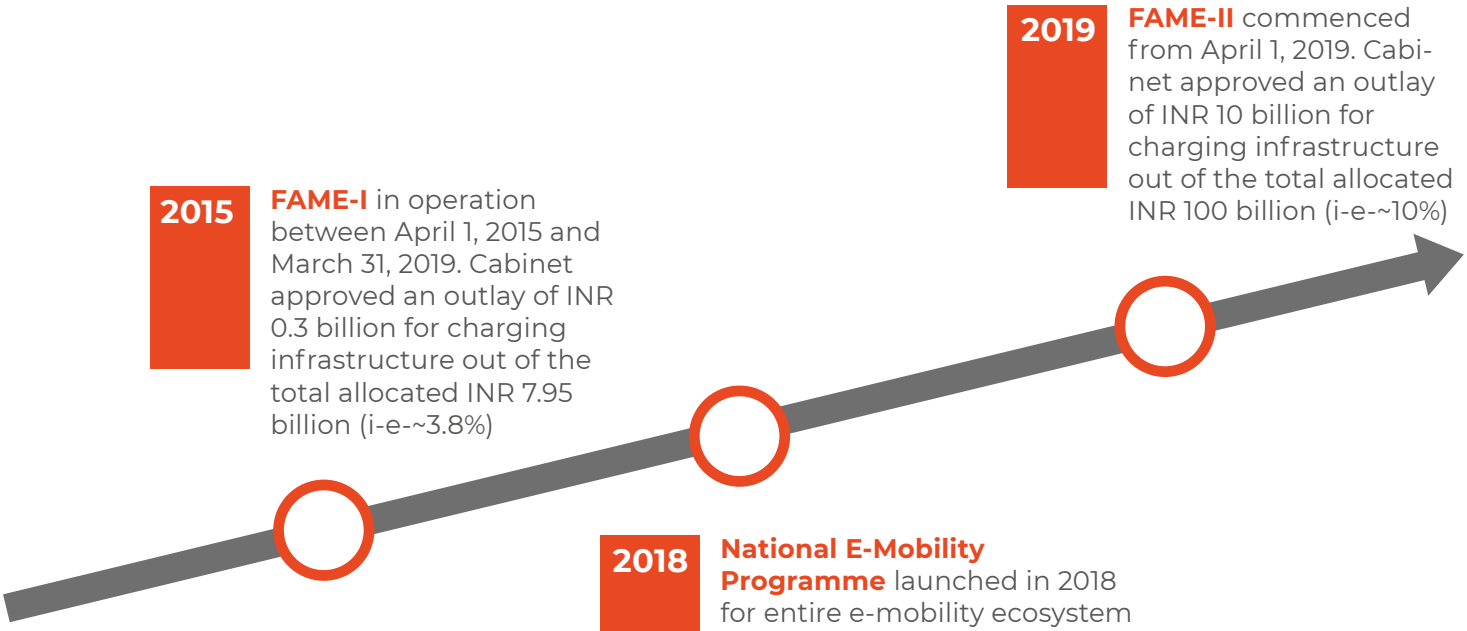
A similar EoI was issued in August 2019 to deploy ~7,000 EV charging stations and received 106 proposals from public as well as private entities. However, it sanctioned only 2,877 charging stations.

Substantial Numbers from Plans of Leading Players

JMK Research expects that in the next 18 months, the total number of charging stations to be established by key players including some fresh start-ups will be around 7,000. Out of this, the state-held players – EESL and REIL – would account for ~50% of the market share. This will be followed by some experienced and already established private players – Volttic, Tata Motors, and Fortum.

Central-State Government Initiatives

Policy Roadmap for EV Charging Infrastructure in India



NEMMP

In 2013, the Government of India launched NEMMP 2020, intending to reduce dependence on crude oil for transportation by promoting EVs in India. It is a National Mission document providing the vision and the roadmap for the faster adoption of EVs and their manufacturing in the country.

FAME-I

As part of the NEMMP 2020, the Department of Heavy Industry (DHI) launched a Scheme viz. **Faster Adoption and Manufacturing of (Hybrid & Electric Vehicles in India** (FAME India) Scheme for a period of 2 years commencing from 1st April 2015. The Scheme was implemented through four focus areas namely (i) Demand Creation, (ii) Technology Platform, (iii) Pilot Project and (iv) Charging Infrastructure.

The scheme had an approved financial outlay of INR 7.95 billion for a period of two years out of which INR 0.3 Billion was earmarked for the installation of charging infrastructure (INR 0.1 Billion for FY 2015-16; INR 0.2 Billion for FY 2016-17

National E-Mobility Programme

Launched in 2018, the program targets 30% of vehicles to be electric by 2030. In addition, the programme, envisaged that no licensing to setup charging infrastructure in India would be required and the tariff would be less than Rs 6.

FAME-II

Based on the experience gained in the Phase-I of FAME India Scheme, it was observed that sufficient bandwidth of charging infrastructure is required to achieve expected outcome of the plan, which is being addressed presently in Phase-II of FAME Scheme notified on 8th March 2019.

Under FAME II India Scheme INR 10 Billion (INR 3 Billion for FY 2019-20; INR 4 Billion for FY 2020-21; INR 3 Billion for FY 2021-22) has been allocated for the establishment of charging infrastructure. 241 charging stations for electric buses were sanctioned under the scheme.

- The scheme proposes to offer the buyer one fast charger for every 10 electric buses and one slow charger per electric bus
- Funding available for the establishment of charging infrastructure to the extent of 100% of cost involved.
- Six projects for setting up of EV charging infrastructure have been funded under this Scheme. These include four solar projects, with Bharat Heavy Electricals Limited (BHEL) and Rajasthan Electronics & Instruments, Jaipur (REIL) setting up two.
- Similarly, among conventional infrastructure mahindra Reva Electric (now Mahindra Electric Mobility) has received funding for its public fast charging infrastructure network in Bangalore, which it will set up in collaboration with Lithium Urban Technologies.

Other Amendments and Supports

1. Several amendments were made to the Model Building Byelaws (MBBL) 2016 and Urban Regional Development Plans Formulation and Implementation (URDPFI) Guidelines 2014 to establish a robust EV charging infrastructure.

2. The Housing and Urban Development Ministry of India issued guidelines in January 2019 that mandated commercial and residential complexes to allow 20% of their parking space for accommodating EV charging facilities.

3. Oil-ministry guidelines, in October 2019, allowed Companies with a net worth of INR 2.5 billion to sell petrol and diesel subject to condition that they install facilities for marketing of at least one new generation alternate fuel such as CNG, LNG, biofuels or EV charging within three years of start of operations. Many gas stations are therefore opting for EV charging to adhere to that condition.

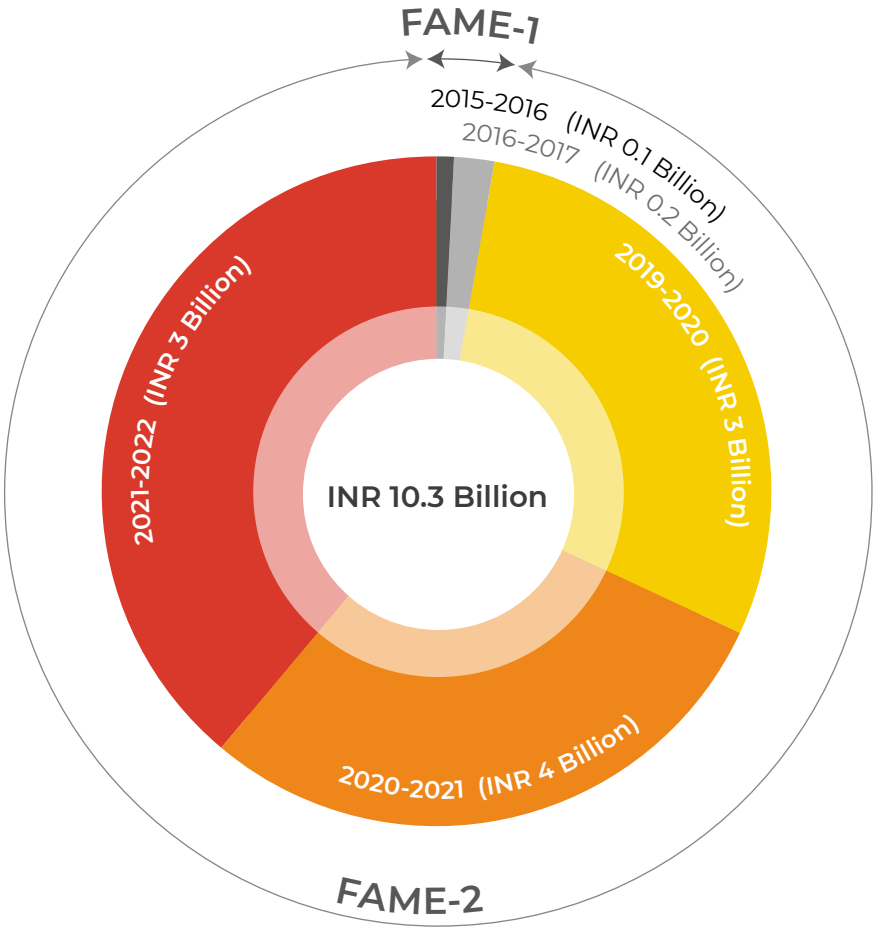
Ministry of Power guidelines for states on Charging Infrastructure for EVs (as of October, 2019)

- Priority of roll out of EV public charging infrastructure includes mega cities and all connected expressways and highways (Phase I for 1-3 years) followed by big cities like UT headquarters and state capitals and connected highways (Phase II for 3-5 years).
- Permission for private charging at offices/residences.
- The battery charging station (BCS) will be treated at par with the public charging station (PCS) and the applicable tariff for electricity supply will also be the same as for the PCS.
- To boost setting up of public EV charging stations in India, delicensing of EV public charging infrastructure allowed (through a clarification issued on April 13, 2018) i-e- Companies setting up charging infrastructure for EVs do not require any separate license for electricity transmission, distribution, or trading.

    I. Connectivity for PCS will be provided on priority by the Distribution Company licensee and any charging station can obtain electricity from any generation company through open access.

    II. Each PCS to have one or more or any combination of chargers – CCS/CHAdeMO/Type 2 AC for fast charging and Bharat DC-001/Bharat AC-001 for slow charging. Other requirements include appropriate civil, cabling, electrical works; 33/11 KV line/cables; exclusive transformer; and adequate space for

Fund allocation under Phase I and Phase II of FAME, INR Billion



Source: Department of Heavy Industry

charging and entry/exit of vehicles.

III. Tie-up with atleast one online network service provider (NSP) required to enable advance online/remote booking of charging slots by EV owners.

IV. PCS for long-range EVs/heavy-duty EVs (trucks, buses) need to have atleast two chargers of minimum 100kW each of different specification and appropriate liquid cooled cables.

V. In addition, provision of at least one charging station within each 3km x 3km grid and at every 25 km on both sides of roads/highways is required. For long-range EVs, the requirement is to have fast charging stations at every 100 km on both sides of roads/highways.

VI. The Central Nodal Agency for rollout of EV public charging infrastructure is Bureau of Energy Efficiency (BEE). Similarly, every state should nominate a Nodal Agency for the deployment of public charging infrastructure. The State Nodal Agency (SNA) is responsible to achieve a phased plan for prioritized roll-out of public charging infrastructure by selecting an Implementation Agency to set up, operate, and maintain public charging facilities in the state.

- Private charging points meant for non-commercial use of individual EV owners do not need to follow any minimum infrastructure requirements. Similarly, captive charging infrastructure meant for internal use for a company's own/leased fleet does not require to have NSP tie-ups to install chargers as were required for PCS.

- The tariff for the supply of electricity to the EV PCS should not be more than 15% of the average cost of supply of power.

State-wise Announcements

State	Targets (# of Charging Stations/Charging Station Density)	Infrastructural Incentives	Financial Incentives
Andhra Pradesh (Approved)	0.1 Million (by 2024)	Mandating all new commercial complexes, residential townships, and housing societies with a built-up area of 5,000 sq. m. to have charging stations	Capital Subsidy of 25% (maximum of INR 1 Million) of the value of the charging station equipment/machinery for first 100 stations utilizing DC Chargers (100V and above); Capital Subsidy of 25% (maximum of INR 30,000) for first 300 stations utilizing DC Chargers (below 100V)
Bihar (Drafted June 2019, awaiting approval)	Every 50 km on all highways	Charging infrastructure to be created at all major government offices	25% capital subsidy on machinery/ equipment (limited up to INR 1 Million per station) for first 250 commercial EV PCS
Chandigarh (Drafted October 2019, awaiting approval)	1,000 (by 2030)	Mandatory provision of charging spots in all commercial complexes and dedicated lanes in every sector; INR 4/unit rate including 30% subsidy on the power bill for home charging	30% subsidy on installation of home chargers; 15% subsidy to charging infrastructure companies that plan to install PCS

State	Targets (# of Charging Stations/Charging Station Density)	Infrastructural Incentives	Financial Incentives
Delhi (Approved August 2020)	Every 3 km	For private charging points,changes in building bye-laws to be made so that all new home and workplace parking are 'EV ready' with 20% of all vehicle holding capacity	Capital subsidy for the cost of charger installation expenses to be provided to the selected Energy Operators; A grant of 100% for the purchase of charging equipment up to INR 6,000 for the first 30,000 charging points
Gujarat (Drafted September 2019, awaiting approval)	N/A	Reserved parking/ charging facility for EVs; Charging points to be provided in office parking areas	N/A
Karnataka (Approved September 2017)	Every 50 km on highways between prominent cities	Mandating charging infrastructure in public buildings	N/A
Kerala (Approved March 2019)	Every 5km x 5km grid in cities and at every 25 km interval along the entire National Highway	Mandating all new permits for housing societies, residential townships, and commercial complexes with a built-up area 5,000 sq. m. to have a charging station; new and renovated non-residential buildings with 10 equivalent car spaces to have atleast 20% EV ready spots while 100% demarcated EV ready spaces required for residential ones	N/A
Madhya Pradesh (Approved October 2019)	Every 50 km on major roads including highways	Mandating all new permits for housing societies, residential townships, and commercial complexes with a built-up area 5,000 sq. m. to have a charging station	For PCS, Capital Subsidy of 25% of the value of the charging equipment/machinery for first 300 charging stations (Maximum of INR 0.15 Million) for small charging stations; Maximum of INR 0.2 Million Capital Subsidy for first 100 medium charging stations; Capital Subsidy of Maximum of INR 1 Million for first 100 large charging stations
Maharashtra (Approved February 2018)	None	Allowing for setting up of common PCS in parking areas of malls, residential properties (not mandatory)	25% capital subsidy on machinery/ equipment (limited up to INR 1 Million per station) for first 250 commercial PCS

State	Targets (# of Charging Stations/Charging Station Density)	Infrastructural Incentives	Financial Incentives
Punjab (Drafted November 2019, awaiting approval)	None	For new and renovated buildings, the count stands at 1 Electric Charging Spot (ECS) for every 3 parking slots and 1 ECS for every 5 parking slots for residential and non-residential complexes that have parking demarcated for atleast 10 cars.	25% capital subsidy on equipment/machinery (limited up to INR 50,000 per private charging point) for the first 1,000 charging points; capital subsidy to be 50% in case the charging equipment is manufactured in Punjab
Tamil Nadu (Approved September 2019)	Every 25 km intervals on both sides of NHAI and State Highways	At least 10% of parking space to be earmarked for setting up EV charging stations in commercial buildings including hotels, cinema halls, shopping malls, and apartments	In cases where State Goods and Services Tax (SGST) reimbursement is not applicable, a capital subsidy of 15% will be given on eligible investments over 10 years; Manufacturing units related to charging infrastructure to receive 100% electricity tax exemption till 2025
Telangana (Cabinet approval August 2020)	Every 50 km within state boundaries on highways to cities like Bengaluru, Mumbai, and Chennai	Preferential parking slots with required charging infrastructure to be made available	
Uttar Pradesh (Approved August 2019)	0.2 Million (by 2024)	Mandatory for public parking spaces, new housing societies, residential townships, and commercial complexes with a built-up area 5,000 sq. m. to have a charging station	Capital Subsidy of 25% on fixed capital investment (excluding land cost) to first 100 charging stations (maximum of INR 0.6 Million per charging station)

Source: State EV Policies, JMK Research

Key Market Drivers

India is expected to witness considerable growth in the EV Charging Infrastructure market owing to the following key drivers

Strong Government Push

There has been continued and expanded policy interventions at state and central level to ensure deployment of charging infrastructure in the last few years.

- The first and most significant step has been to treat EV charging as a "service". This allows anyone to set up and operate an EV charging station without requiring a license.
- The states have introduced fiscal and non-fi¬scal incentives such as reduced tariff charges for the manufacture and operation of chargers. In addition, treating 'EV Charging Station' as a separate category under Tariff Order by electricity regulators has been a step in the direction of promoting e-Mobility in the country.
- In the Union Budget announced in July 2019, GST rate on EV charger/charging stations was reduced from 18% to 5%.
- The government, as of November 2020, is planning to set up at least one EV charging kiosk at around 69,000 petrol pumps across the country to induce people to go for electric mobility.

Industry Initiatives

Setting up of charging infrastructure has evinced interest from many automobile companies and other private players, including standalone charging infrastructure developers.

- **Tie-Ups**

  1. **With Fleet Operators** (for employee transportation by MNCs): When it comes to the business prospects for CPOs, large-scale fleet operators like Ola, Uber, Lithium Urban,

Zoom Cars, and door-to-door delivery/courier operators are expected to become strategic drivers of the market. They have the right business incentives to develop strategic charging and digital infrastructures to support their own EV fleet given that they often operate many vehicles across India. Add to that the strong financial backing from investors, large fleet operators have become the early adopters of charging infrastructure in India.

2. **With Petrol Pumps:** Charging companies/OEMs are tying up with petrol pumps to increase the reach of charging primarily through battery swapping option. OLA Electric Mobility and Sun Mobility have already tied up with Indian Oil Corporation (IOC) for battery swapping stations while VoltUp has tied up with Hindustan Petroleum Corporation Ltd (HPCL) for 50 battery swapping stations. Similarly, Bharat Petroleum Corporation Limited (BPCL) has partnered with EV-maker Kinetic Green Energy and Power Solutions and IIT Madras for technology support, for supply of swappable lithium-ion batteries at its retail outlets in Kochi and Lucknow in the first phase for e-3Ws.

3. **With shop owners**: e-2W Companies (like Ather) are opting for decentralized charging systems where they have tied up with shop owners in many instances to use part of their space for the chargers or tied up with kirana stores for battery swapping (like Bounce).

- **Community Charging Stations**: There has been an increasing trend of setting up of EV charging stations known as community charging stations by hotels, businesses, or resorts which are at a distance of 40-70 km around cities to setup normal 15 Amp charge points for electric cars and electric bikes. This phenomenon has been captured and supported by initiatives such as PluginIndia, a community of EV users and enthusiasts in India who have been promoting EVs since 2013. Around 257 such community charging stations existed as of January 2020 across India, with routes such as the ones between Mumbai and Nashik, Mumbai and Pune (up to Mahabaleshwar, Delhi and Jaipur, Bengaluru to Mangaluru, and Chennai to Mahabalipuram.

- **Charging Plazas**: In order to boost the e-mobility ecosystem in India and availability of charging facilities at public places,

there has been an advent of charging plazas with India's first public charging plaza already inaugurated on July 20, 2020 at Chelmsford Club, New Delhi, by EESL. The charging plaza is capable of charging 14 electric cars at the same time. Technically, a plaza has more than one charger with different types of power output for servicing different kinds of automobile models. EESL has plans to install around 10 EV charging plazas during the 2020-21 fiscal.

Challenges

India's infrastructural challenges are unique, and, hence, the best e-mobility practices identified in advanced international markets might not be effective or feasible to address India's problems. The approach to tackling the challenges and thereby developing solutions needs to be home-grown or tailor-made for Indian cities.

End-User challenges

- **Range Anxiety**: For an EV user, range anxiety deals with the concern for the number of kilometres an EV will run i-e- how long will the battery power last. In India, a primary factor investigated thoroughly before purchasing an ICE vehicle is its mileage i-e- number of kilometres per litre. Many EV users like to travel long distances on a single charge, which is not feasible with the current battery technology installed in electric cars. A recent study by lubricants major Castrol on 1,000 consumers, fleet managers, and industry specialists across India indicate that drivers expect a range of 401 km from a single charge.

- **Time Anxiety**: Customers are keen to charge as quickly as they can refuel a petrol tank, which is not feasible with the current charging technologies especially with the slow charging technologies. The study by lubricants major Castrol indicate that drivers expect a 35-minuite average charge time and not more than that.

- **Charge Anxiety**: Charge anxiety is about whether or not the EV will find a charging station in the first place. This is followed by the issue of trust. In case of a gas station, for instance, people in India often check the meter twice even before filling the tank; similarly, they have trust issues with electric charging stations such as whether the vehicle is getting charged or not and whether the charging station is working properly.

CPOs

- **Sub-optimal Utilization Rates** of ~10-15% at public charging stations, considering a fast charging station charges a car in ~1.5 hours and not more than 2-3 cars coming in on any given day, do not compare with the huge capital that has been invested in. The CAPEX per station excluding land cost/rent in the current situation where 6 guns are required to be installed, comes out to be ~12 Million considering average cost of Rs. 2 Million per charging gun. These high costs associated with the equipment and its installation acts as the major challenge when the returns are not substantial owing to utilization rates being quite poor. The utilization rate in turn is low because of not-so encouraging EV numbers on road. Taking into account the current trend including the FAME II scheme and its benefits, the number of EVs on the roads are not expected to be exciting enough, till say 2024, to look at operating charging infrastructure as a stand-alone business.

- **Land banks** including parking spaces in right corners of the cities has been one of the bottlenecks that the government till now has failed to address. Even the state enterprises have been facing the issue of procurement of land even though they get the land for free of cost as per the government order. In addition, there have been no fixation of charges, leading to high rental costs. For instance, in certain cases, land lease alone is said to constitute more than 40% of the operational cost of a charging station.

- **FAME II** requires having atleast 2 chargers of ~100kW each on every PCS which works fine in a state like Delhi that considers this much power under the low tension (LT) connection. However, in a state like Gujarat/Uttar Pradesh that considers limit of LT connection as ~50kW, the concerned CPO will have to go for high tension (HT) connection and in the process, install cables, transformers etc.. The price of latter is 2-3 times more than the subsidy it is getting. So, the whole effort goes in for a toss.

Private Fleet Operators

- Obtaining a reliable electricity connection for an EVSE installed at the EV charging station that is owned and operated by fleet operators is a concern.

- The cab aggregators/fleet operators operating in multiple states find it difficult when different tariffs for EV charging are charged in different states with many states declaring EV as a separate tariff category.

DISCOMS

- **Distribution network and frequent overloading of system components**. The issue of increase in peak load of the service areas will require more investment in network up-gradation and procurement of power which will not be profitable for DISCOMs in the long run.
- **Unpredictable electricity demand**, given the consumers charge their vehicles at various locations and for varying periods. This will impact the grid in terms of power quality. Further mass adoption of EVs will lead to skewed nature of power demand which in turn will lead to issues including unforeseen peaks in power consumption including transformer overload, voltage drop and voltage imbalance, along-with harmonics injection.

Key Players

List of key CPOs based on count of charge points

Charge Point Operator	Description
VOLTTIC	Noida-based Volttic, a trademark product of Tvesas Electric Solutions Pvt. Ltd., offers EV Charging Services including EV Charging Stations and Cloud-based Charger management system. The Company's core business is EV charging (commercial charging and home charging) where it entered in the year 2017. Commercial Charging: The primary clientele here includes fleet operators especially employee transporters that offer fleet services to Companies like Fidelity, Infosys, and Wipro. Home charging: Volttic doesn't own the set-up here and only sell out the required infrastructure. **Location**: The Company has pan-India presence in metro cities including Delhi-NCR, Mumbai, Pune, Hyderabad , Bangalore, and Chennai. Volttic chargers are currently operating at corporate offices of Infosys, Mckinsey, Fidelity ,HP Computing, TESCO, JP Morgan, and Amazon along with having public installations at Indore,Mumbai, Delhi, and Gurugram. **Vehicle-Type**: Volttic solutions support all types of EVs - 2W, 3W, 4W, and electric buses. Volttic chargers range from 3.3 kW to 22 kW on AC side where as DC fast charger ranges from 15 kW to 150 kW. **Order Value**: Volttic already boasts of orders worth ~USD 1 Million. The company is planning to deploy 25,000+ fast charge points by 2025 across Indian cities. **Charge points Installed:** 190+
CHARGE+ZONE™ AN EV CHARGING COMPANY	It is a Vadodara-based start-up, part of TecSo Global group, and operational since 2018; It received pre-Series A Funding of USD 3 Million in November, 2020. The Company recently acquired the battery swapping stations of OlaElectric. **Charger Type**: Type 2 Fast DC and Fast CCS2 150 kW DC (for electric bus) **Clients**: Ashok Leyland, EEE-Taxi, Shuttl, SmartE, BluSmart, Bajaj Auto **Charge points Installed:** 210+
REIL	A joint venture (JV) between the Government of India & the Government of Rajasthan, it is one of the leading state-held players in the EV charging infrastructure space. **Charge points Installed:** 800

Charge Point Operator	Description
Fortum charge & drive	It is a subsidiary of Finland-based clean-energy Company, Fortum and has been in operation since the end of 2017. **Vehicle Type and Locations:** The Company offers public charging specifically for e-4W and fleet operators and operates in 7 Indian cities as of now. **Charger Type**: Primarily fast dc charging points (DC-001) followed by CHAdeMO and CCS **Clients**: MG (Morris Garages) Motor India, Indian Oil, Hyderabad Metro, GoMechanic **Diversification Plans**: The Company has plans to come up with ~250-300 charge points every year. It is working with Swedish light EV manufacturer Clean Motion to jointly develop a battery swap system tailored specially for light EVs – taxis – such a station is already installed at DLF Mall of India, Noida. **Charge points Installed:** 100
TATA POWER SOLAR	TATA Power is operational at the entire value chain of conventional & renewable energy. It offers end-to-end customized solutions for EV charging including EV Chargers of different charging standards, Backend Power Infrastructure, Charger Installation, Charger Management Software Platform Subscription, Annual Maintenance, and Mobile App. **Charging Segment**: Public Charging **Charger Type**: AC/DC (7 kW to 50 kW); CCS2 standard **Clients**: Prakriti E-Mobility Private Limited, MG Motor India, TATA Motors, Jaguar Land Rover (India) **Charge points Installed:** 300
EESL Energy and Environmental Simulation Laboratory	It is a JV of 4 PSUs - Power Finance Corp. Ltd., NTPC Ltd., POWERGRID Corp. of India, REC Ltd.; formed to offer renewable energy services. Services offered include procuring EVs for deployment in Government Departments and Ministries and setting up charging infrastructure **Charging Segment:** Public and Captive Charging **Charger Type:** DC-001/AC-001 **Clients**: NDMC Delhi, CMRL Chennai, Maha Metro Nagpur, Noida Authority, SDMC Delhi, Naya Raipur Development Authority, NKDA Kolkata **Charge points Installed:** 1200
EVI Technologies	EVI Technologies, a startup incubated in June 2017, at the government-funded Electropreneur Park in Delhi. EVIT offers its charging stations on lease for private users. It offers has two products—a battery for e-2W and e-3W and a charging point which can be set up at both public places and homes. EVIT has developed VCube EV Charging Station capable of charging EVs in less than 80 minutes. The Company won orders for 50 charging stations from EESL in December 2017. **Charger Type**: AC (slow) – AC Type 2 Charger and AC-001 Charger; DC (fast) – Li-ion charger for e-3W and DC-001 Charger; Battery Swapping **Locations**: 16 different locations in 10 states **Charge points Installed:** 215

Basis the number of chargers installed, the overall experience in the charging infrastructure space in India and abroad, and the tenders won, the key charger OEMs have been identified as follows:

Charger OEMs

Charger OEMs	Description	Clients	Installations/Plans
Delta Electronics	Delta Electronics India, part of Taiwan-based Delta Group and a subsidiary of Delta Electronics (Thailand) PCL, has been operating in India, since 2003 as a Power and Energy management company with focus on Power Electronics, Automation, and Infrastructure. The EV Charging Solutions offered by the Company include AC EV charger, DC quick charger, and Site Management System. AC and DC EV Chargers start from 3.3 kW up to 150 kW	• Maharashtra Mantralaya • EESL • NTPC • PowerGrid Cooperation Delhi • SDMC Office • Gujarat Bhavan Delhi • Ministry of Health	Established 700 chargers as of December, 2019. Under EESL tender, as of 2019, BHEL and Delta had to supply 100 DC chargers
Exicom Tele-Systems	Exicom, founded in 1994, is operational in 3 key business areas of storage, telecom, and green mobility. The Company established new BUs of EV Battery and EV Chargers in 2018. The EV charging product portfolio of Exicom includes Bharat EV DC Charger 15kW/ 20kW; Bharat EV AC Charger 9.9kW; Type 2 AC Charger 7.5kW/ 11kW/ 22kW; and Harmony - Fast combined AC & DC Charger. The Company offers complete range of EV charging solutions including AC, low and high voltage DC fast chargers, and portable chargers.	• EESL • REIL • NTPC	• Installed 125 chargers as of January, 2018. • Won EESL tender in May, 2018 to supply 100 DC fast chargers of 15kW and 1,080 AC chargers of 3.3kW • Won EESL tender in November 2019, for 200 122-150 kW CCS/ CHAdeMO/Type 2 AC PCS fast chargers. • Won NTPC tender in August 2018 for development of EV DC charging infrastructure comprising of 120 kW and 50 kW CCS chargers for e-buses at Jabalpur, Madhya Pradesh.
ABB	Betting big on the EV market in India and ABB is considering to locally manufacture EV charging equipment out of its Bangalore facility. ABB has tied up with local partners to offer public charging stations across Ludhiana, Delhi, Chennai, Coimbatore, Nagpur. ABB India manufactures chargers for passenger cars as well as buses.	EV Motors India	Installed ~10 chargers as of now It installed its first EV charger (ABB Terra 53, a 50kw fast charging station) in India at the NITI Aayog building in Delhi in February, 2018.

Charger OEMs	Description	Clients	Installations/Plans
Okaya Power Pvt. Ltd	Okaya is a leading player in the Indian Battery Manufacturing Industry. The diverse product portfolio of the Company includes Tubular Battery- Inverter Battery and Solar Battery, E-Rickshaw Battery, as well as Lithium and EV charging solutions. The Company offers AC/DC chargers as well as off-board AC charger for use at residential locations and offices for personal use.	• REIL • EESL	• Bagged contracts for 5,264 charging stations in November, 2020 and January, 2021 alone. • Contract from Power Grid, for 55 Multi-Standard EV charger (100 kW) in Shillong, Meghalaya and of 200 multi-standard EV chargers between 122-150 kW, 10kW AC slow chargers and 15kW DC fast chargers in November, 2019. • It has over 10,000 charger installation orders and had completed over 500 till November, 2020.

Conclusion

With strong government thrust for EV transition and hence EV charging infrastructure, the key stakeholders have been encouraged to drive the market growth on the back of proper regulatory mechanism and industry initiatives. EV policy incentives of various states as well as central initiatives including lowering of GST rates and introduction of FAME schemes have been able to set up an initial base for private players – CPOs, equipment manufacturers, cab aggregators, and other such players – to operate efficiently.

The Companies are however facing challenges in terms of paying fixed capacity charges based on connection capacity (kVA or kW) in states like Maharashtra, Haryana, Jharkhand, Gujarat, Chandigarh, and Karnataka. The infrastructure set up by these players have been lying under-utilized owing to lesser number of EVs on roads. Therefore, there should be minimum/no capacity (fixed monthly) charges on EV tariffs in the initial 3 to 5 years for CPOs as volumes will be very low and the capacity will be barely utilized. In addition, the government needs to plan for increasing the number of EVs on road by say, buying a greater number of EVs than what it is already doing through EESL for the different government departments. In addition, the government can even decide to lease such vehicles in cases where budget constraints do not allow for outright purchase. As per CPOs, only an increase in number of EVs will lead to more utilization of already installed chargers and hence encourage private players to enter the market and already existing players to increase the installed capacity. Lastly, there needs to be clearly defined market rules as regards which stakeholders pays for which element) in charging infrastructure, for instance, if CPO needs to pay for public/private land. Similarly, if fleet operators need grid optimization for accommodating charging in say an office building for 20 vehicles then who pays for that element. This will help strike a balance of optimum investment and maximum returns between the service providers and the service users over the long run.

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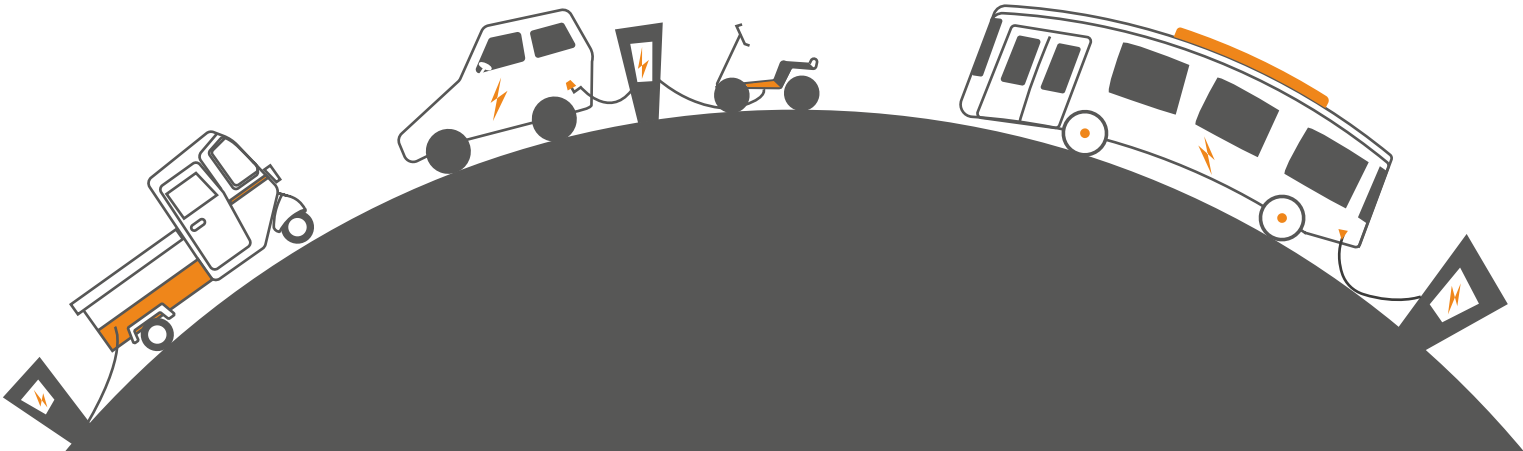

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