Tamil Nadu Public Charging Infrastructure Guidelines

September 2025

Prepared by

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Public Charging Infrastructure Guidelines

Tamil Nadu

Foreword

Tamil Nadu has emerged as the undisputed EV Capital of India, producing 40% of the country's EV four-wheeler production and a staggering 70% of its EV two-wheelers. From Hosur to Thoothukudi, powerful industrial corridors are fuelling the rise of new-age mobility. Global and national players like Ola, Ather, TVS EV, Ampere Electric, Tata JLR, VinFast, Hyundai EV, and Tata-JLR have chosen Tamil Nadu as their preferred destination.

This transformation has been powered by visionary policy and excellent investment facilitation by Guidance Tamil Nadu. The Tamil Nadu EV Policy 2023, with generous tax exemptions, charging infrastructure mandates, and a push for e-mobility in urban transport, is creating both demand and robust infrastructure.

Tamil Nadu's industrial growth story is rooted in the idea that development must ultimately improve people's lives. As we look into the future, we see electric mobility as not just a technological shift, but as a social and economic opportunity. The creation of a strong public charging infrastructure is central to enabling this transition in a way that delivers benefits to all.

We are also keen on creating high-end and high-value jobs. From skilled technicians and energy system operators to young entrepreneurs and digital service providers, the ecosystem around electric mobility holds immense potential for better livelihoods. A well-designed charging network enables this by supporting local industry, driving demand for new skills and ensuring equitable access to clean mobility.

The Public Charging Infrastructure Guidelines offer a practical roadmap for rolling out this infrastructure in a way that is inclusive, scalable and responsive to the needs of both users and investors. It brings together technical clarity, institutional roles and urban planning insight, elements necessary to guide coordinated action across the State.

I appreciate Guidance Tamil Nadu and ITDP India for this timely and well-curated document. It reflects our shared commitment to ensuring that Tamil Nadu's industrial progress continues to empower people, protect the environment and position the state as a leader in future-ready development.

Dr. TRB Rajaa
Hon'ble Minister for
Industries, Investment Promotion and Commerce
Government of Tamil Nadu

Foreword

The rapid evolution of electric mobility presents both an opportunity and a responsibility. For a state like Tamil Nadu, with its strong industrial base and leadership in clean energy, the task is not only to enable adoption but to ensure that the transition is orderly, inclusive, and backed by resilient infrastructure.

The Public Charging Infrastructure Guidelines are an important step in this direction. It is designed to help public institutions, utilities, and private enterprises work in sync, with a well collated comprehensive document that covers every aspect of charging infrastructure implementation. What distinguishes this effort is the way it translates a complex challenge into actionable guidance that different agencies and stakeholders can readily use.

For the Industries Department, this initiative represents more than just supporting the growth of a new sector. It is about ensuring that the benefits of electric mobility extend across the economy, strengthening supply chains, creating opportunities for small and medium enterprises, and enhancing the competitiveness of Tamil Nadu as a destination for sustainable industry.

The success of this endeavour will depend on continued collaboration. Local governments, energy providers, automobile companies and communities all have a role to play in expanding access to charging infrastructure. With the right partnerships, Tamil Nadu can set a benchmark for other states by building a charging ecosystem that is efficient, equitable and future-ready.

I am confident that these guidelines will support decision-makers in building a charging ecosystem that reflects both the dynamism of our industries and the aspirations of our people. I thank all partner institutions who have contributed to shaping this document and urge stakeholders across the board to take full advantage of it in accelerating Tamil Nadu’s transition toward clean mobility.

Mr. Arun Roy V, IAS
Secretary to Government
Industries, Investment Promotion & Commerce Department
Government of Tamil Nadu

Foreword

Tamil Nadu is steadily advancing toward a cleaner mobility future, guided by a vision to build a sustainable and future-ready economy. As the nodal agency for investment promotion and facilitation, Guidance Tamil Nadu has been deeply committed to enabling this transformation by fostering an environment where innovation, industry and infrastructure work in tandem to build a cleaner and future-ready ecosystem.

Tamil Nadu has emerged as the EV capital of India, home to a robust manufacturing ecosystem that spans electric two-wheelers, cars, buses, and components, supported by strong supply chains and skilled manpower. Equally important, the state is witnessing a surge of investments in battery technologies and energy storage systems, which are at the heart of the electric mobility revolution. The state has consistently attracted major domestic and international investments in this sunrise sector, reinforcing its position as a preferred destination for green industries. For Guidance Tamil Nadu, electric mobility represents not just a growth opportunity but a chance to align industrial development with sustainability and future-ready investments.

The Public Charging Infrastructure Guidelines for Tamil Nadu, developed in partnership with ITDP India, build on this momentum by providing a clear roadmap for creating a robust, safe, and equitable network of charging stations across the state. From defining technological standards to offering site planning typologies, the guidelines equip stakeholders with practical tools to accelerate deployment on the ground. We commend ITDP India for its technical expertise and partnership in preparing this timely and thoughtful document.

We believe that this document will serve as a reference point for public officials, industry partners, urban planners, and community leaders, not just within our state, but across India, as we collectively work toward a cleaner and smarter future.

Dr. Darez Ahamad, IAS
Managing Director & Chief Executive Officer
Guidance
Government of Tamil Nadu

Foreword

Tamil Nadu has always been a pioneer in building sustainability into its development landscape. Though the transportation sector is fundamental to economic progress, it continues to be one of the major contributors to air pollution and climate change. The state has taken many initiatives to mitigate the impact of the transportation sector on climate change. Tamil Nadu came up with an EV policy in 2019 which was further revised in 2023.

The adoption of EVs continues to be a challenge for various reasons. One of the major initiatives being taken up by the state to improve EV adoption is to promote semi-public and public charging infrastructure. In this context creating a uniform guideline becomes essential, underscoring the significance of the Tamil Nadu Public Charging Infrastructure Guidelines.

I am confident that this document will serve as a reference and catalyst for cities, and service providers seeking to accelerate Tamil Nadu's clean mobility transition. The TNGECL is committed to supporting these efforts as a technical anchor and institutional bridge, bringing energy expertise, robust planning, and a spirit of partnership in every stage of implementation.

I sincerely appreciate the combined efforts of our teams at TNGECL, Tamil Nadu Power Distribution Corporation Limited (TNPDCL), Guidance Tamil Nadu, and ITDP India in bringing these guidelines to fruition. I encourage all stakeholders to make full use of this resource as we work together for a cleaner, more sustainable future for Tamil Nadu.

Dr. Aneesh Sekar S, IAS
Managing Director
Tamil Nadu Green Energy Corporation Limited (TNGECL)
Government of Tamil Nadu

Acknowledgements

We extend our sincere thanks to the Industries Department of the Government of Tamil Nadu, Guidance Tamil Nadu, Tamil Nadu Green Energy Corporation Limited (TNGECL), Tamil Nadu Power Distribution Corporation Limited (TNPDCL) and Sandeep Gandhi Associates for their continuous support and invaluable input throughout the development of this report. Their expertise has been crucial in shaping this comprehensive guideline document.

Background

Public charging infrastructure plays a pivotal role in facilitating the widespread adoption of electric vehicles (EVs). The successful integration of EVs into mainstream usage greatly depends upon the systematic development of accessible and widespread public charging facilities. This necessity is especially evident in densely populated urban areas, where home-based charging has limited access, making public charging infrastructure a key enabler for EV adoption.

In the light of rapidly growing electric mobility industry, there exists an urgent need for comprehensive guidelines outlining the methodology to establish a public EV charging infrastructure. In the same attempt, this guideline provides a step-by-step approach to setting up a public charging infrastructure. The guideline content covers various aspects starting from the introduction of the electric vehicle (EV) charging ecosystem and covering a range of specifics such as EV charging requirements, technologies involved in EV charging, assessment of EV charging demand, EV location planning, and the adherence to bye-laws and standards during the setup of public charging infrastructure.

The guideline is divided into two parts:

Part 1: EV Charging Ecosystem

This part provides an overview of the EV charging ecosystem, covering all the essential theoretical components for implementing the guidelines. It includes terminologies, technologies, classification, standards and bye laws related to EV charging infrastructure.

Part 2: Planning and Implementation Guidelines for Charging Infrastructure

This part outlines the practical approach for estimating the number of charging points and stations within a city. It further addresses the planning and site identification processes, emphasising the necessary steps for the installation of public charging infrastructure. Additionally, it encompasses the charging infrastructure requirements according to specific site typologies.

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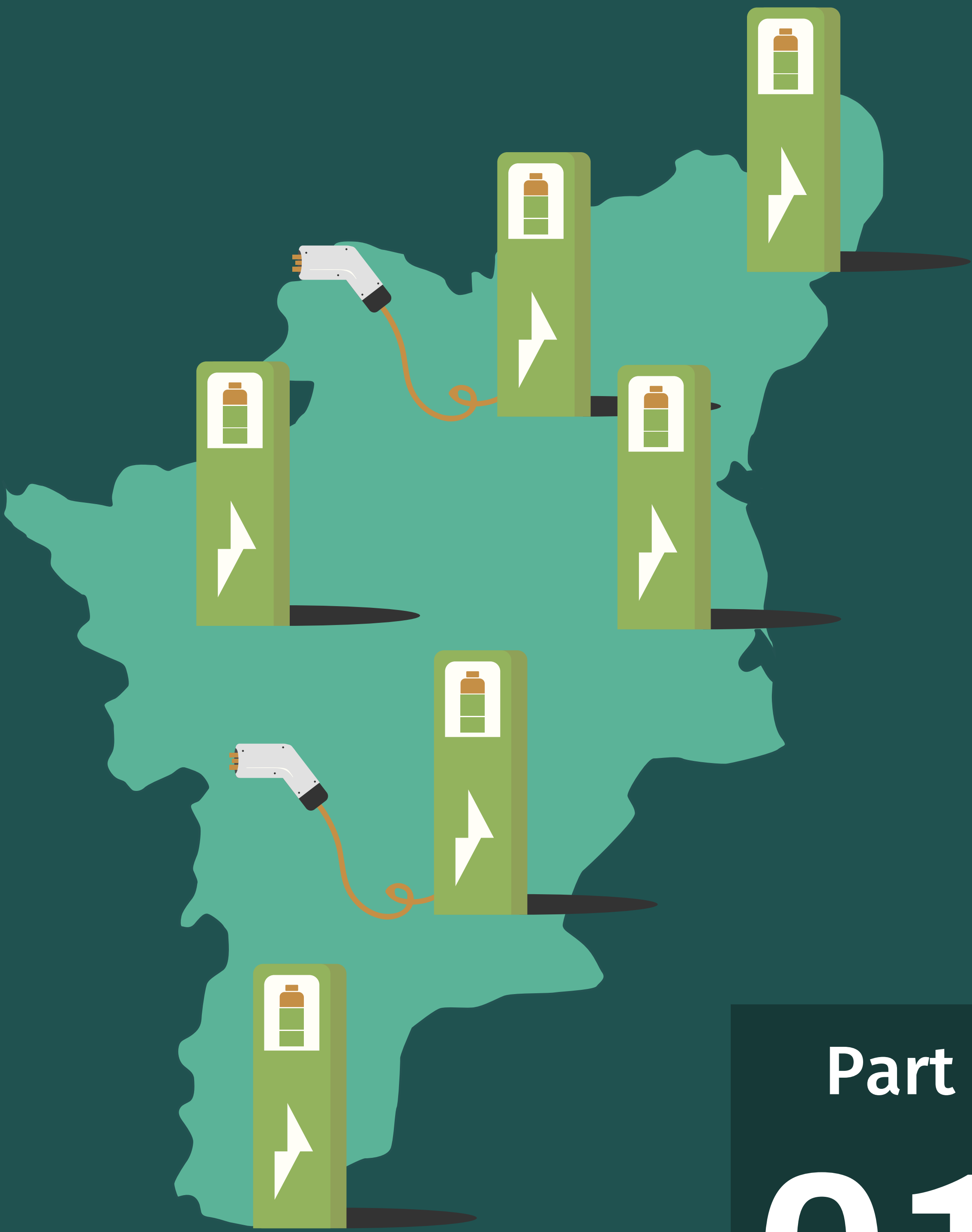
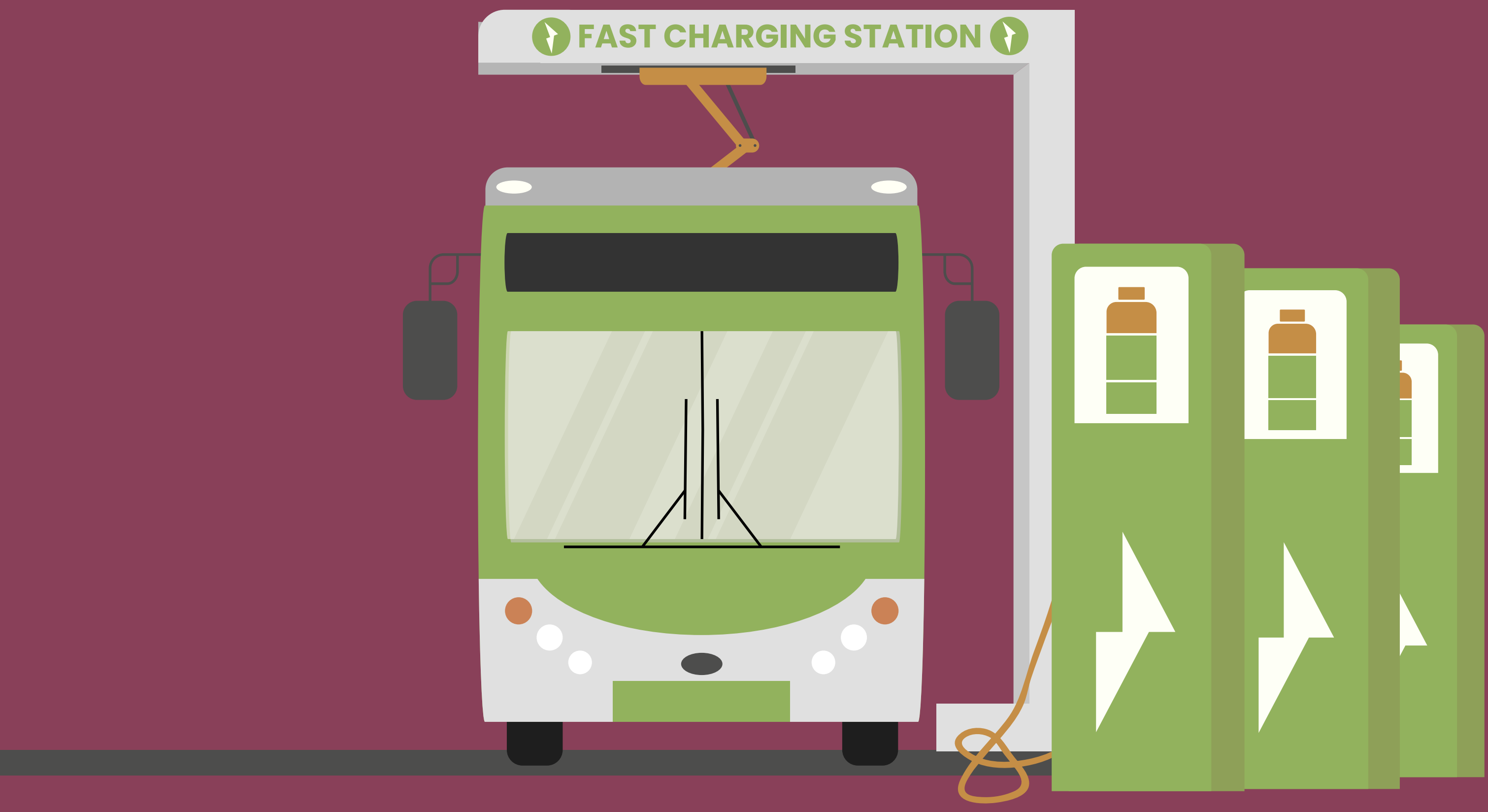
2 W	Two-wheeler
3 W	Three-wheeler
4 W	Four-wheeler
AC	Alternating Current
Amp	Ampere
BIS	Bureau of Indian Standards
CCS	Combined Charging System
CHAdeMO	Charge de Move
CPO	Charge Point operator
CS	Charging Station
DC	Direct Current
DISCOM	Distribution Company
DT	Distribution Transformer
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FC	Fast Charger
HT	High Tension
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
kWp	kilowatt peak
LT	Low Tension
MBBL	Model Building Bye-Laws
MoP	Ministry of Power
MoHUA	Ministry of Housing and Urban Affairs
OEM	Original Equipment Manufacturer
PCS	Public Charging Station
RoW	Right of Way
SC	Slow Charger
SoC	State of Charge
TNEI	Tamil Nadu Electrical Inspectorate
TNERC	Tamil Nadu Electricity Regulatory Commission
TNPDCL	Tamil Nadu Power Distribution Corporation Ltd
TNGECL	Tamil Nadu Green Energy Corporation Ltd



Part

01

EV Charging Ecosystem



01

EV Overview and Introduction

1.1. The Global Transition into Electric Vehicles

By the end of 2020, the global fleet of Electric Vehicles (EV) reached 10 million units, constituting 1% of the total global vehicle stock. EV sales are expected to exceed 40 million units by 2030, representing more than 30% of all vehicle sales for that year.[1]

The year 2021 represented a pivotal moment for EV sales, with the number of new electric vehicles sold doubling compared to 2020. This substantial growth is presented in *Figure 1*

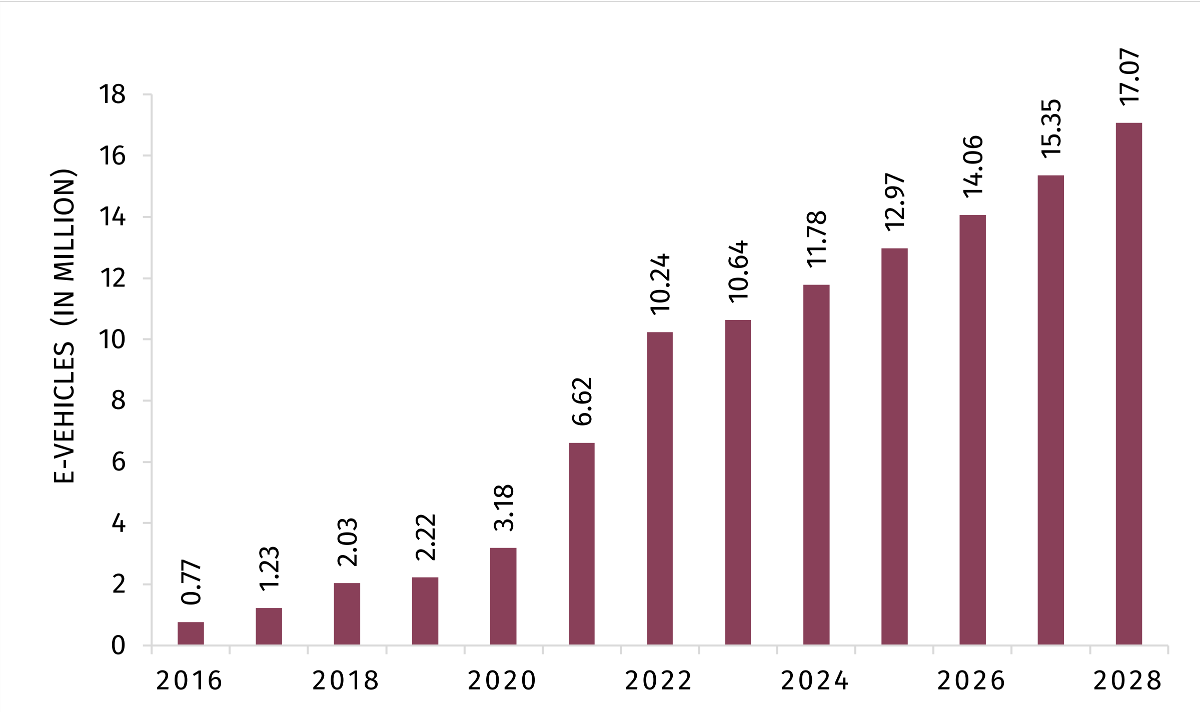


Figure 1 - Global EV Sales: Historical data (2016-23) and future projections (2024-28)[2]

EVs in India currently represent a small share (1.7% of the total registered vehicles[3]) as the country is at an early stage of EV adoption. However, more than 30% of new vehicle registrations are expected to be EVs by 2030.[4] India's EVs recorded a strong growth in the year 2022 as presented in *Figure 2*.

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[1] IEA. (2021). Accelerating ambitions despite the pandemic. *Global EV Outlook 2021.*
[2] Statista Market Insights, September 2023
[3] Vahan Dashboard. (2023). Vahan Dashboard. https://vahan.parivahan.gov.in/vahan4dashboard/vahan/dashboardview.xhtml
[4] NITI Aayog, Ministry of Power (MoP), Department of Science and Technology (DST), Bureau of Energy Efficiency (BEE), & WRI India. (2021). Handbook of electric vehicle charging infrastructure implementation (1st ed., Vol. 1).

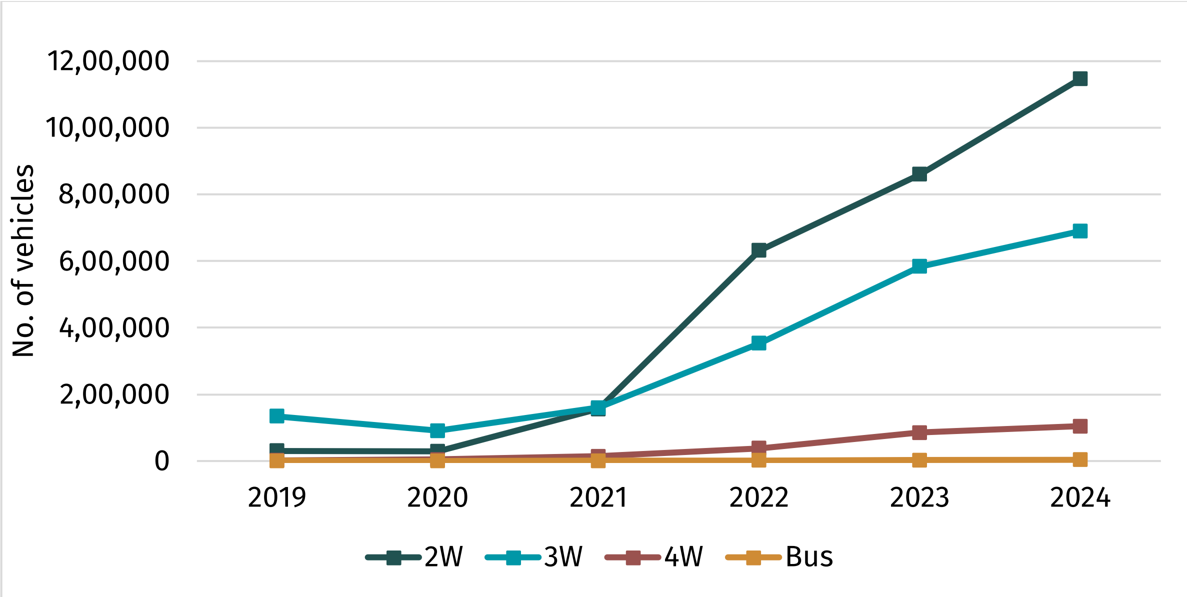


Figure 2 - EV registrations in India[3]

As of December 2024, India has recorded a cumulative sale of close to 55 lakh EVs from 2014 to 2024[3]. Electric two-wheelers (E-2W) dominate the market, accounting for nearly 51% of all EVs sold in the country. This is followed by passenger electric three-wheelers (E-3W including e-rickshaws), which make up approximately 39% of the Indian EV market (*Figure 3*).

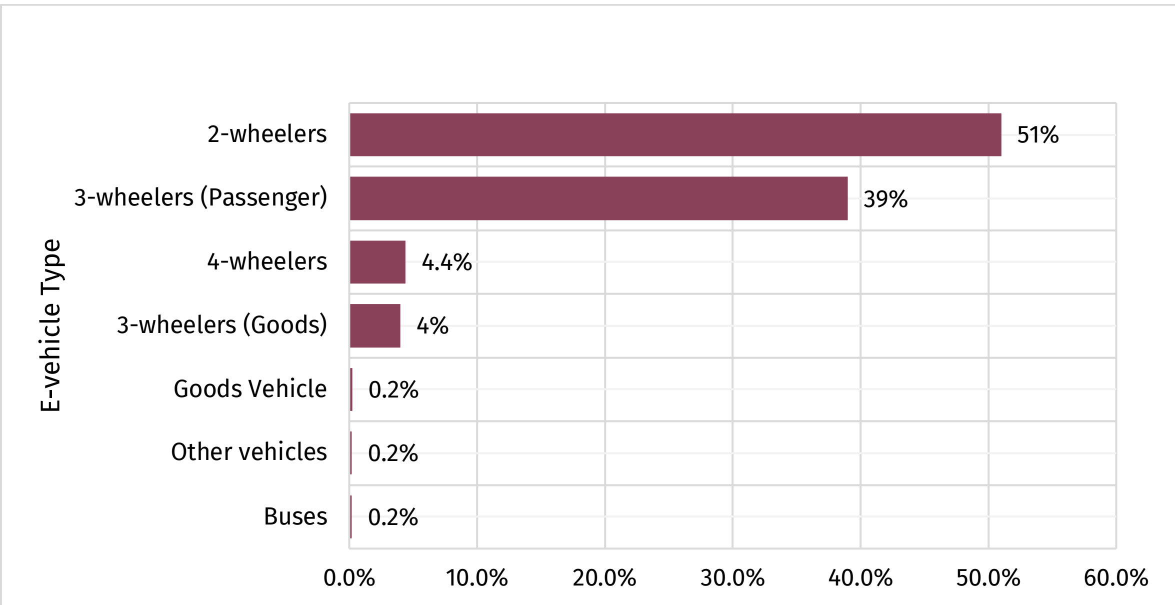


Figure 3 - Sale of EVs in India (2014 to –2024)[3]

1.2. Types of EVs

Any vehicle with an electric motor which can be powered by battery storage, fuel cell, photovoltaic array, or any other source of electric current, is called an Electric Vehicle (EV).

EVs can be categorised based on the number of wheels and engine type. They are classified as two-wheelers (2W), three-wheelers (3W), four-wheelers (4W), trucks, buses, and mobile machinery. Additionally, the United Nations Economic Commission for Europe (UNECE) introduced a classification system in 2017 that categorises EVs into three groups:

1. **Category 1** includes power-driven vehicles with four or more wheels designed primarily for transporting people.
2. **Category 2** encompasses power-driven vehicles with four or more wheels designed primarily for transporting goods, including mobile machinery.
3. **Category 3** consists of power-driven vehicles with two or three wheels for transporting persons and/or goods.

Electric vehicles can also be classified based on their engine type, with four categories described below.

1.2.1. Battery EV (BEV)

1. **Engine and propulsion:** BEVs are entirely electric vehicles that rely solely on an electric motor for propulsion.
2. **Charging characteristics:** These vehicles are charged by plugging them into an external electricity source, such as a home charger, public charging station, or high-speed DC fast chargers. BEVs also utilise regenerative braking, which captures and converts kinetic energy during braking back into stored electrical energy.
3. **Utilisation:** BEVs are typically used for daily commuting, city driving, and shorter trips due to their reliance on battery capacity for range.
4. **Storage capacity:** BEVs have large battery packs, typically ranging from 3kWh to 470kWh or more, depending on the vehicle type and model. This storage capacity directly influences their driving range.

1.2.2. *Hybrid EV (HEV)*

1. **Engine and propulsion:** HEVs combine a conventional internal combustion engine (ICE) with an electric propulsion system. The electric motor assists the ICE, reducing fuel consumption and emissions.
2. **Charging characteristics:** HEVs do not require plugging into an external power source for charging. Instead, they rely on regenerative braking and ICE to generate electricity and recharge the onboard battery while driving.
3. **Utilisation:** HEVs are versatile and suitable for various driving conditions, including city driving and longer trips. They benefit from the extended range provided by the ICE while gaining efficiency from the electric motor.
4. **Storage capacity:** The battery capacity in HEVs is smaller compared to BEVs, usually around 1kWh to 2kWh. This smaller battery provides sufficient energy for short bursts of electric-only driving and assists the ICE to improve overall efficiency.

1.2.3. *Fuel Cell EV (FCEV)*

1. **Engine and propulsion:** FCEVs use hydrogen as fuel, which is converted into electricity through a fuel cell stack. This electricity powers the electric motor for propulsion.
2. **Charging characteristics:** FCEVs are refuelled with hydrogen gas at specialised refuelling stations, that are like conventional gasoline refuelling stations and typically take only a few minutes. They also utilise regenerative braking to capture and store energy.
3. **Utilisation:** FCEVs are suited for a range of driving conditions including longer trips, due to their quick refuelling times and extended driving range.
4. **Storage capacity:** FCEVs have smaller battery packs compared to BEVs, typically around 1kWh to 2kWh, which are used to store energy from regenerative braking and to buffer power from the fuel cell stack. The hydrogen tanks store the primary energy source, with a typical range of 450 to 650km per refuel.

1.2.4. *Plug-in Hybrid Electric Vehicle (PHEV)*

1. **Engine and propulsion**: PHEVs combine a conventional internal combustion engine (ICE) and an electric motor. The electric motor can work independently or with the ICE, enhancing efficiency and reducing emissions.

2. **Charging characteristics**: PHEVs can be plugged into external power sources (home outlets, EV chargers, and public stations) and use regenerative braking to capture energy. Charging times range from two to eight hours with Level 1 (120V) or Level 2 (240V) chargers.
3. **Utilisation**: PHEVs are versatile, suitable for short trips on electric power alone, and longer trips using the ICE for extended range. This flexibility makes them a practical choice for various driving needs.
4. **Storage capacity**: PHEVs have batteries typically ranging from 8kWh to 20kWh, providing an electric-only range of 30 to 80km. They also have a conventional fuel tank, allowing for a total range that can exceed 480km.

1.3. EV Specifications

Charging infrastructure development needs to be accelerated to cater to the rapid growth of EVs in India. The demand for charging infrastructure and their specifications are governed by the specifications of EV models and their utilisation. Hence, for planning the charging infrastructure, an understanding of current and future EV demands and models is necessary.

Specification and standards of EV chargers vary in each country based on the technology of EV models available in the market. As various EV models have different battery capacities and power input demands, they require different types of chargers and connectors. The battery capacity and stated range for currently available EV models are presented in Table 1.

Vehicle Segment	Battery Capacity KWH		Stated Range in KM	
	Minimum	Maximum	Minimum	Maximum
2W	3	8.2	50	250
3W (Passenger)	3.6	12.4	80	151
3W (Goods)	3.6	12.4	80	151
Car (Personal)	15	112	110	857
Car (Commercial)	15	71.7	110	600
4W (Goods-LGV)	17.2	62.5	120	250
4W (Goods-MGV)	40	100	150	250
Truck	62.5	300	150	350
Bus	60	470	70	350

Table 1 - Specifications for currently available EV models[5]

[5] Market survey by SGA

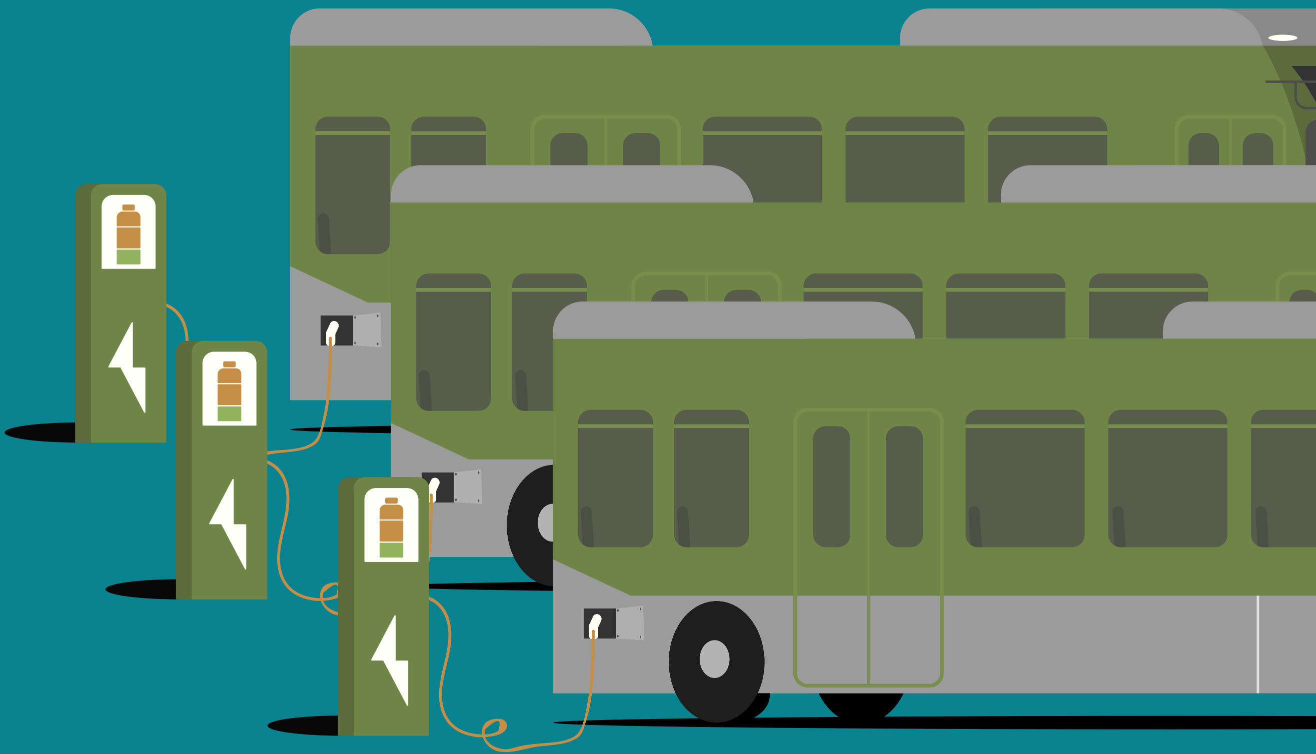
1.4. Classification of Vehicle Use by Typology

Based on their vehicle segment, EVs have unique requirements for charging including charging location, charging station type, charging behaviour, and the share of charging demand that needs to be met by public charging. For example, personal electric cars charge more frequently at residences or offices, while commercial electric cars rely more on public charging preferring public and semi-public charging locations. Table 2 (below) categorises EVs based on their typology (e.g., private or commercial) and lists their charging requirements.

Typology	Type of charger AC/DC[6]	Share of charging demand met by public charging[6]	Typical charging behaviour[7]	Desirable charging location[7]	Desirable charging station type[7]
Two-Wheeler	AC/DC	**10%**	Daytime and nighttime	Private Residences	Private/ Semi-Public
Three-Wheeler (Passengers)	AC/DC	**20%**	Slow charging speed at night Fast charging during day	On-street/ Off-street	Public/ Private night charging
Three-Wheeler (Goods)	AC/DC	**20%**		On-street/ Off-street	Public/ Private night charging
Car (Personal)	AC/DC	**10%**	Daytime and nighttime	Residences /Offices	Private/ Semi public
Car (Commercial)	AC/DC	**25%**	Slow charging speed at night Fast/High charging speed during day	On street/ Off street	Semi-public/ Public
Four-Wheeler Goods (LGV & MGV)	DC	**20%**		Off street	Public
Trucks	DC	**70%[8]**	High charging speed both at night and day	Transit station	Public
Bus	DC	**60%[9]**	High charging speed both at night and day	Transit station	Public/ Semi public

Table 2 - Classification of vehicle use by typology

[6] NITI Aayog, Guidelines & standards for EV charging infrastructure
Handbook of electric vehicle charging infrastructure implementation (NITI Ayog)
[7] Market survey
[8] Gandhi, H., Sharma, P., Chattopadhay, G., 2019. Road turns rough for small fleet operators. Mumbai.and market survey by SGA
[9] Gandhi, S., Ahmed, F., Singh, S., Jayaraman, S., Ganguly, S., 2023a. Roadmap for Private Sector to Transition to Electric Buses. Chennai.



02

Introduction and Classification of EV Charging Infrastructure

Charging infrastructure can be defined as a location where EVs can be parked and connected to an electricity source for recharging, using an Electric Vehicle Supply Equipment (EVSE)[10]. To enable faster adoption of EVs, it is crucial to establish a charging infrastructure ecosystem that is safe, reliable, accessible, and affordable. Additionally, public charging infrastructure (i.e. charging infrastructure accessible to the public) is critical to achieve EV adoption to attract potential owners who don't have private charging and parking facilities at their residences or workplaces.

2.1. Classification of Charging Infrastructure

Charging infrastructure can be classified into public, semi-public, and private categories based on different parameters such as level of access, tariff collection, payment method, type of vehicle, type of vehicle ownership, type of operation or management, and location of the charging infrastructure (Table 3). However, these categories are not fixed, and some charging facilities may be designed as more than one category.[11] Table 3 presents the characteristics of different categories of charging infrastructure.

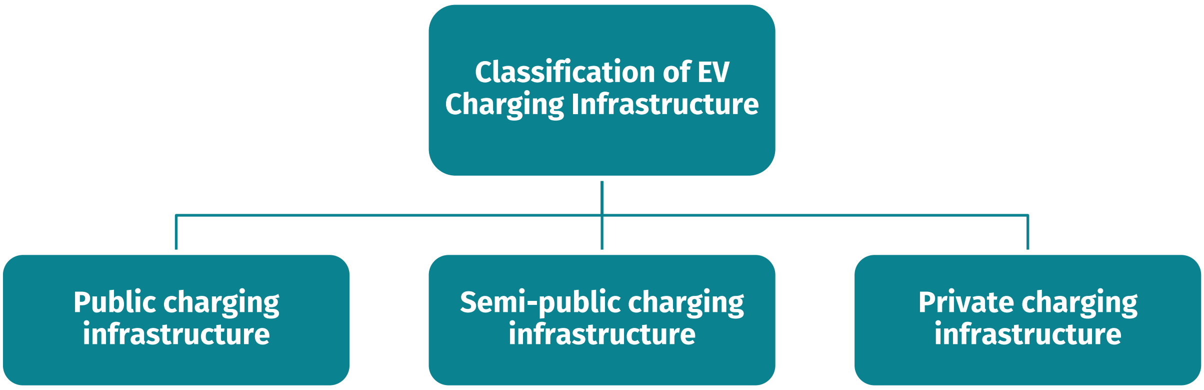


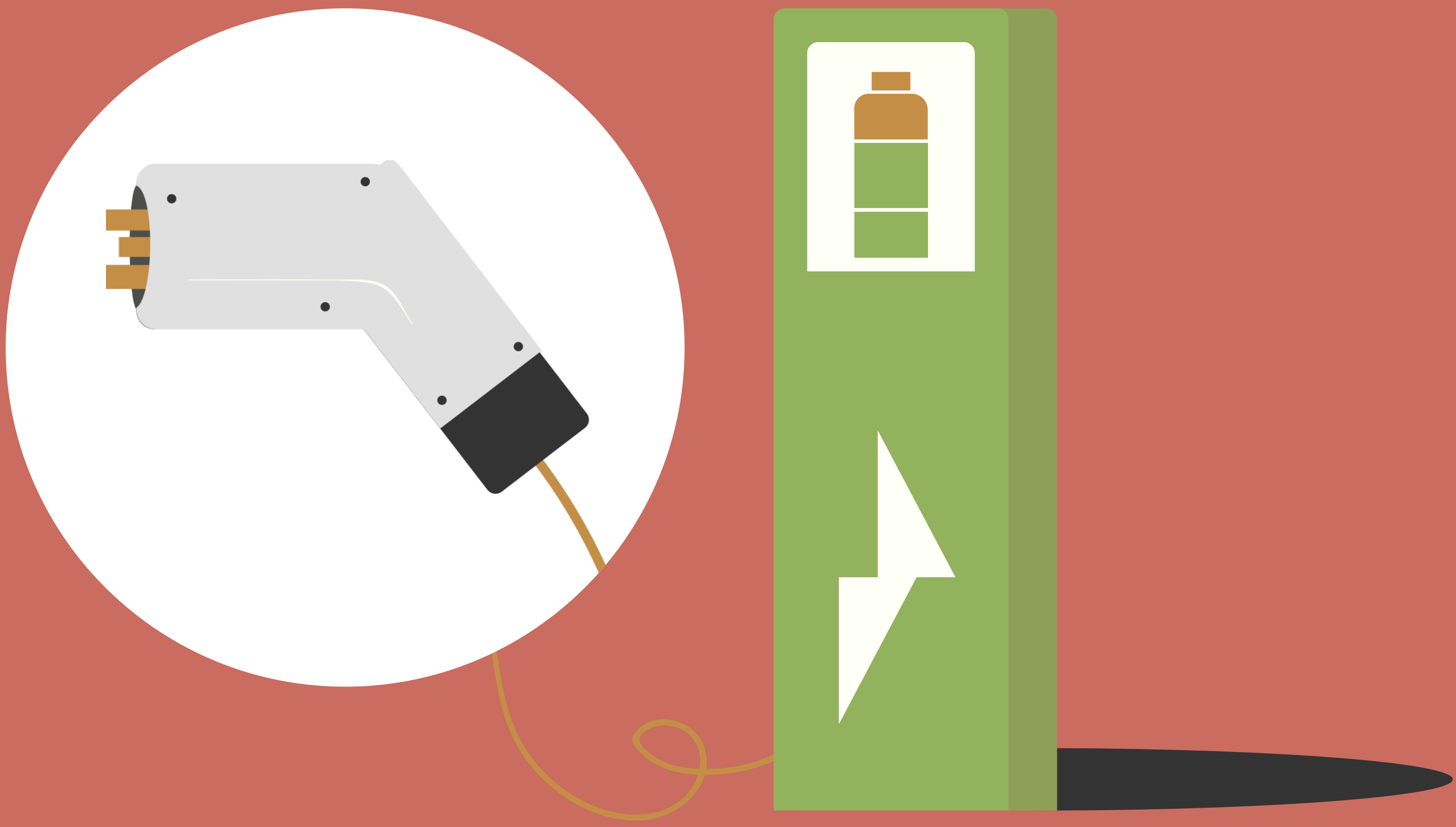
Figure 4 - Classification of EV *charging infrastructure*

[10] Bernstein, C. (2018). Tech Target Definition.
[11] NITI Aayog, Ministry of Power (MoP), Department of Science and Technology (DST), Bureau of Energy Efficiency (BEE), & WRI India. (2021). Handbook of electric vehicle charging infrastructure implementation (1st ed., Vol. 1)

	Public charging	Semi-public charging	Private charging
By tariff collection & payment	Charges collected from users and electricity bill is paid by the operator		The user is the owner of the charging infrastructure and, is responsible for paying usage charges.
By access	Access to all EV users	Access to defined user group.	Access to the owner EV only or EV fleet owned by one entity.
By operation or management	CPO-managed	CPO-managed	Self-operated
By ownership	Municipal authorities, PSUs, CPOs, host properties	Host properties	Individual EV owners, EV fleet owners/ operators
By travel mode	All vehicles except passenger public vehicles	Passenger public vehicles, private passenger vehicles, commercial passenger vehicles, goods carriers	Any private vehicle
By location	Public parking lots, on-street parking, charging plazas, petrol pumps, highways, metro stations.	Apartment complexes, office campuses, gated communities, shopping malls, hospitals, universities, government buildings, public vehicle fleet depots/parking, etc.	Independent homes, dedicated parking spots in apartments or offices
	Standalone public charging infrastructure	Combined with parking	

Table 3 - Characteristics of different categories of charging infrastructure[12]

[12] Source: Charging Infrastructure for EV- Revised consolidated Guidelines and standards (2022); Handbook of electric vehicle charging infrastructure implementation (NITI Ayog) ; Report-1 Fundamentals of electric vehicle charging technology and its grid integration



03

Charging Technologies and Components of Charging Infrastructures

EV chargers use different types of technologies: conductive (plug-in), wireless, and battery swapping (presented in *Figure 5*).[13] Conductive charging and battery swapping are currently available in India, while wireless charging is not commercially available. Both technologies have specific uses and are applicable to different segments in different scenarios. This document focuses on conductive public charging infrastructure, while this chapter covers the fundamentals of conductive charging technologies and components related to charging. The advantages and barriers of battery swapping in India have also been discussed.

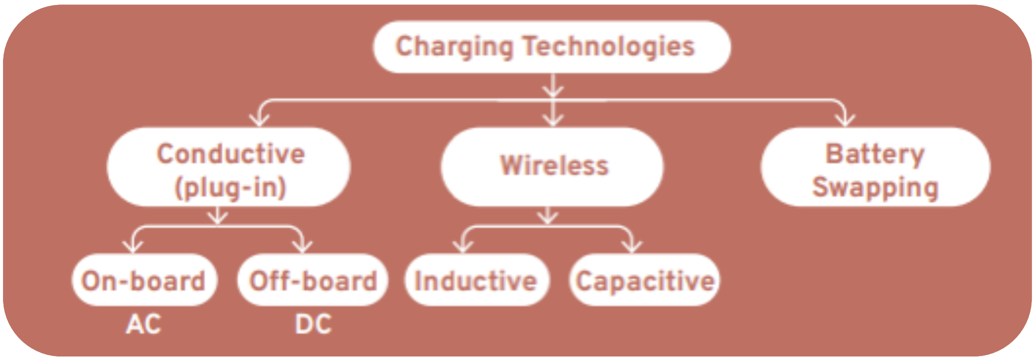


Figure 5 - Charging technologies[14]

[13] 'Rather, Z.', 'Nath, A., 'Banerjee, R., & 'Juta, C. (2021). Report-2 International review on integration of electric vehicles charging infrastructure with distribution grid.

[14] Source: Report-1 Fundamentals of electric vehicle charging technology and its grid integration

3.1. Conductive (plug-in/wired) Charging

Conductive or plug-in charging can employ either AC or DC current, with two distinct categories: on-board charging and off-board charging (

Table 4). It depends on whether the charger is within the vehicle or in the EVSE. On-board chargers are within the vehicle, and the input charge is AC, while off-board chargers are part of the EVSE, and the input charge is DC.

	On-board charging	Off-board charging
Charging mechanism	AC is **supplied** to the on-board charger	Convertor is **a part of** EVSE
	The on-board charger **converts** AC into DC	DC is **directly** supplied to EV
Speed	**Slow/Moderate charging** Restricted power ratings due to space constraints in EV and bulkiness of converter	**Moderate/Fast /Rapid charging** No constraints in off-board charging

Table 4 – Difference between on-board and off-board charging[15]

3.2. Electric Vehicle Supply Equipment (EVSE)

An EVSE is a core component or a basic unit of charging infrastructure. It is the equipment that draws power from electricity distribution network and utilises that power to safely recharge the EV. An EVSE can be of two types — an AC EVSE or a DC EVSE.

AC EVSE (On-board charger): In an AC EVSE, the AC power is supplied to the on-board charger of an EV which converts the AC power into DC power to charge the battery. AC charging is the most basic form of charging and involves simply plugging a 2W/3W/car into a standard three-pin 5-amp/15-amp wall socket (IS 1293) or the industrial socket (IEC 60309). Most vehicles are equipped with an on-board charging system that converts grid-supplied AC power to the DC power required to charge the battery. On-board chargers enable a vehicle

[15] Source: Report-1 Fundamentals of electric vehicle charging technology and its grid integration

to be charged from a specialised AC charger (moderate AC) at residences, workplaces, or a public location. AC chargers in India come with various power ratings. The most common ones include 3.3 kW, 7.2 kW, 11 kW, and 22 kW chargers.

DC EVSE (Off-board charger): A DC EVSE converts the power externally and supplies the DC power directly into the EV, bypassing the on-board charger. DC charging is usually done in commercial operations owned and/or operated by a Charge Point Operator (CPOs). DC charging is also referred to as DC fast charging, as it provides higher charging rates. DC chargers can provide an 80% charge just in 30 minutes, depending on the charger's power rating and the vehicle's compatibility.

3.3. Modes of Charging

In India, there are four modes of charging for electric vehicles, categorised as either AC or DC charging, as shown in Figure 6**.** Out of these four modes, three are for AC charging, while one is for DC charging.

Mode-1

The EV is connected to a regular socket outlet of 230V using a portable cable and plug. The charging capacity is limited to 2.3 kW to ensure safety, as this mode lacks communication between the EV and the EVSE. It is also known as 'dumb charging' and its use is not recommended.

Mode-2

The EV is connected to a regular socket outlet of 230V using a portable In Cable Control Box (ICCB) with in-built protection and control capability. The charging capacity ranges from 2.3 kW (10 A) to a maximum of 7.4 kW (32 A) with a single-phase supply. This mode is typically used for domestic charging.

Mode-3

An alternating current from the charging station is applied to the on-board circuit to charge the battery. This system adjusts the charging current to match the maximum capacity of the cable assembly. The maximum current in this charging mode is 32A for 230V in a single-phase network or 415V in a three-phase network. It also supports a Mode-2 compatible operating mode, where the maximum current is limited to less than 32A in both single-phase and three-phase networks.

Mode-4

This mode uses DC charging and is therefore used for fast charging. The charging capacity starts at 30 kW and goes higher.

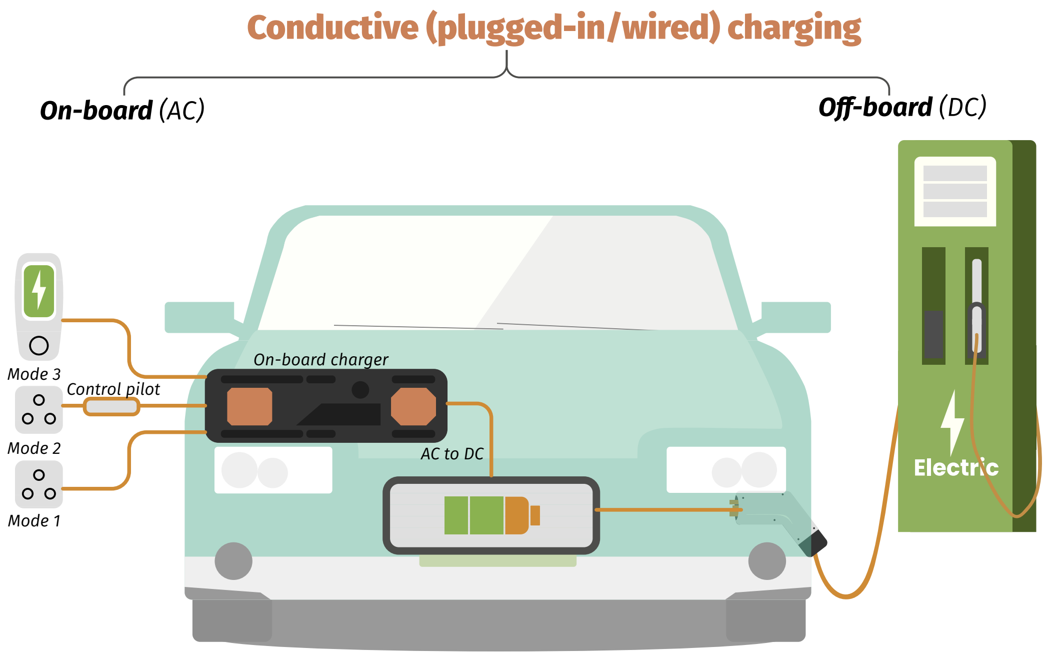


Figure 6 - Conductive charging

3.4. Connectors

Chargers are further classified based on the type of connectors on the charging cord. As notified by the Ministry of Power (MoP) in their guidelines[16], the public charging stations should be equipped with any of the connectors illustrated in Figure 7.

Additionally, to ensure compatibility and interoperability within the EV ecosystem, Public Charging Stations (PCS) are required to adhere to prevailing international standards widely adopted by most vehicle manufacturers for cars, 4W goods, trucks, and buses (for instance, CCS 2 connector- See Figure 8). The Bureau of Indian Standards (BIS) gave its approval for a combined standard connector (Figure 9) for 2W, 3W, and LCVs in October 2023 under the

[16] Ministry of Power. (2024). Guidelines for Installation and Operation of Electric Vehicle Charging Infrastructure-2024

IS17017 Part 2 / Sec 7: 2023. Incorporation of any additional connector models is permissible under approved the BIS standards, as and when notified.

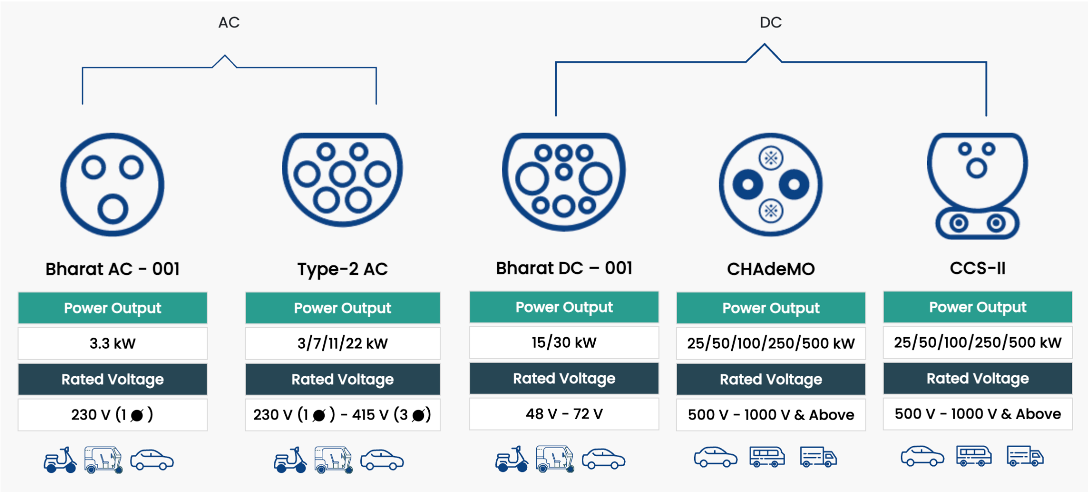


Figure 7 - Different types of connectors in India[17]

Figure 8 - CCS 2 connector for cars, 4W (goods), trucks, and buses

Figure 9 - Combined standard connector for 2W and 3W

[17] Bureau of Energy Efficiency website

3.5. Types of Chargers

Charging speed is one of the most important aspects of a public charger. Chargers can be broadly divided into four types based on charging speed: slow chargers, moderate chargers, fast chargers, and rapid chargers.[18] The charging rate of an electric vehicle is influenced by both the on-board charger rating and the C-rate[19] of the battery. During AC charging, the on-board charger's power rating dictates the maximum charging speed. In DC fast charging scenarios, the charging rate is primarily governed by the capacity of the fast charger and the battery's C-rate, which determines how quickly the battery can safely accept the charge.

Slow Chargers (below 7 kW)

Most slow chargers typically use a standard 3-pin plug on the charger side and connector. Most EV manufacturers provide a cable for slow charging, which can be plugged into a single-phase socket. This requires a low tension (LT) connection if the total demand is less than 150kW.

Moderate Chargers (7-22 kW)

Moderate chargers are typically rated at either 7 kW or 22 kW (single or three-phase). Most moderate chargers are 7 kW and untethered, for which the user needs their own cables to plug-in their vehicle, but the tethered units generally use a Type 2 connector. This requires an LT connection if the total demand is less than 150kW.

Fast Chargers (30 – 60 kW)

Fast chargers are typically DC chargers, as AC chargers are generally slower and used for private or low capacity charging needs. Fast DC chargers commonly use the CCS 2 (Combined Charging System) to deliver power from upwards of 30 kW. For power loads up to 150 kW, a LT connection may suffice; however, if the aggregate load exceeds 150 kW, a HT connection is required.

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[18] 'Rather, Z., 'Banerjee, R., 'Nath, A., & 'Dahiwale, P. (2021). Report-1 Fundamentals of electric vehicle charging technology and its grid integration.

[19] The C-rate of a battery represents the rate at which it can be charged or discharged relative to its total capacity.

Rapid Chargers (>60 kW)

Rapid chargers are the fastest ways to charge an EV. These chargers are the next generation of chargers and can provide DC power at more than 60 kW. However, if the charger speed exceeds 150 kW, an HT connection is required.

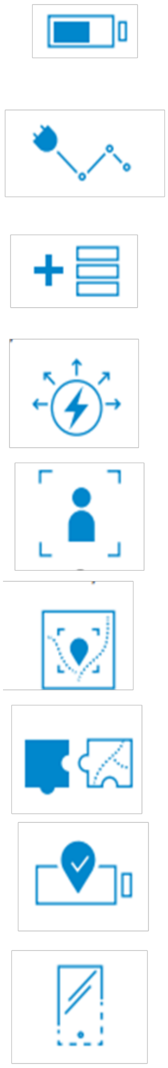
In India, the MOP guidelines state that a PCS is expected to have at least one or a combination of chargers presented in the following table (Table 6). Incorporation of any additional fast, slow, or moderate charger models is permissible under approved BIS standards, as and when notified.

Charger type	Charger connectors	Rated Voltage (V)	No. of charging points/ No. of connector guns (CG)	Vehicle type
Fast charger	CCS 2 (min 30 kW)	200-1000 or higher	1/1 CG	4W
Moderate charger	Type- 2 AC (22 kW)	230-415	1/1 CG	4W, 3W, 2W
Slow charger	Bharat DC- 001 (15 kW)	72 or higher	1/1 CG	4W
	Bharat DC- 001 (12kW)	48	1/1 CG	4W, 3W, 2W
	Bharat AC- 001 (10 KW)	230	3/3 CG; 3.3 kW each	4W, 3W, 2W
(Any other charger fast/slow/moderate/rapid charger as per approved BIS standards whenever notified)				

Table 5 - Charger models

3.6. Smart Charging

Unlike conventional chargers, smart charging can communicate with the vehicle and the grid to offer optimised charging stations with better rates and higher efficiency. With smart charging technologies, people can opt for methods such as charging via renewable energy, which will help reduce the CO2 emissions and energy tariffs. There are other benefits of smart charging as presented in Figure 10.



- **Provides real time and predicted information on charger status and availability**
- **Tracks energy consumption**
- **Gathers data on usage patterns to improve the system**
- **Distributes energy between vehicles**
- **Recognises and invoices users**
- **Be recognized on maps of charging stations**
- **Integrates with route planning applications**
- **Allows users to reserve charging spots**
- **Can integrate with future applications**

Figure 10 - Benefits of smart charging[20]

[20] . 'Fishbone, A., 'Shahan, Z., & 'Badik, P. (2017). Electric Vehicle Charging Infrastructure, Guidelines for Cities.

3.7. Battery Swapping

Battery swapping is the process in which a depleted EV battery is replaced with a fully charged battery at dedicated swapping stations. It is an alternative to the battery recharging method. Using this process, EV users can quickly replace the depleted batteries without waiting for their vehicle's battery to be fully charged. Battery swapping makes EVs a more practical choice for consumers.

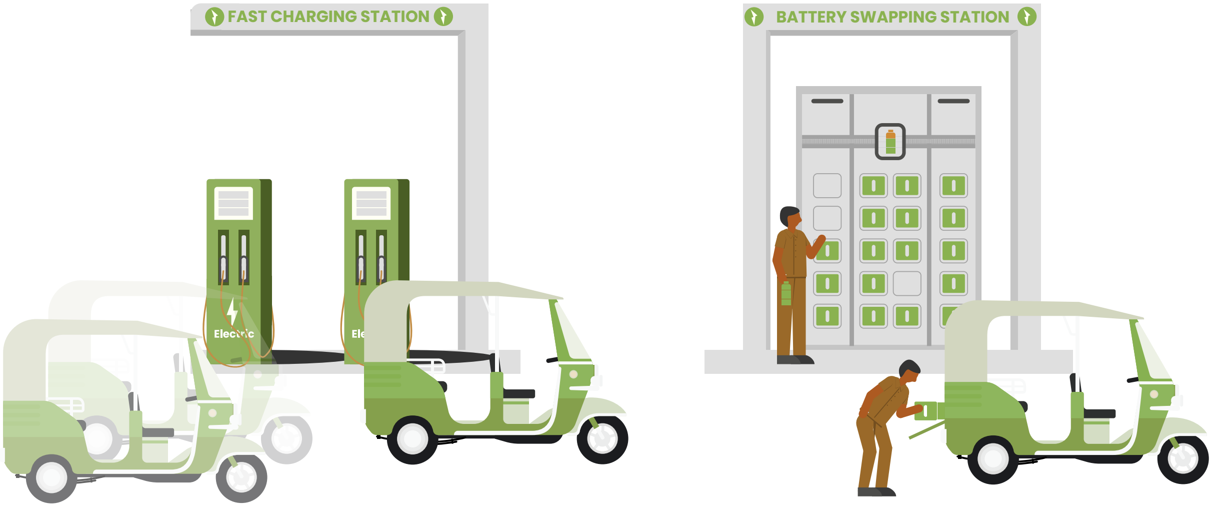


Figure 11 – An EV charging station vs a battery swapping station

Figure 12 – A battery swapping station in Gujarat

Battery swapping is often facilitated through Battery-as-a-Service (BaaS) model where EV users can access fully charged batteries without owning the battery itself. This eliminates the high upfront cost of battery ownership, reduces maintenance concerns, and ensures consistent battery performance. The combination of battery swapping and BaaS further enhances the feasibility and convenience of adopting EVs.

Presently in India, battery swapping is a feasible solution only for commercial EV fleets, particularly for electric 2W and 3W. This technology is also being experimented in other EV segments such as e-cars and e-buses. The Ministry of Road Transport and Highways (MoRTH) has allowed the sale and registration of EVs without batteries, which provides a huge boost to battery-swapping solutions.[21] Further, industry stakeholders are making large investments in developing the battery-swapping ecosystem. This indicates that battery swapping will emerge as a distinct part of the EV charging ecosystem in the coming years in the country.

Battery swapping is of two types: manual battery swapping and autonomous battery swapping.

Manual battery swapping: A manual battery swapping station is a standalone device, in which batteries are replaced and moved manually from the battery slot. It is used for 2W and 3W batteries because of the smaller and lighter battery pack. These stations are modular, compact, and occupy a minimal amount of space.

Autonomous battery swapping: This process is party or fully automated, where a robotic arm is used to place and remove the batteries. Autonomous swapping can be used for battery swapping of 4W, buses and trucks because of their larger and heavier battery packs which require mechanical assistance. These swapping stations are more expensive and have a higher space requirement.

[21] NITI Aayog, Ministry of Power (MoP), Department of Science and Technology (DST), Bureau of Energy Efficiency (BEE), & WRI India. (2021). Handbook of electric vehicle charging infrastructure implementation (1st ed., Vol. 1).

Battery swapping has some distinct advantages over plug-in charging, but it also faces several challenges in becoming a mainstream charging method. The advantages and challenges of battery swapping are presented below. [22]

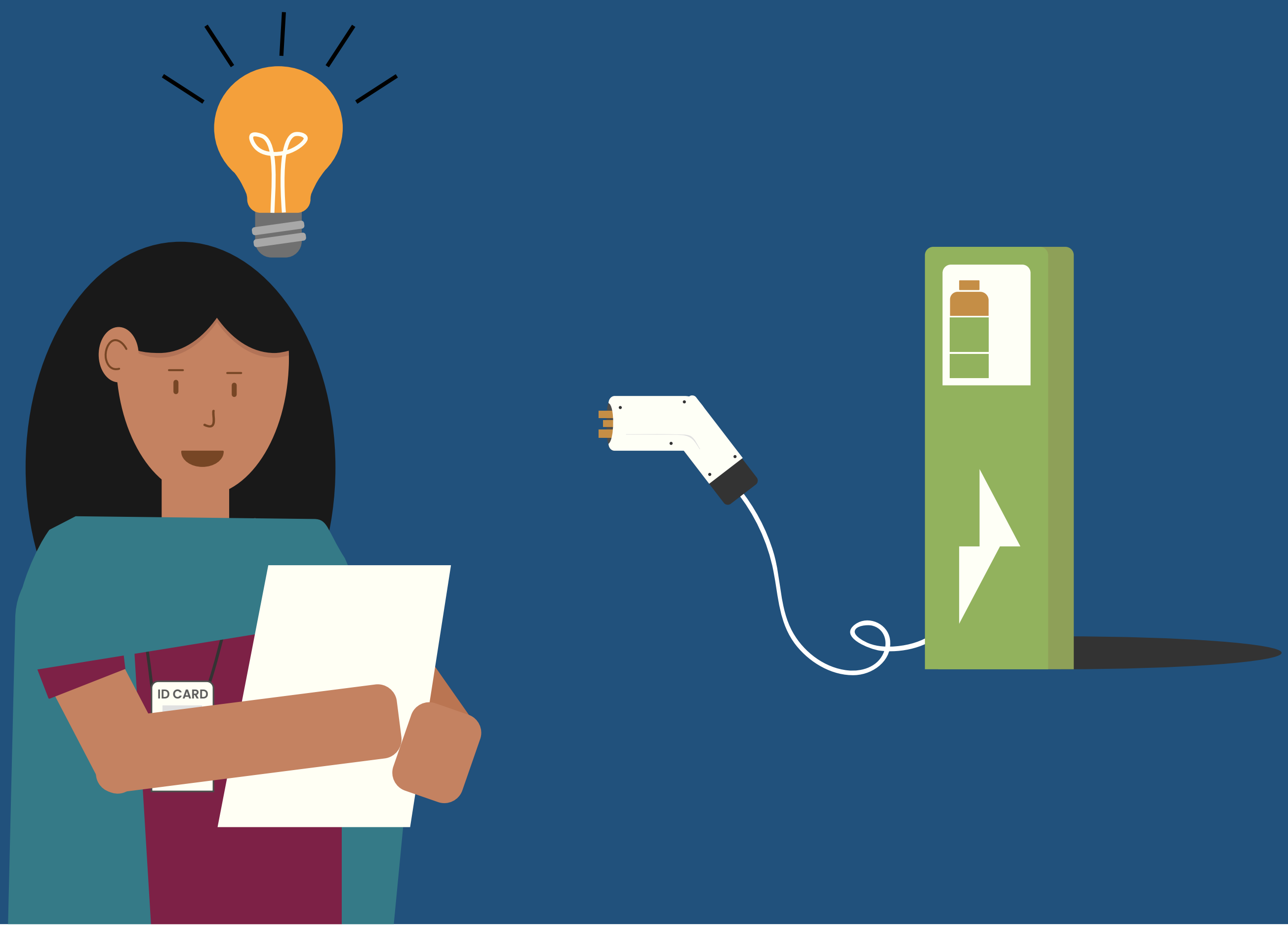
Advantages of battery swapping

1. Quick EV recharging
2. Flexibility in setting up swap facilities as batteries can be charged away from swapping points
3. Reduction in upfront cost of purchasing an EV, as battery ownership is replaced by battery leasing

Challenges of battery swapping

1. Lack of standardisation for EV batteries
2. Unsuitable battery pack design preventing the ease of swapping (weight, dimensions and ergonomics)
3. Requirement for a greater number of batteries to power same number of EVs
4. Slower rate of adoption of this charging method by Original Equipment Manufacturers (OEMs)
5. Higher capital cost for operators due to a higher GST on a separate battery (18%) vs a battery sold with EV (5%)

[22] Source: Handbook of electric vehicle charging infrastructure implementation (NITI Ayog)



04

EV Charging Infrastructure Norms, Bye-Laws, and Standards

EV charging infrastructure norms and byelaws are required to ensure safety against any hazards, while the standards ensure compatibility and interoperability of any EVSE with all EVs. This chapter covers the national and state level norms, standards and byelaws for charging infrastructure that needs to be followed for setting up charging infrastructure. Different authorities at the centre, state and local levels are responsible for formulating these norms, bye-laws and standards.[23] Based on the roles they play, the authorities can be categorised as policy making or regulatory authorities and implementing or executing authorities (Figure 13).

4.1. Policy Making or Regulatory Authorities

These are authorities responsible for formulating necessary policies, regulations, norms and byelaws, and establishing standards and specifications at both the national and state level. The complete list of policy making or regulatory authorities and the documents prescribed by each authority are presented in Table 6 and Table 7.

4.2. Executive or Implementing Authorities

These are authorities responsible for execution of policies and day-to-day governance of EV charging infrastructure as guided by the policy. It also includes permitting, functions of planning and supporting implementation of EV charging infrastructure. The list of executive or implementing authorities and their roles are presented in Table 8.

[23] NITI Aayog, Ministry of Power (MoP), Department of Science and Technology (DST), Bureau of Energy Efficiency (BEE), & WRI India. (2021). Handbook of electric vehicle charging infrastructure implementation (1st ed., Vol. 1).

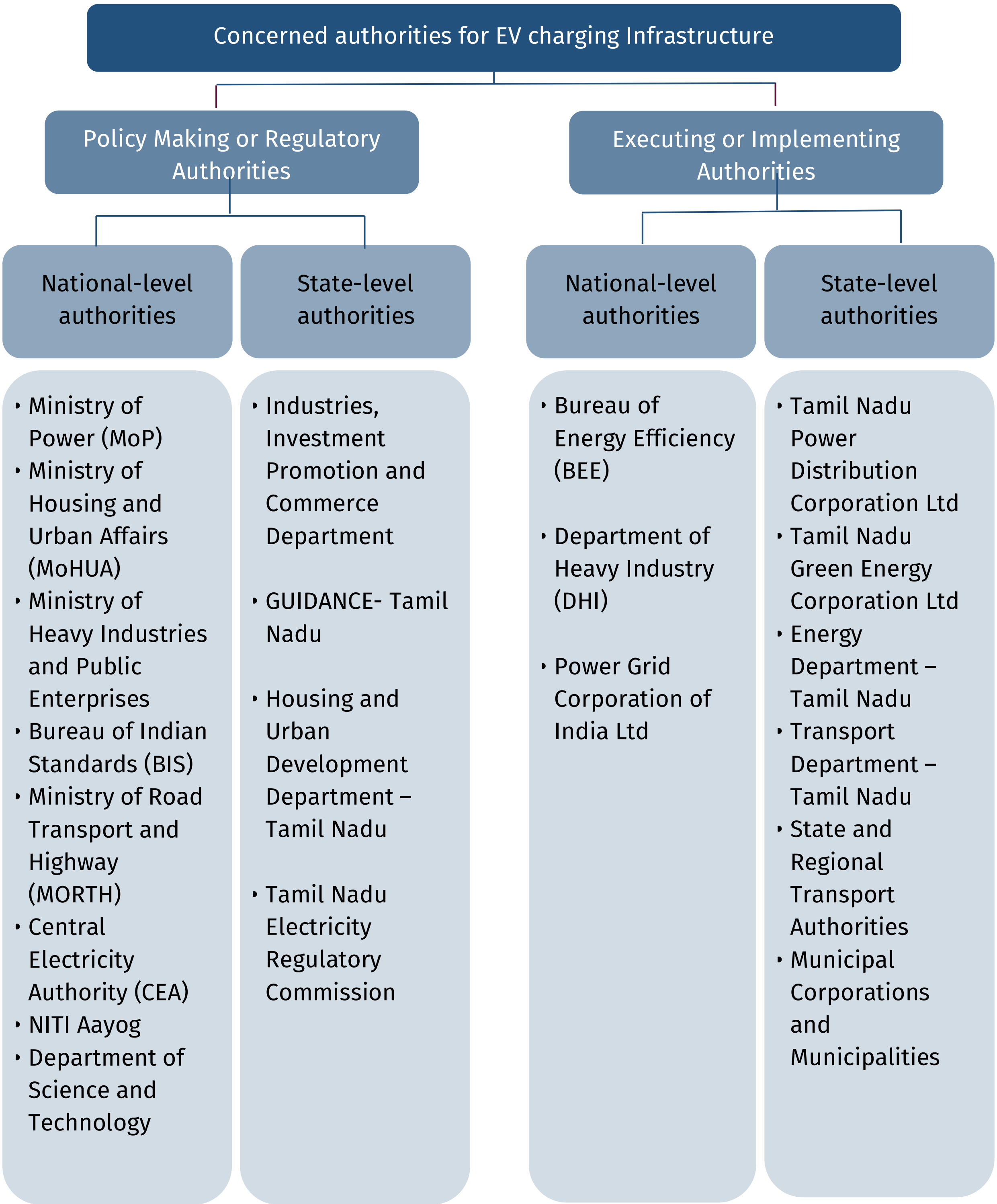


Figure 13 - Concerned authorities for EV Charging infrastructure[24]

[24] ITDP(2024), Status Report on Public Charging; NITY Aayog, Handbook of Electric Vehicle Charging Infrastructure Implementation

POLICY MAKING OR REGULATORY AUTHORITIES

National level			
Authority	**Prescribed Document**	**Type**	**Remarks**
Ministry of Power (MoP)	Guidelines for Installation and Operation of Electric Vehicle Charging Infrastructure-2024	Guideline and Standards	Framework for EV charging infrastructure implementation and includes minimum requirements for PC infrastructure, location of PCS, provision of land for PCS and other related guidelines (Ministry of Power).
Ministry of Housing and Urban Affairs (MoHUA)	Model Building Byelaws (MBBL - 2016)	Amendments- recommended for implementation by state governments	Amendments for installing "charging infrastructure" in the building premises and core urban areas of the cities (MoHUA, 2016).
	Urban & Regional Development Plans Formulation & Implementation Guidelines (URDPFI - 2014)	Amendments- recommended for implementation by state governments	Amendments for charging infrastructure in cities, master plans and regional plans (MoHUA, 2014).
NITI Aayog	Battery swapping policy	Policy	Development of battery swapping policy and framework for promoting battery swapping technology via BaaS business models.

Bureau of Indian Standards (BIS)	IS-17017- Part-1	Standard	The standard describes general requirements, characteristics, operations and communication connection between EV and EVSE for a conductive EV charging system (BIS, 2018).
	IS-17017-Part-2	Standard	Specifies general requirement of plug, socket, outlet, connectors, inlet, mechanical, electrical & performance. Provides details of construction and design of vehicle inlets, connectors and latch for AC & DC charging (BIS, 2020).
	IS-17017-Part 21	Standard	Standardises electromagnetic compatibility of EV charger and provides electromagnetic compatibility of on-board and off-board EVSE (BIS, 2019).
	IS-17017-Part 22	Standard	Covers the conductive charging configuration for light EV AC charge point with a supply voltage of 240 V AC and current up to 16-amp AC (BIS, 2021b).
	IS- 17017- Part 23	Standard	Describes the requirements for DC charging stations, with power output of 50kW to 200kW (BIS, 2021c).
	IS-17017-Part 24	Standard	Digital communications between the DC EVSE and the EV, data communication standards are specified (BIS, 2021d).
	IS- 17017- Part 25	Standard	Standardises electromagnetic compatibility of EV charger and provides electromagnetic compatibility of on-board EVSE (BIS, 2021a).
	ISO-15118	Standard	Provides AC and DC charging communication standards for the Combined Charging System (CCS) standard is deployed, which can provide both AC and DC charging (BIS, 2020b).

Table 6 - List of policy-making or regulatory authorities and documents prescribed by each authority

4.3. Provisions for Public and Semi-public Charging by the Ministry of Power and the Ministry of Housing and Urban Affairs

The Ministry of Power (MoP) and the Ministry of Housing and Urban Affairs (MoHUA) prescribes provisions for public and semi-public charging infrastructure to achieve minimal coverage in a city or region. [25]

For public charging

The Ministry of Power (MoP)'s Charging Infrastructure Guidelines and Standards provides the following minimum requirements for the location of public charging stations:

- At least one charging station should be available in a grid of 1km x 1km inside the city boundary.
- One charging station should be set up every 20km on both sides of highways, expressways and major roads.
- For long-range EVs and heavy-duty vehicles like buses and trucks, a fast-charging station should be located every 100km on each side of the designated expressways, highways and major roads.

For semi-public charging

- In all new buildings, charging infrastructure should be provided for EVs for at least 20% of the complete vehicle holding capacity or parking capacity of the premises.
- The building premises should have an additional power load, equivalent to the power required for all charging points to be operated simultaneously, with a safety factor of 1.25.
- The amendments are applicable to all buildings except independent residences.

[25] Ministry of Power (2022), *Charging Infrastructure for EV - Revised consolidated Guidelines and standards;* MoHUA (2014), Urban and Regional Development Plans Formulation and Implementation Guidelines (URDPFI - 2014); MoHUA (2016), Model Building Byelaws (MBBL - 2016).

For existing buildings,

Delhi government mandates 5% parking for EV charging

In March 2021, the Delhi Government directed all commercial and institutional buildings with a parking capacity of more than 100 vehicles to set aside 5% of their parking spaces for EV charging. This includes shopping malls, hospitals, hotels, offices, educational institutions, movie theatres, etc. Properties will be required to set up slow EV chargers (at a minimum) at the reserved parking spots and will be able to avail of a subsidy of INR 6,000 per charging point, as per in the Delhi EV Policy.

4.4. Charging Infrastructure for EVs: Guidelines and Standards by the Ministry of Power

According to the Ministry of Power (MoP) guidelines, every Public Charging Station (PCS) should include the following equipment and features:

- **EV charger specifications:** EV chargers should be as per the conventions of the BIS, detailed in Annexure I. For small size EVs such as two wheelers, three wheelers, quadri-cycles and four wheelers, CPOs should preferably provide a minimum 7.4 kW AC or DC EV chargers.
- **User convenience:**
  1. **Online booking (Optional):** A PSC may partner with network service providers for convenient selection of EV chargers and remote booking of charging slots.
  2. **Real-time information:** A station should display user-friendly information including:
     a. Location
     b. EV charger types (AC/DC, kW capacity)
     c. Number of available EV chargers
     d. Charging rates
     e. Any additional fees
     f. Information specified by the Central Nodal Agency

- **Communication protocols:** Open standards are recommended. Public CPOs may adopt open communication protocols such as OCPP (Open Charge Point Protocol -

for charger management), OCPI (Open Charge Point Interface - for inter-network roaming), OpenADR (Open Automated Demand Response - for grid integration) and ISO/IS 15118 (for vehicle–grid communication / Plug & Charge) for EVSE/device-level communication. At the system/interoperability layer, states and CPOs may adopt UEI — Unified Energy Interface (Beckn-based) for discovery, transactions, and flexible demand response. All protocols must be compliant with extant provisions of cyber security

- **Payment options:** Flexible payment methods must be offered, including pre-paid and post-paid payment options, potentially with time-based rates and discounts during solar hours.
- **Station amenities (Optional):** Larger Public EV Charging stations (i.e. stations with more than 10 EV chargers for four-wheelers) may offer additional amenities like washrooms, drinking water, and covered waiting areas for customers. They may also be equipped with surveillance cameras with at least one month data storage.
- **Fast charging for long-range and heavy-duty EVs:** A PCS equipped for fast charging long-range EVs and heavy-duty vehicles (like trucks and buses) must meet the following specifications:
    1. **High-power EV chargers:** At least two EV chargers with a minimum capacity of 240 kW each, complying with Power Levels 3 or 4 as defined in Annexure I
    2. **Liquid-Cooled Cables (Optional):** A station may also choose to provide liquid-cooled cables for high-speed charging of vehicles.
- **Other general requirements:**
    1. An exclusive transformer with all related substation equipment including safety appliances if necessary
    2. Power supply lines/cables with adequate capacity and associated equipment as needed for line termination/metering etc.
    3. Appropriate civil works
    4. Appropriate cabling and electrical work ensuring safety
    5. Appropriate fire protection equipment and facilities
    6. The EVSE (electric vehicle supply equipment) shall be type tested by a third-party lab accredited by National Accreditation Board for Testing and Calibration Laboratories (NABL)

POLICY MAKING OR REGULATORY AUTHORITIES			
National level			
Authority	**Prescribed document**	**Type**	**Remarks**
Ministry of Road Transport and Highway	AIS 138 Part-1 2017- Draft Final (Electric Vehicle Conductive AC Charging System)	Automotive Industry Standard (AIS)	This standard covers all aspects of AC conductive charging ranging from general requirements for charging, rating, charging modes, connectors, safety of EVSE and protection against electric shocks (MoRTH & Automotive Industry Standards Committee, 2017).
	AIS 138 Part- 2 2018 - Draft final (Electric Vehicle Conductive DC Charging System)	Automotive Industry Standard (AIS)	This standard gives the requirements for DC EV charging stations (MoRTH & Automotive Industry Standards Committee, 2018).
Central Electricity Authority (CEA)		Standards	This covers the measures related to Safety & Electrical Supply Regulations. CEA manages a national database of public charging stations with state and national agencies.
Ministry of Heavy Industries and Public Enterprises		Scheme	Launch and rollout FAME-I, II and PM E-Drive schemes, which includes subsidies for accelerating the development for public EV charging infrastructure.
Department of Science and Technology		Charging Standards	DST and BIS are working together on indigenous charging standards.

State-level			
Authority	**Prescribed document**	**Type**	**Remarks**
Industries, Investment Promotion & Commerce Dept.	Tamil Nadu Electric Vehicles Policy 2023	State EV Policy	This state-level policymaking and coordinating body is mandated to attract investment in this sector (Government of Tamil Nadu, 2023).
GUIDANCE- Tamil Nadu			
Housing and Urban Development Department – Tamil Nadu		Building Byelaws	As of 2024, state specific norms and byelaws are not present for EV charging infrastructure. According to EV policy, the Government of TN is in the process of amending the TN Combined development and building Rules, in line with the Model Building Byelaws (MBBL) 2016 for EV Charging Infrastructure issued by the Government of India. Housing & Urban Development Department will be the nodal department for issuing amendments to the Combined Development and Building Rules
Tamil Nadu Electricity Regulatory Commission (TNERC)	Tariff regulations	Electricity tariff orders for charging stations	The TNERC determines the electricity tariff, regulates electricity purchase and procurement process, issues license, facilitates intra-state transmission and promotes cogeneration, specifies the State Grid Code, and specifies or enforces standards of performance. Any revision in demand and energy tariff to accelerate the growth of charging stations is approved from TNERC.

Table 7 - List of policy-making or regulatory authorities and documents prescribed by each authority[26]

[26] *ITDP (2024), Status Report on Public Charging; NITI Aayog, Report 3- Electric Vehicle Charging Infrastructure and its Grid Integration in India.*

EXECUTING OR IMPLEMENTING AUTHORITIES

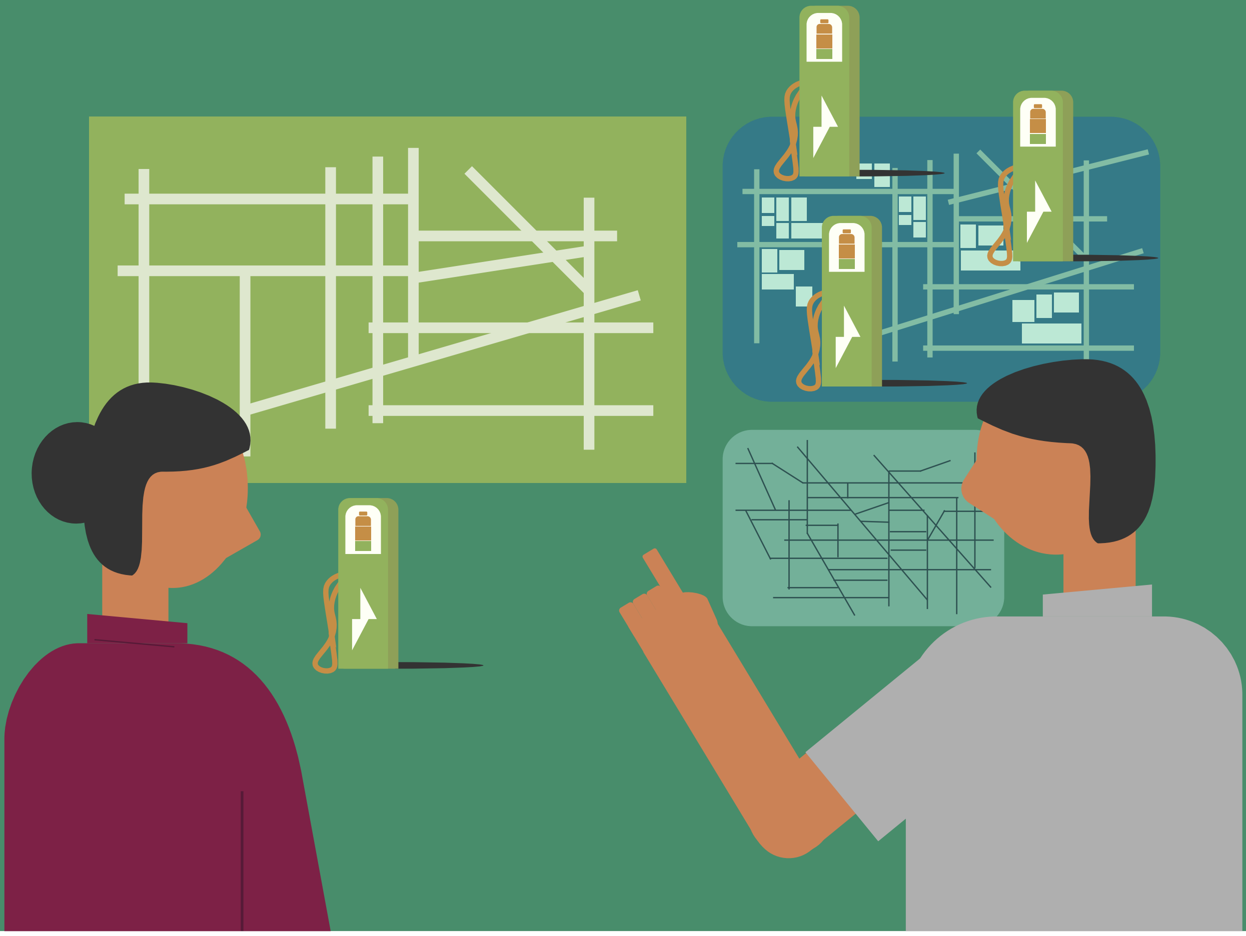
National level	
Authority	**Role**
Bureau of Energy Efficiency (BEE)	Central nodal agency for rollout of public EV charging infrastructure across the country, also technically supports the 'Go Electric' awareness campaigns at the national and state levels
Department of Heavy Industry (DHI)	Central nodal agency responsible for implementation of public charging at national level
Power Grid Corporation of India Ltd	Responsible for regional and national power grid's establishment and operation, and to facilitate the transfer of power within and across the regions with reliability, security, and economy on sound commercial principles
State level	
Authority	**Role**
Tamil Nadu Power Distribution Corporation Ltd (TNPDCL)	State nodal agency (SNA) responsible for facilitating the development of charging infrastructure in the Tamil Nadu state. Provides electricity connections for EV charging, implementing EV tariff, ensuring that EV charging infrastructure is connected and operating properly, preventing improper use of EV connections, managing the distribution network, and undertaking grid upgrades based on growth in load including from EV charging
Tamil Nadu Green Energy Corporation Ltd	Leads the implementation of initiatives to strengthen EV charging infrastructure across the state. Works closely with stakeholders to ensure coordinated deployment, operational efficiency, and policy alignment.
Energy Department – Tamil Nadu	Analyses the power demand and supply of the state facilitates seamless provision of affordable, reliable and quality power
Transport Department – Tamil Nadu	Issues guidelines and undertake capacity building of RTOs to enable registration of commercial EVs, including electric two- wheelers for commercial use
State and Regional Transport Authorities	An important stakeholder in planning for public charging infrastructure, as this agency holds information on EV penetration trends in the city or region through vehicle registration data
Municipal Corporations and Municipalities	Responsible for ensuring implementation of amendments to building bye-laws and urban planning provisions for EV charging

Table 8 - List of executing or implementing authorities and role played by each authority[27]

Tamil Nadu Electric Vehicle Policy
For existing buildings, TN EV policy suggests that the state shall undertake the following efforts:

- All existing apartment associations with 50+ families shall be encouraged to provide inhouse charging infrastructure.
- Existing residential townships with 500 + families shall be encouraged to install charging stations.
- Commercial building owners and operators shall be encouraged to establish EV charging stations/points their premise such as hotels, shopping malls, cinema halls, and apartments.
- Amendments to building and construction laws shall be framed to ensure that charging infrastructure is integrated at the planning stage for all new constructions in cities.

[27] *Source: Status report on public charging, TN (ITDP), Handbook of electric vehicle charging infrastructure implementation (NITI Ayog), Report-3 Electric Vehicle Charging Infrastructure and its Grid Integration in India*



05

EV Charging Infrastructure Demand Assessment

The EV charging demand at an urban or regional level depends on EV penetration and utilisation. Charging demand assessment for different EV segments can be used for various aspects of charging infrastructure planning. For instance, it can be used as input data for estimating charging points based on the EV supply. Thus, charging demand assessment is the first step in charging infrastructure planning.

5.1. Methodology for Calculating Number of Public Charging Points

Determining public charging point requirements involves a structured approach based on EV penetration and usage patterns. The process segments EVs by vehicle type and usage, then analyses each segment's operational characteristics and charging needs. This ensures the charging infrastructure is appropriately tailored to meet the specific demands of each EV segment.

5.1.1. Segmenting EVs by vehicle types

According to specific vehicle usage, EV segment can be divided into 2W, 3W (passenger), 3W (goods), personal cars, commercial cars, 4W (goods-LGV), 4W (goods-MGV), trucks (HGV) and buses. Dividing EV into different segments according to vehicle use is important because each EV segment has a different battery capacity, charging speed, average daily utilisation and share of charging demand met by public charging of that segment.

5.1.2. Deriving EV characteristics for each segment

Each EV segment has unique characteristics based on its usage. To calculate the number of vehicles a charger can serve, the first step is to study and document the operational and vehicle characteristics of each segment.

Key characteristics to assess for each segment include:

- Average utilisation or daily km driven
- Average battery capacity (in kWh)
- Maximum charging speed supported by vehicles (in kWh)
- State of Charge used- (example from 20% SoC to 85% SoC used= 65%)
- Stated driving range in km (when fully charged)
- Percentage of charging demand served by public charging

Share of charging demand served by public charging of all vehicle segments.[28]

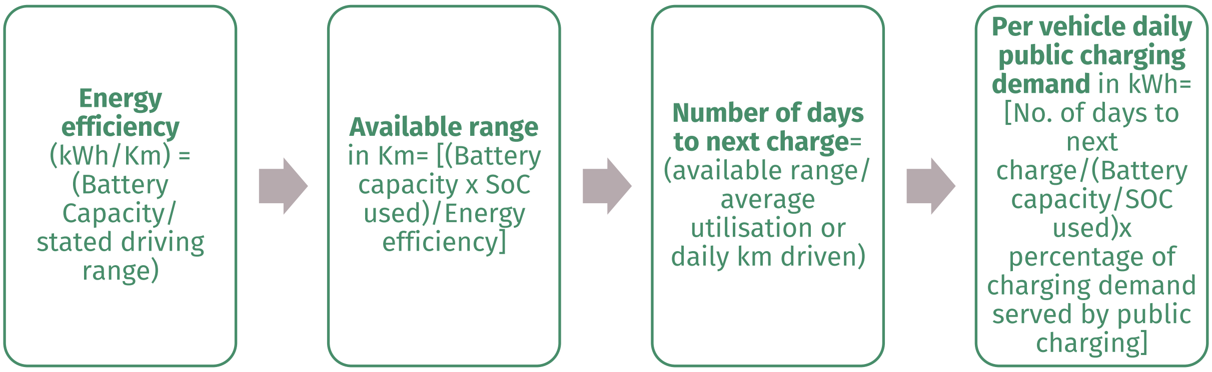
E-Vehicle segment	Charging demand
2W	10%
3W (Passenger)	20%
3W (Goods)	20%
Car (Personal)	10%
Car (Commercial)	25%
4W Goods (LGV)	20%
4W Goods (MGV)	70%
Truck (HGV)	70%
Bus	60%

Table 9 - Share of charging demand served by public charging of all vehicle segments

5.1.3. Daily public charging demand per vehicle for each segment

Using the vehicle segment characteristics, the energy efficiency, available range, frequency of charging and per vehicle charging demand of an EV is derived in kWh.

Daily public charging demand per vehicle for each segment



[28] The data is from multiple sources including NITI Aayog, Ministry of Power(MoP), Department of Science and Technology(DST), Bureau of Energy Effeciency(BEE), and a 2021 report from WRI, Handbook of Electric Vehicle Charging Infrastructure Implementation (1st ed., Vol1).

5.1.4. *Deriving charger characteristics for each segment*

The number of vehicles that a charger will serve depends on the operational and equipment characteristics of the charger. These are charger speed, charger efficiency, total operational time of charger, and the total average idle time between charges.

Charger characteristics

- **Charger speed** *(in kWh)*
- **Charger efficiency** *(example 75%)*
- **Total operational time of charger** *(example 12hr)*
- **Total average idle time between charges** *(example 1 hr from the 12 operational hr)*

5.1.5. *Charging time and total EV charged per day for each segment*

Using vehicle characteristics and charger characteristics, the charging time and total vehicles charged by a single charger per day for each vehicle category is derived.

$$\textbf{Charging Time} = \frac{\text{Battery Capacity} \times \text{SoC used}}{(\text{Charger Speed} \times \text{Charger Efficiency})^{*}}$$

**If (charger speed x charger efficiency) > maximum charging speed supported by EV then maximum charging speed supported by EV should be considered instead of (charger speed and charger efficiency)*

$$\textbf{Total vehicles charged per day} = \frac{\text{Total Operational Time of Charger}}{(\text{charging time} + \text{average time between charges})}$$

5.1.6. *Total vehicle demand served by a charger for each segment*

The total vehicles served in a day by single charger is derived.

$$\textbf{Total vehicles demand served by a single charger} = \frac{\text{Total Vehicles Charged per day}}{(\text{\% of charging demand served by public charging} + \text{No. of Days to next charge})}$$

5.1.7. Forecast number of EV for each segment for the horizon year

Based on estimates of EV sales, EV penetration rate and future targets, the number of EVs for each segment for the horizon year for which charging infrastructure needs to be planned is forecast.

5.1.8. Charging points required for each vehicle segment

Using the estimates of vehicles served by a single charger and the number of EV in each segment in the horizon year, the total number of charging points required in the city for that segment can be calculated to meet the charging needs of that vehicle segment.

Note: Using the above method, the graphs are derived which are presented in Part 2 Stage 1. These graphs can be directly used to determine the required number of charging points based on the projected number of electric vehicles in each segment for the target year.

The assumptions used in the above calculation:

1. Average utilisation or daily km driven (NITI Aayog et al., 2021):

Vehicle segment	Daily km driven
2W	40
3W (Passenger)	120
3W (Goods)	120
Car (Personal)	40
Car (Commercial)	100
4W Goods (LGV)	110
4W Goods (MGV)	350
Truck (HGV)	350
Bus	73

2. SoC used- example from 20% SoC to 85% SoC used= 65%
3. Total operational time of charger (example 12hr)
4. Total average idle time between charges (example 1 hr from the 12 operational hr)

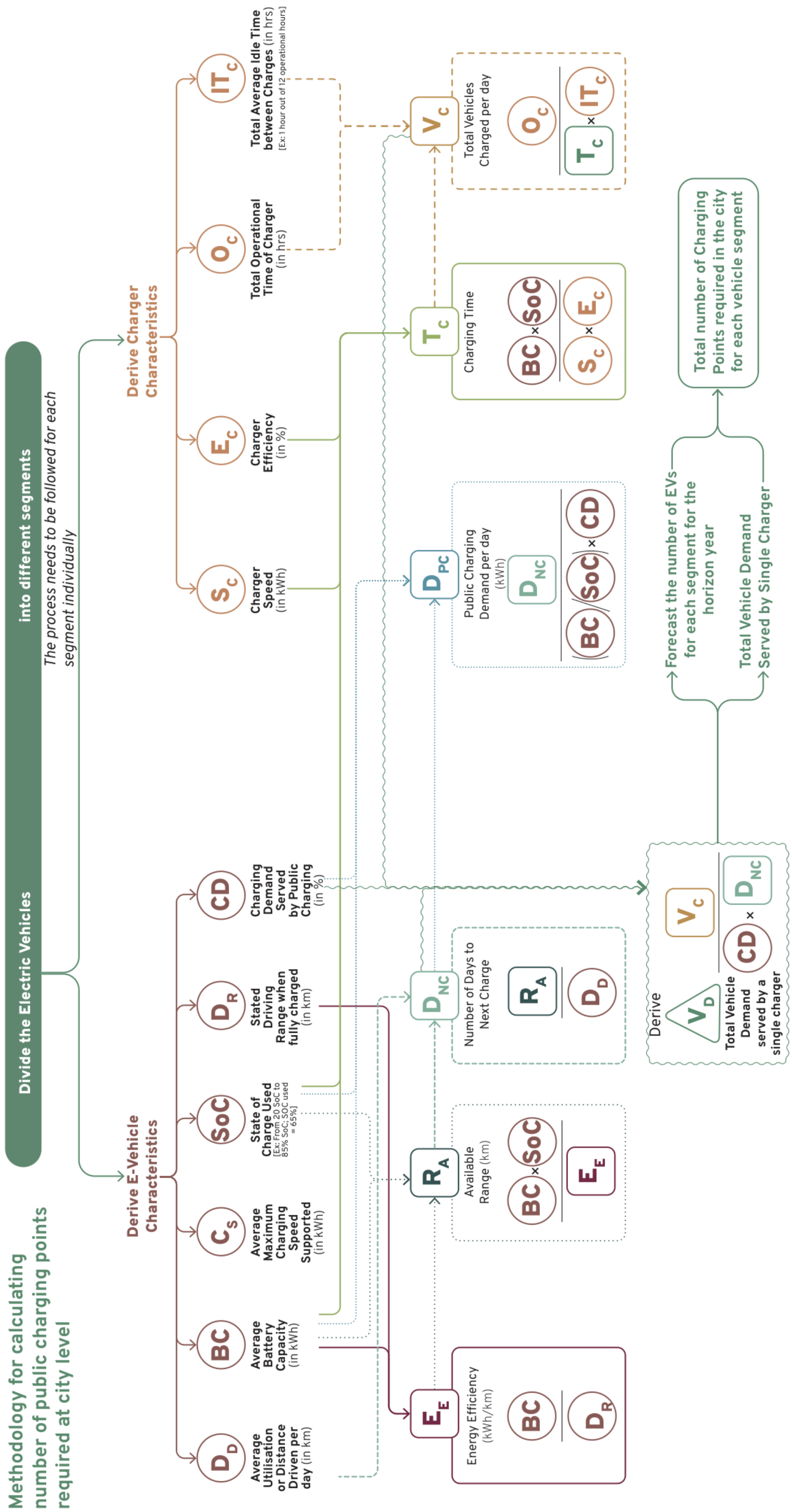
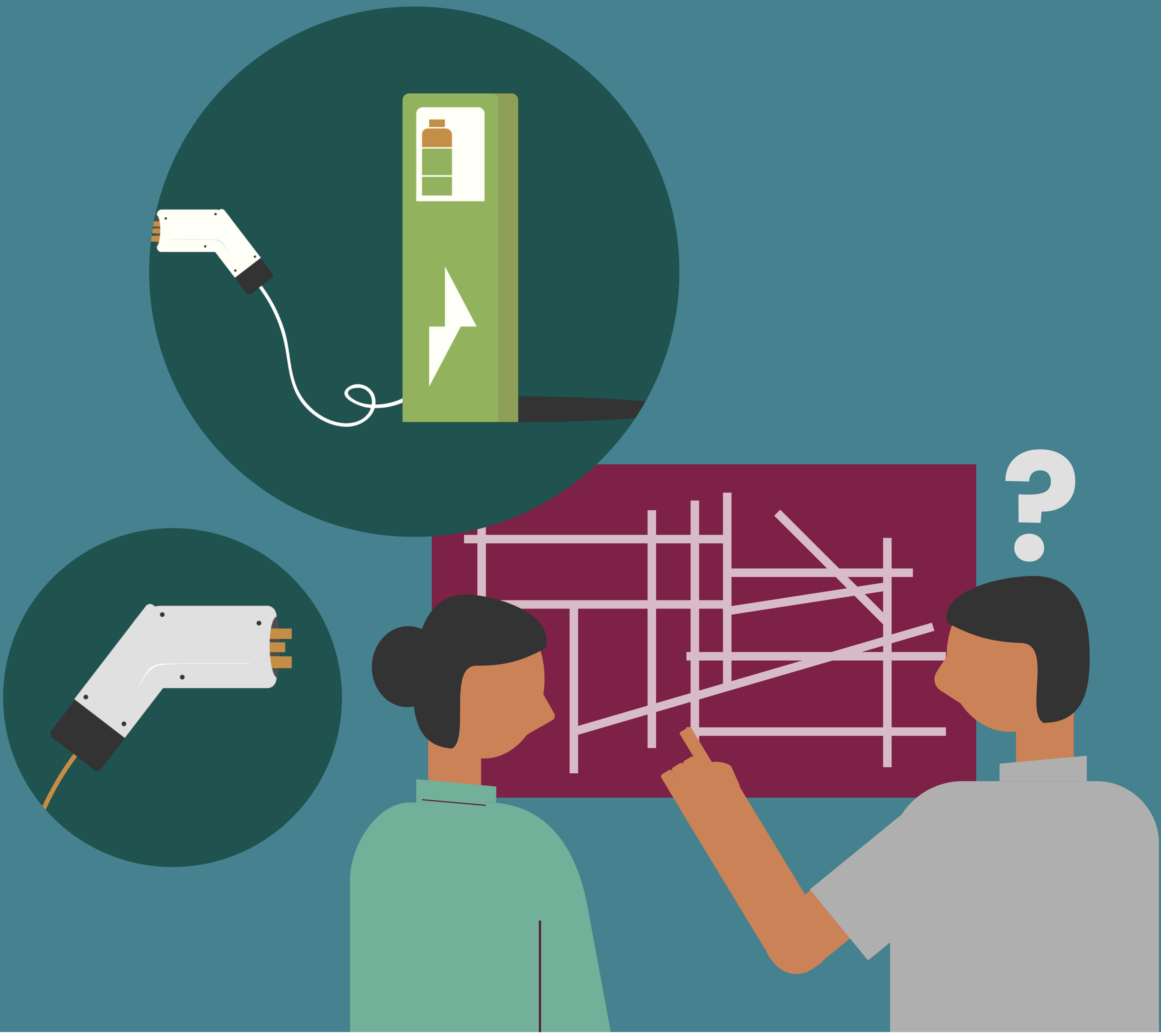


Figure 14 – Flowchart - Methodology for calculating number of public charging stations

Part

02

Charging Infrastructure Planning & Implementation Guidelines for Cities/Regions



06

Estimating the Number of Charging Stations and Charging Points

6.1. Stage 1 - Estimation of Charging Points

Charging infrastructure numbers can be estimated using a two-step process:

1. Step 1 - Estimating the minimum charging stations required based on the size of the city/region
2. Step 2 - Estimating the total number of charging points required in the city/region based on number of vehicles and the charging point capacity

Figure 15 - Charging stations and charging points

6.1.1. *Estimating Minimum Charging Station Requirement*

Using the size of the city or region, the minimum charging station requirement can be estimated. As per the MoP guidelines 2024[29], at least one charging station is required for every grid of 1km x 1km.

City size (in sq. km.) / 1 = Minimum no. of charging stations required

Example:
Let us assume the size of a city is 135 sq. km. According to MoP Guidelines, at least one charging station is needed in 1km x 1km grid. Therefore, the minimum number of charging stations required is 135 divided by 1, which comes to 135 charging stations.

[29] Ministry of Power. (2024). Guidelines for Installation and Operation of Electric Vehicle Charging Infrastructure-2024

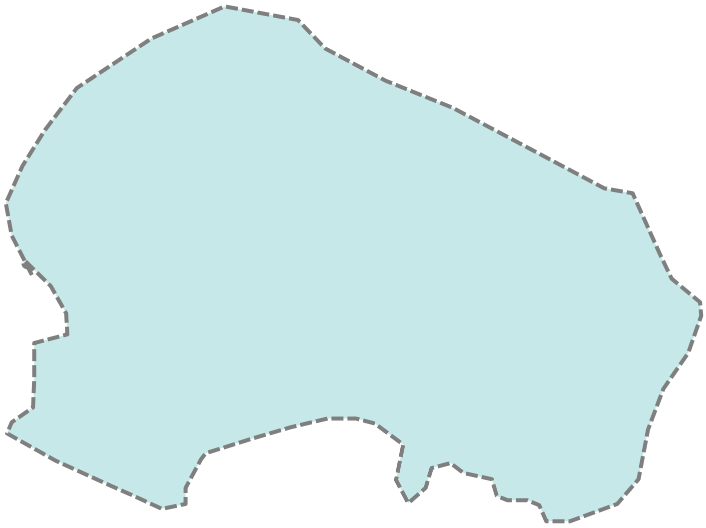


Figure 16 - Assumed city boundary

6.1.2. Estimating Total Charging Points

The following steps show how to estimate the total number of charging points required in the city for each segment, considering the distribution of different charger types and the selection of chargers suitable for the cities.

Step 1

Based on expected EV sales, penetration rate and future projections, the EV fleet size in the coming years for different travel modes is estimated.

Step 2

The number of charging points required for each travel mode based on expected fleet size and charge point capacity is estimated.

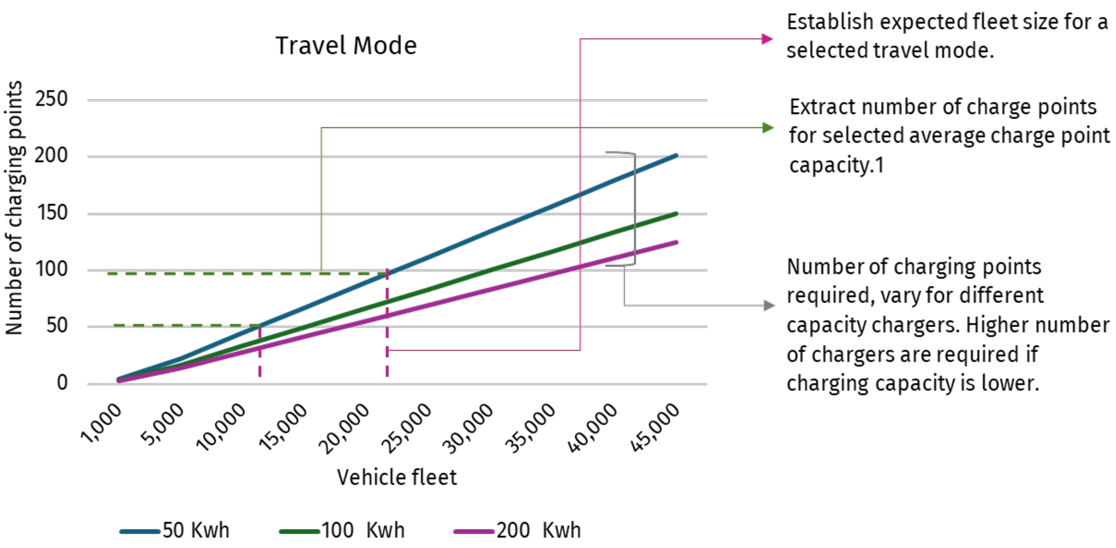


Figure 17 - Example of charging points estimation from number of vehicles

Based on the estimated number of EV by different travel modes, several factors are used to derive the charging points required in that horizon year. The methodology for estimating the number of charging points is explained in Section 1.5 of Part-1. Vehicle and charger-specific factors and inputs used for this estimation have been presented below.

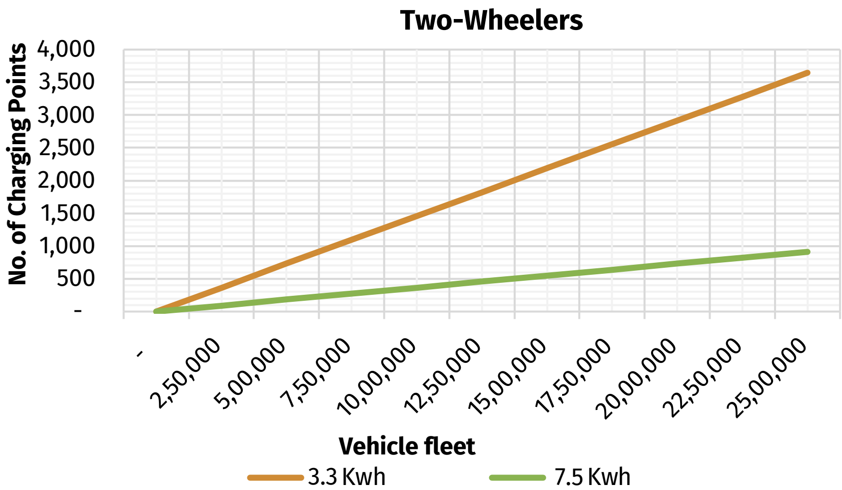
Vehicle factors

- Average utilisation or daily km driven
- Average battery capacity (in kWh)
- SoC used- example from 20% SoC to 85% SoC used= 65%
- Stated driving range in km (when fully charged)
- Percentage of charging demand served by public charging

Charger factors

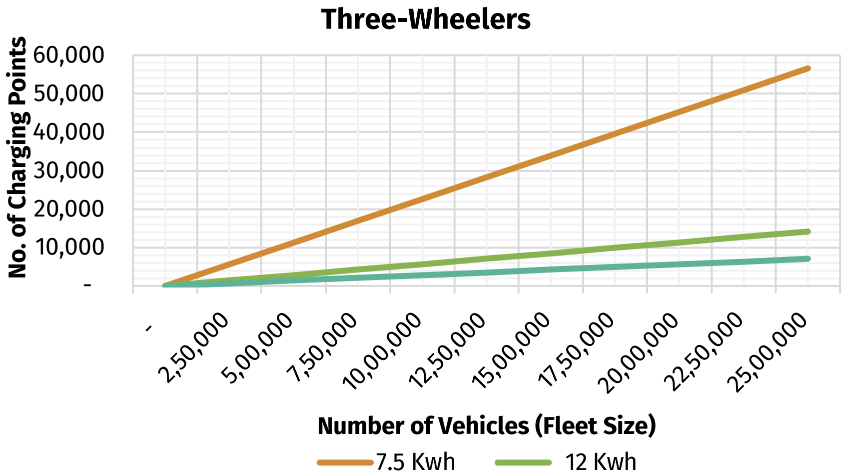
- Charger speed (in kWh)
- Charger efficiency (example 75%)
- Total operational time of charger (example 12hr)
- Total idle time between charges (example 1 hr from the 12 operational hr)

The results obtained using the above methodology have been used to produce graphs given below. These can be used to estimate charging points required in a city/region for different EV types.



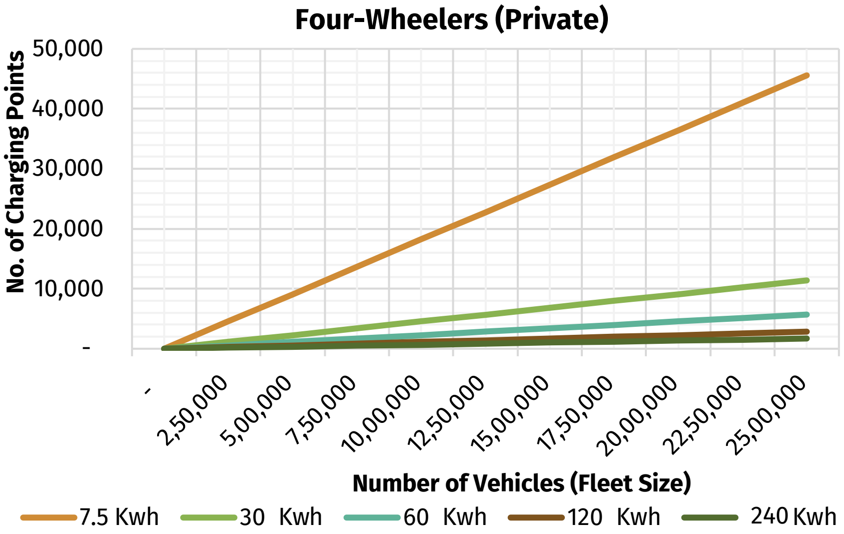
Note
The compatible chargers for 2W are:
- Bharat AC- 001
- Bharat DC- 001
- LECCS

Figure 18 - Demand and supply of 2W charging stations



Note
The compatible chargers for 3W are:
- Bharat AC- 001
- Bharat DC- 001
- LECCS

Figure 19 - Demand and supply of three-wheeler charging stations

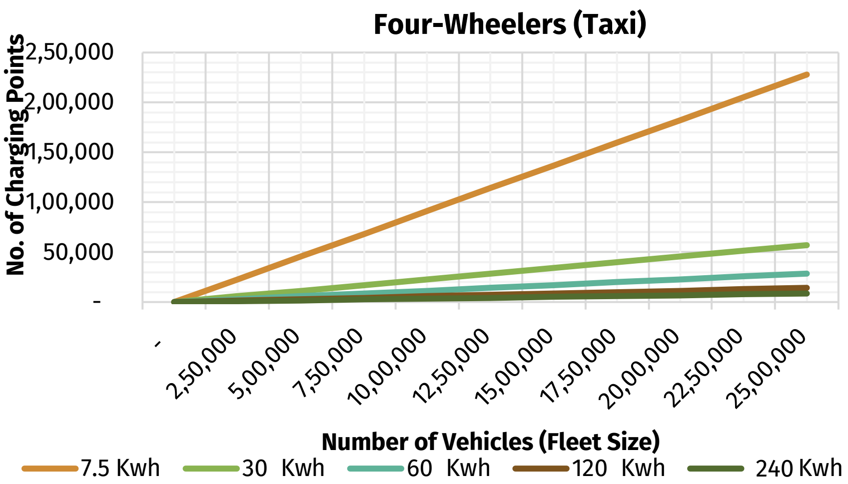


Note

The compatible chargers for 4W are:

- Bharat AC- 001
- Bharat DC- 001
- Type-2 AC
- CHAdeMO
- CCS 2

Figure 20 - Demand and supply of four-wheelers (private) charging stations

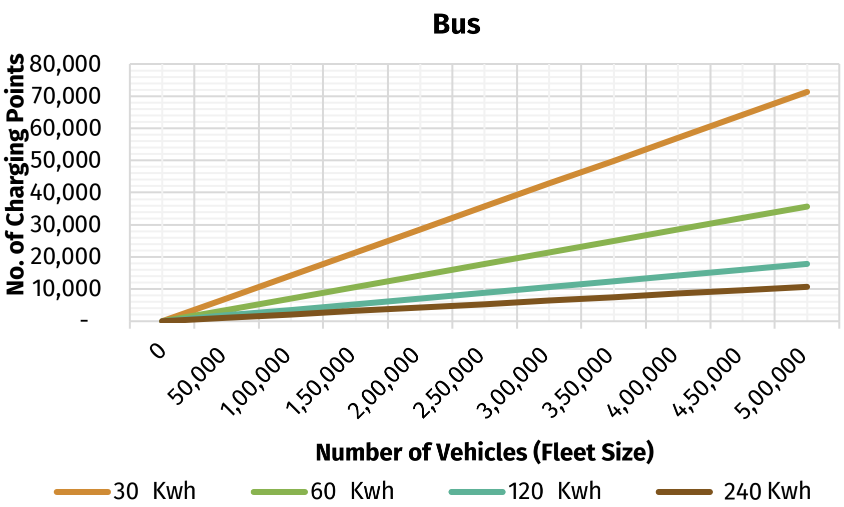


Note

The compatible chargers for 4W are:

- Bharat AC- 001
- Bharat DC- 001
- Type-2 AC
- CHAdeMO
- CCS 2

Figure 21 - Demand and supply of four-wheelers (taxi) charging stations

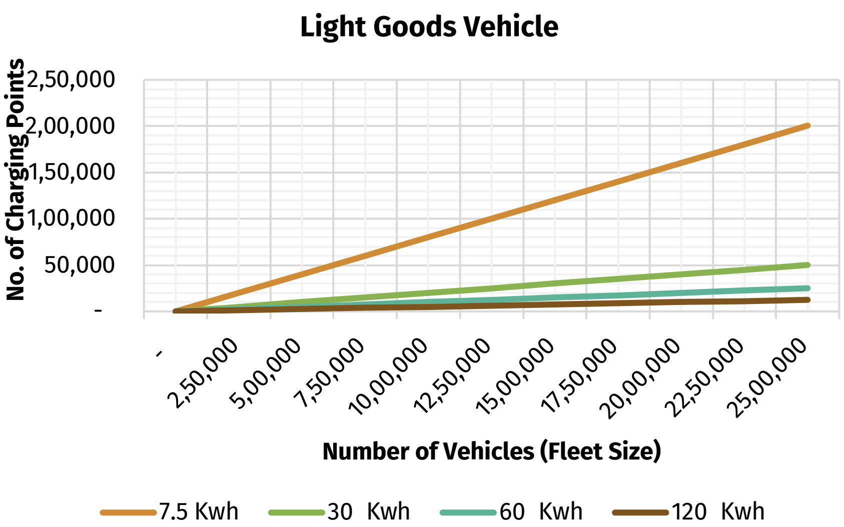


Note

The compatible chargers for bus are:

- CCS 2

Figure 22 - Demand and supply of e-Bus charging stations

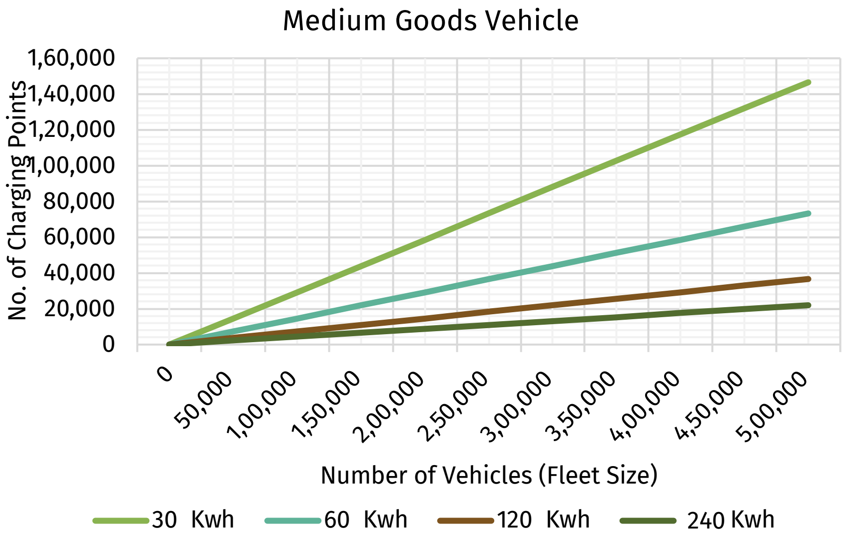


Note

The compatible chargers for LGV are:

- Type-2 AC
- CCS 2

Figure 23 - Demand and supply of Light Goods Vehicle charging stations

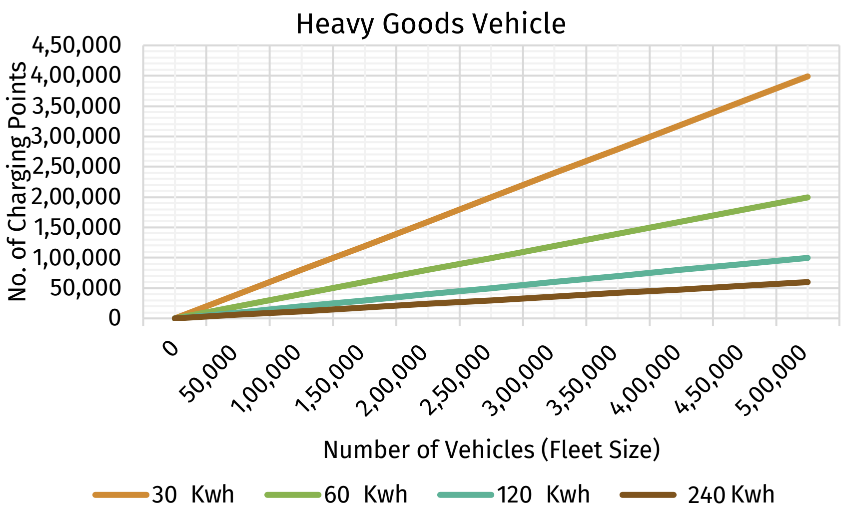


Note

The compatible chargers for Medium Goods Vehicle are:

- CCS 2

Figure 24 - Demand and supply of Medium Goods Vehicle charging stations

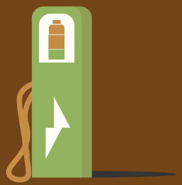


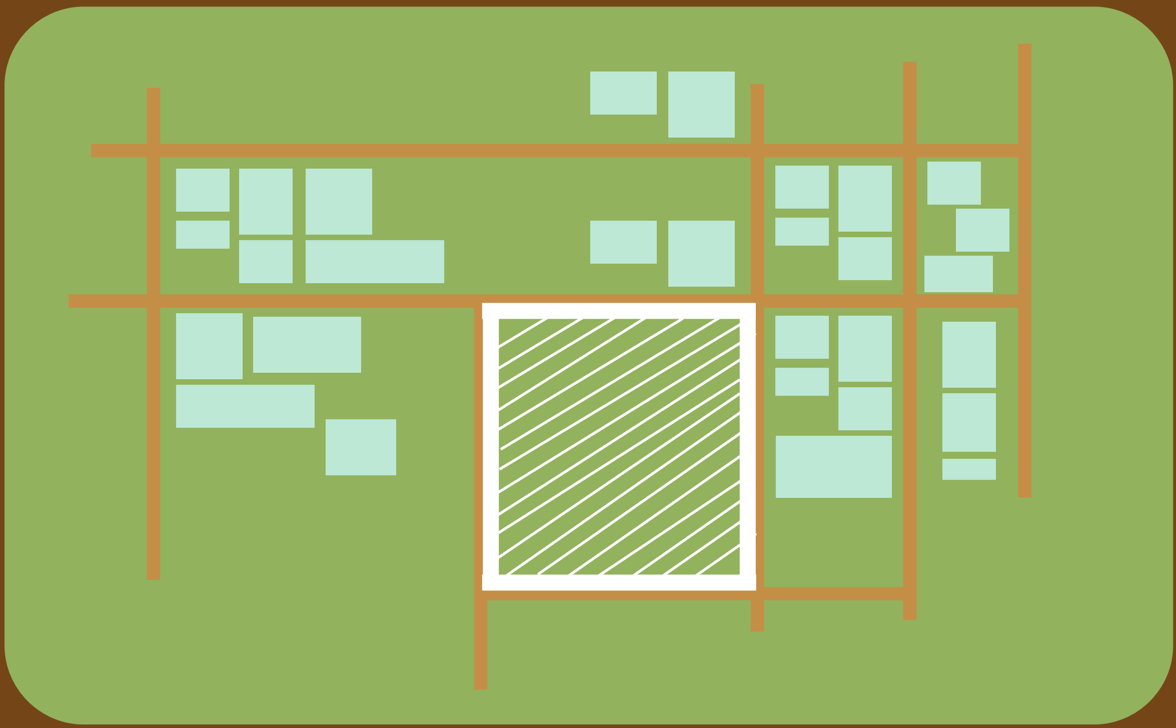
Note

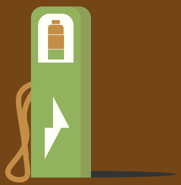
The compatible chargers for Heavy Goods Vehicle are:

- CCS 2

Figure 25 - Demand and supply of Medium Goods Vehicle charging stations







07

Charging Infrastructure Location Site Identification

Optimising EV charging station locations is essential for meeting the growing demand and enhancing user convenience. This document outlines a three-step process for identifying optimal charging station sites. By leveraging critical data, this approach ensures charging stations are positioned to maximise accessibility and utilisation, supporting the transition to sustainable urban mobility.

- **Step 1-Site identification methodology**: Identification of primary, secondary or tertiary locations for charging stations, followed by identification of sites
- **Step 2- Site typology and infrastructure requirement:** Identifying the typology of the sites and determining charging infrastructure requirements specific to each typology
- **Step 3 - Typical site layout:** Recommendations on broad site layout in terms of charge point location, parking location, alignment, etc., for different on-street and off-street locations

7.1. Site Identification Methodology

Sites for charging stations in a city/area, can be identified using a six-step methodology as follows:

1. **Step 1 - Data collection**
   To identify locations for charging stations, the first step is to collect data for preparing maps such as built-up density, land-use, traffic volume, road networks and prominent places.
2. **Step 2 - Identification of primary locations**
   Primary locations can be identified by combining all five maps into one map and marking the sites where three or more factors merge.
3. **Step 3 - Identification of secondary sites**
   After identifying the primary locations, the secondary locations are identified by demarcating a 3 km x 3 km grid and identifying at least one location in each empty grid.
4. **Step 4 - Identification of tertiary sites**
   Tertiary sides are identified if the charging point demand is not achieved through the identified primary and secondary charging station locations.
5. **Step 5 - Grid Prioritisation**

After identification of all the sites, the next step is to prioritise the individual grids for setting up charging stations based on grid's index score/ priority score.

6. **Step 6 - Final site selection**

   After identification of all the sites for charging stations, the final site selection step should be followed for all the charging stations sites individually within 300 m considering different factors such as proximity of the site to a transformer, road access, space availability, land availability, visibility of site and absence of hazards.

7.1.1. Data Collection

On a suitable map of the city or area for which charging station location is being planned, the following maps need to be marked/superimposed:

a. Built-up density map (High density areas, moderate density areas, low density areas)

Considering built-up density is crucial in locating EV charging stations as it reflects the concentration of residents, commercial activities, and vehicle ownership in an area. High-density areas typically require more charging stations due to higher demand from numerous residents and businesses.

b. Road networks map (Arterial, sub-arterial and collector roads)

Arterial roads and highways are key locations for charging stations, serving high traffic volumes and long-distance travellers. Sub-arterial and collector roads are strategic for local commuters, reducing congestion and ensuring accessibility.

c. Land-Use analysis map

Land-use analysis is critical in determining suitable locations for EV charging stations. Commercial and mixed-use areas, characterised by high traffic volume and prolonged stays, are prime spots for stations to cater to shoppers, office workers, and visitors. Residential neighbourhoods benefit from strategically placed stations to serve residents who may lack access to private charging infrastructure.

d. Traffic volume map

Traffic volume plays a crucial role in determining where to position EV charging stations. By strategically placing charging stations in high-traffic zones, accessibility and convenience are maximised, ensuring that drivers can easily recharge their vehicles during their travels.

e. Map of prominent places

- **Transit stations (bus station, railway stations and airports)**
  Considering prominent places, transit hubs (such as bus and railway stations, as well as airports) are strategic locations for EV charging stations, providing convenience for travellers and commuters.
- **Public access buildings (malls, hospital, universities, theatres, local attractions, shopping & dining areas)**
  Public access buildings including malls, hospitals, universities, theatres, and shopping and dining areas, serve as focal points for community activities, making them ideal spots for charging infrastructure to cater to visitors and patrons.
- **Parking areas**
  Parking areas, including both public lots and private garages, offer opportunities for EV charging stations to support drivers while their vehicles are parked.
- **Petrol pumps**
  Petrol pumps offer prime locations for EV charging stations, capitalising on existing infrastructure and customer traffic to promote the adoption of electric vehicles seamlessly.
- **Existing or proposed charging stations (if any)**
  Locations where charging stations already exist or are planned are identified and excluded to make way for the establishment of new charging stations.

a. Built-up Density Map

Built-up density in a city depends on the land desirability and suitability of a location in terms of quality of public services, access to infrastructure, neighbourhood type, and vibrancy of socio-economic and cultural characteristics. The data can be extracted from satellite imagery.

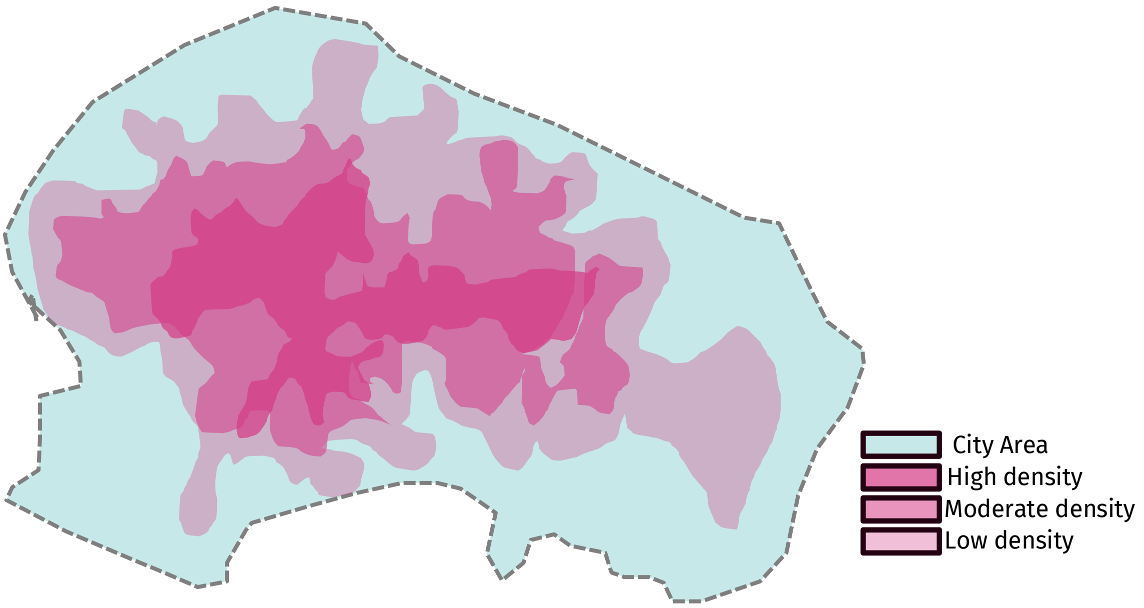


Figure 26 – Sample Built-up Density Map

b. *Road network*

The complete road network including arterial, sub arterial and collector roads in the city should be identified. The data can be derived from Google Earth, Google Maps, and city-level documents like the masterplan and comprehensive mobility plan of specific area/region

Figure 27 - Sample Road Network Map

c. *Land-use map*

A land-use map of the city or region should be created for different land parcels. The data can be collected from the masterplan or regional plan of the specific city/region.

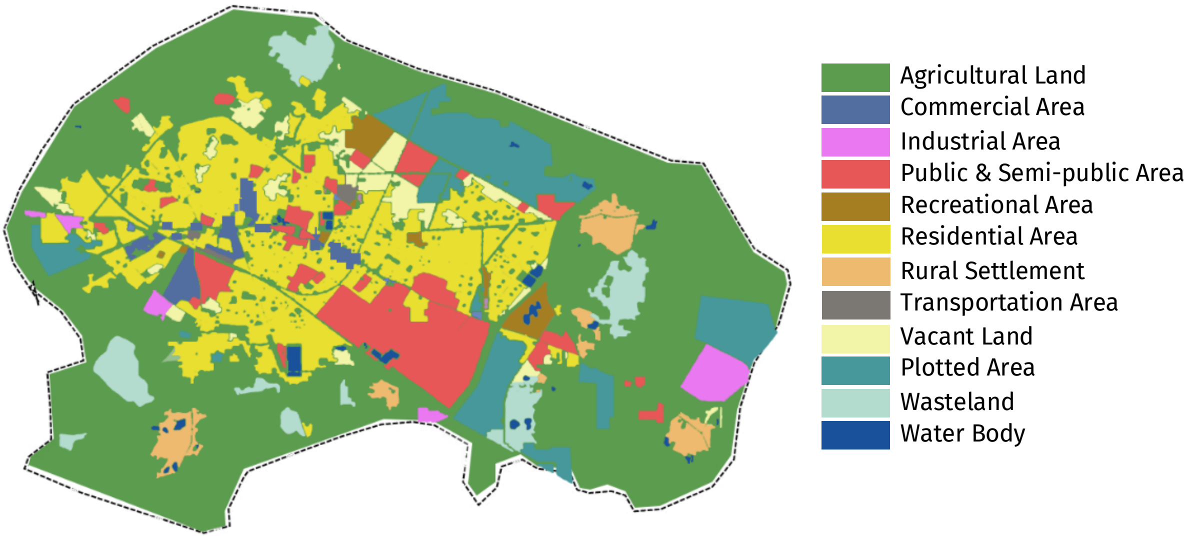


Figure 28 - Sample land use map

d. *Traffic volume map*

The peak hour traffic volume at arterial/ sub arterial and collector roads in the city can be identified by deriving the data from Google Maps traffic overlay.

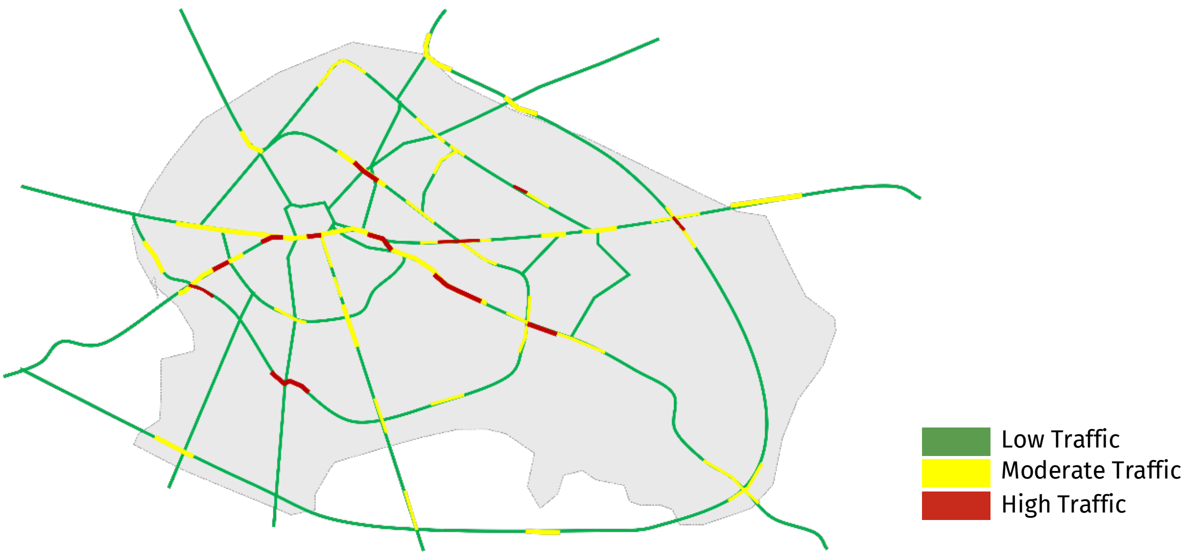


Figure 29 - Traffic volume map

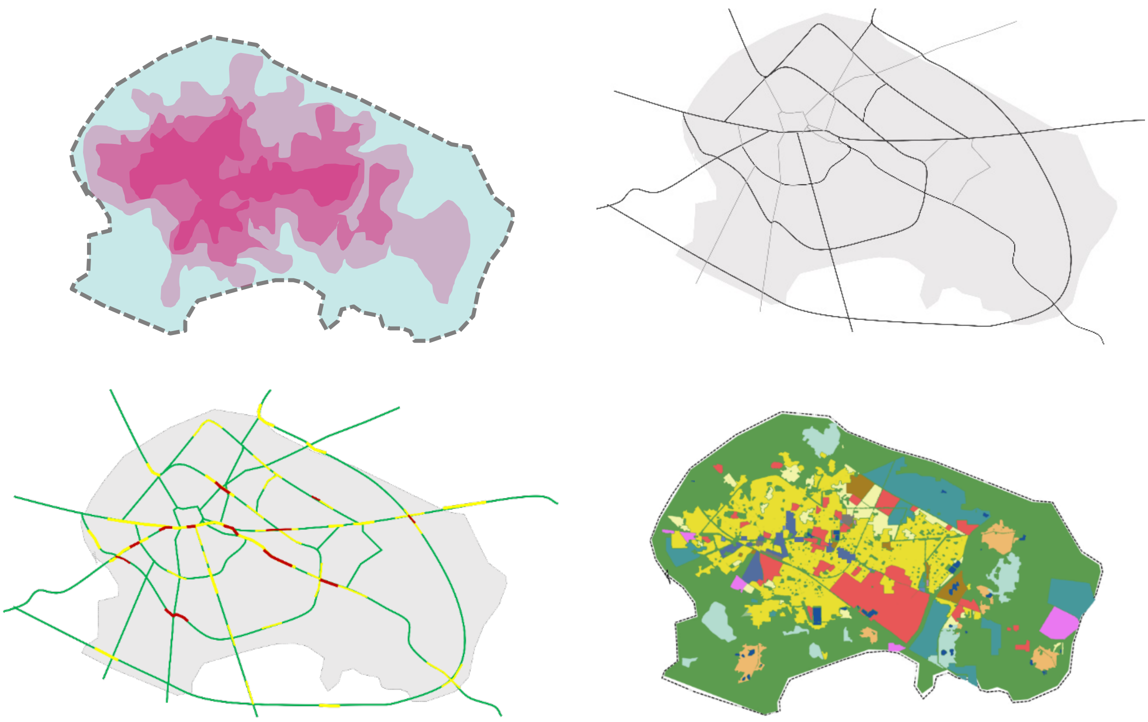
e. *Prominent places map*

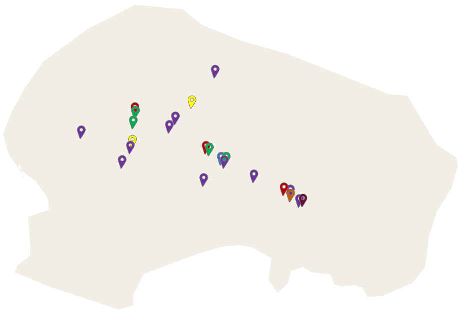
The prominent places in the city which potentially attract traffic should be marked. This data can be collected from Google Maps and other secondary sources like masterplans, tourism plans and comprehensive mobility plans.

Figure 30 - Sample prominent places map

7.1.2. *Primary Site Identification*

On layering all the six maps on top of each other, the primary EV charging locations can be identified.





Primary charging sites are identified as locations where three or more key features converge within a 300-meter radius. These sites exhibit significant potential for high charging demand, making them ideal locations for the establishment of EV charging stations.

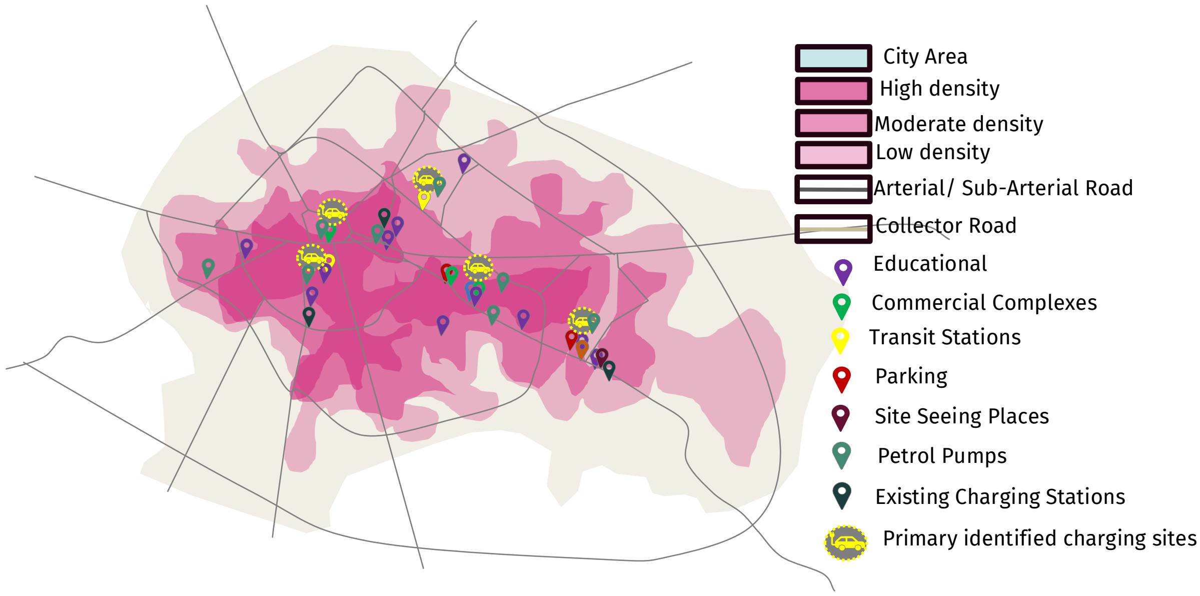


Figure 31 - Combined maps

If the number of primary sites identified is less than the total estimated requirement for charging sites for the city/region, then secondary and tertiary charging sites are to be identified in the following steps to meet the demand.

7.1.3. Secondary Site Identification

To identify secondary sites, a vector grid of 3km x 3km should be marked and adjusted on the map so that each primary site falls in a different grid.

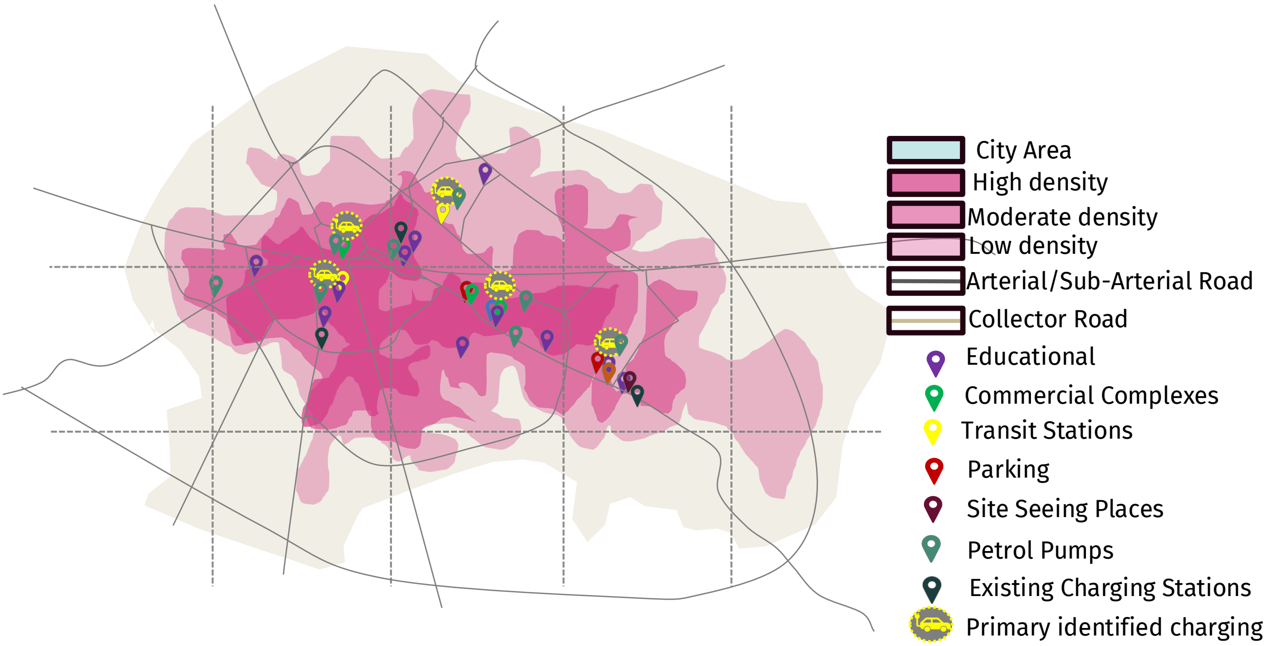


Figure 32 - Identified primary charging sites

After this, the vacant grids are identified, and each of them are assessed for features such as major roads, transit stations, public access buildings, parking areas, and substations/H-poles. Based on this assessment, secondary charging station locations can be selected in each of the remaining grids at the intersection of two or more of these features.

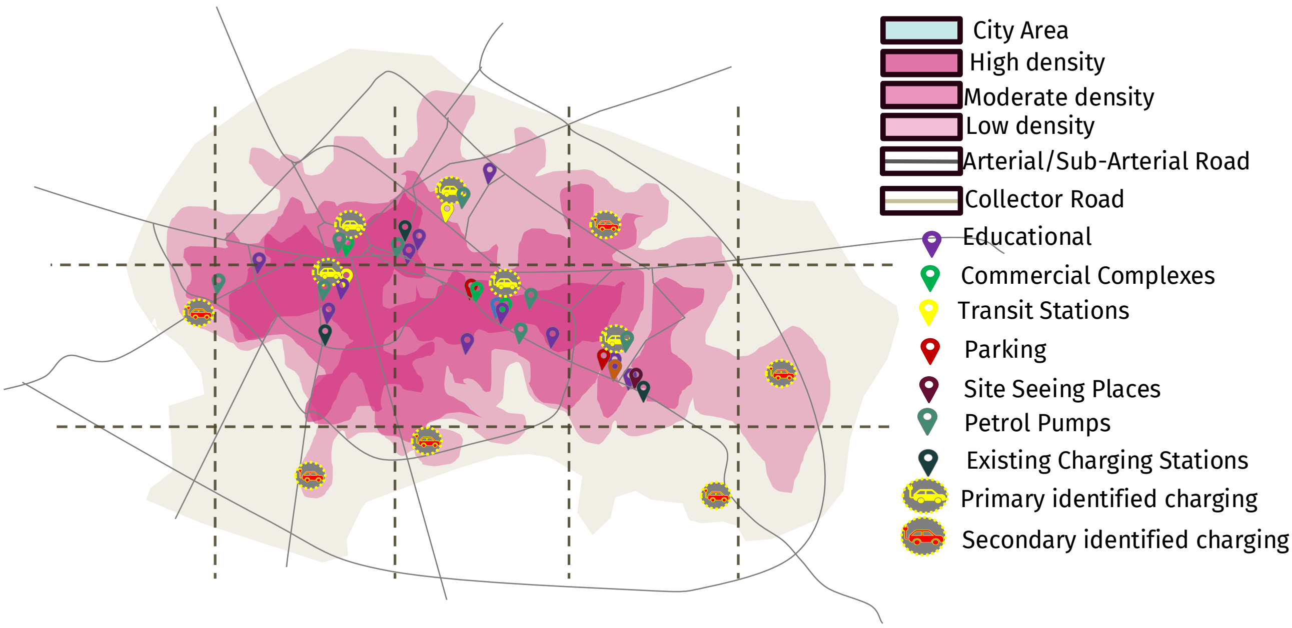


Figure 33 - Identified Secondary Charging Sites

7.1.4. *Tertiary Site Identification*

Tertiary charging sites need to be identified in some conditions: first if there is significant spacing between primary and secondary sites , and second if the supply of charging stations is less than the estimated demand for that city/region. These stations are demarcated as potential charging zones of interest.

To identify tertiary sites, a vector grid of 1km x 1km is marked. along with identifying empty grids.

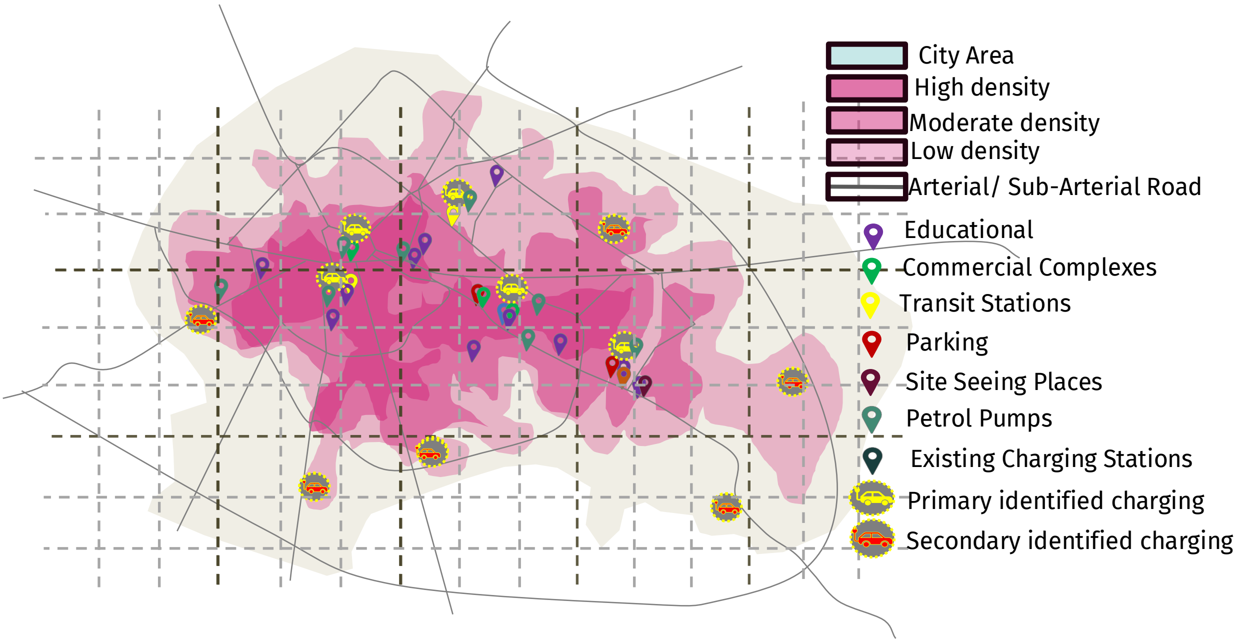


Figure 34 - Tertiary Site Identification

Then, grids that are either vacant or do not have any primary or secondary charging sites are identified. In each of these grids, the presence of features such as major roads, transit stations, public access buildings, parking areas, and substations/H-poles are evaluated. From this analysis, tertiary charging station locations are designated at the intersections of two or more of these features within the remaining grids.

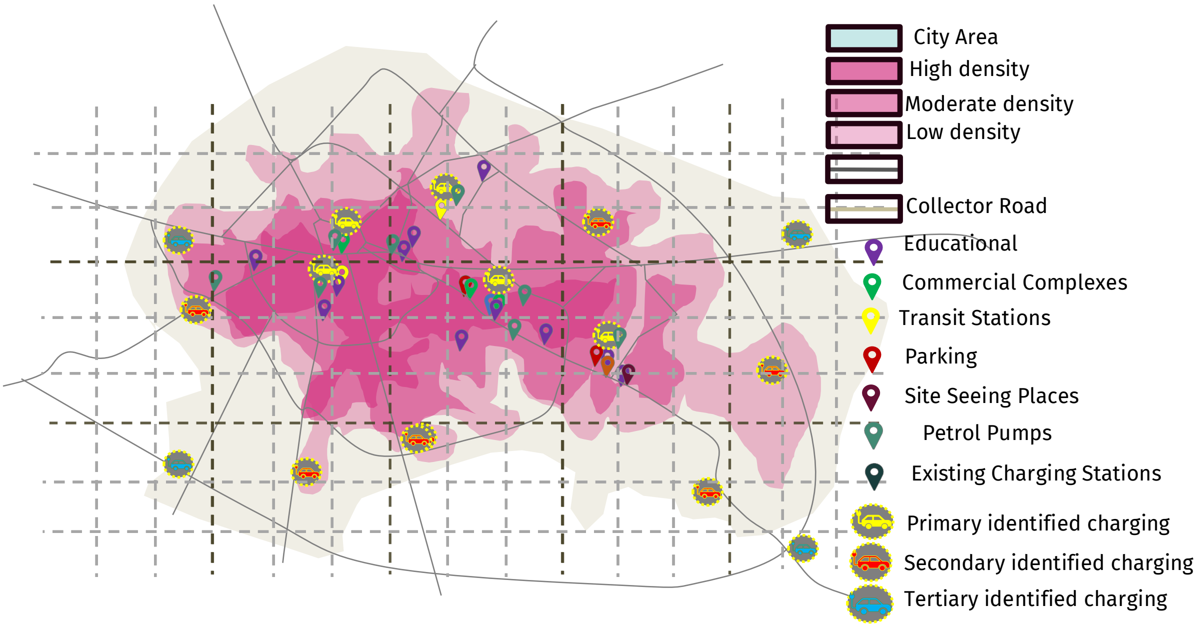


Figure 35 - Identified primary, secondary and tertiary charging sites

7.1.5. *Grid Prioritisation Index*

All the grids which have one or more existing or identified primary or secondary charging station location are highlighted. All the empty (1 km x 1 km) grids are allotted a prioritisation score using a grid prioritisation index. Tertiary locations are identified in these grids based on each grid index score.

A grid prioritisation index method should be applied to prioritise grids for tertiary site locations. This prioritisation method is based on research study titled 'Location Planning for Public Electric Vehicle Fleet Charging Stations', conducted by the Center for Study of Science, Technology and Policy in October 2021.

Steps for creating a grid prioritisation index:

Individual Index **Calculation** → Individual Index **Normalising** → **Overall Index Calculation**

1. **Step 1 - Individual index calculation**

   The individual index score of each 1 km x 1 km grid is calculated. To achieve this, a total of ten parameters in index have been identified. These indexes are of two types: weighted index and equal index.

Weighted index

Land-use index (LUi) (% of Land Use)		Built-up area density index (BUi) (% of built-up area density)		Road network index (RNi) (No. of roads)	
Parameter	**Weightage**	**Parameter**	**Weightage**	**Parameter**	**Weightage**
Commercial	40%	High Density	55%	Arterial	45%
Mixed	30%	Moderate Density	35%	Sub-Arterial	35%
Public/Semi-Public	20%	Low Density	10%	Collector[30]	20%
Residential	10%				
Others	0%				

[30] Combine Arterial and Sub arterial roads if required

Equal index

Travel pattern index (TPi)	**Traffic volume index (TVi) (Peak Hours)**	**Transit station index (TSi)**	**Public buildings index (PBi)**
Total trips of grid/ Total trips of area	Traffic volume of surveyed junctions and mid-blocks in or in proximity of grid/ total traffic volume in surveyed junctions and mid-blocks of area	No. of transit stations in grid / Total no. of transit stations	No. of public buildings in grid / Total no. of public buildings
Parking index (Pi)	**Petrol Pumps index (PPi)**	**Electric sub-station index (SSi)**	**Existing and proposed charging station Index (CSi)**
Either parking area or parking capacity in grid / Total parking area or parking capacity	No. of petrol pumps in grid/ Total no. of petrol pumps	No. of electric sub stations in grid/ Total no. of electric sub stations	No. of existing and proposed charging stations in grid/ Total no. of existing and proposed charging stations

2. **Individual index normalisation**

In this step, the individual index score of each 'Equal Index Input' is normalised. Normalisation of ratings involves adjusting values measured on different scales to a common scale before averaging.

Normalised index value (%) = (Index value for individual grid – Mean of index value for all grids) / Standard deviation of index value for all grids

3. **Overall index calculation**

After normalisation, the individual index score of each parameter is combined to obtain the final index or priority score of each grid. This is achieved by adding up the scores for all index parameters and subtracting the charging station index value.

Overall Index = LUi+ BUi+ RNi+ TPi+ TVi+ TSi+ PBi+ Pi+ PPi+ SSi - CSi

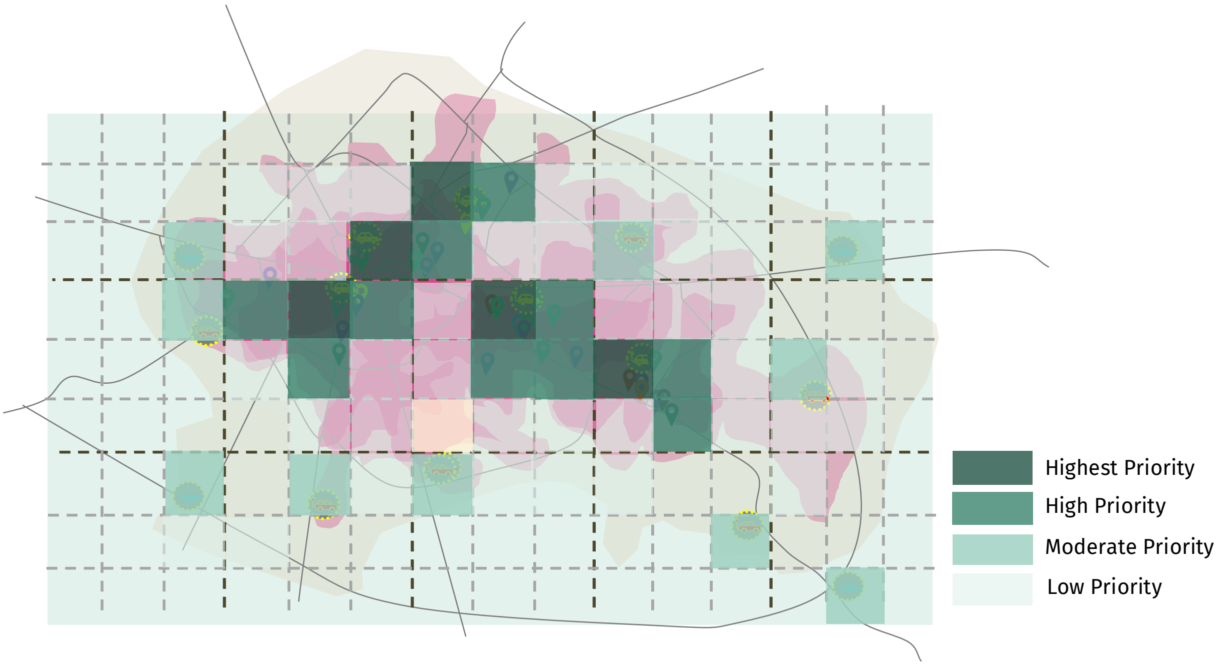


Figure 36 - Primary, secondary and tertiary identified charging sites

Figure 24 presents the priority level of each grid for the development of charging stations. This is based on the index score of each grid. A higher score represents higher priority for charging station development. An example for grid prioritisation process is included in Annexure II.

7.1.6. Site Identification

- In each grid, a key landmark, land use segment, or building should be identified a suitable location for a charging station.
- A circle of 300-meter radius is drawn around the chosen sites to represent the acceptable walking distance between the charging station and the location of interest.
- Final site visits are conducted to decide appropriate site for establishing the charging station within the 300-meter buffer.

Prominent places with high charging demand

300 meters buffer

Figure 37 - Sample charging station identification

The further considerations for charging station site selection are:

- **Close to the H-pole or transformer:** Charging station should be in close proximity to the H-pole or transformer (within 50m is preferred).
- **Connecting road or approach:** The charging station should be on a major road for better connectivity and approach.
- **Space limitation and land availability:** The location of the charging station should consider the land availability and space limitations. It is essential to ensure that charging stations do not obstruct the movement of pedestrians or vehicles. Additionally, for areas with on-street parking, special consideration is needed to integrate charging stations without disrupting existing parking arrangements.
- **Visibility:** The charging station location should ensure visibility to promote the use of EVs and to increase utilisation of the infrastructure.
- **Hazard-free site:** The location of the charging station should be away from any potential hazards. For example, locations prone to flooding (low-lying areas) should be avoided to prevent damage to electrical components and the risk of electrical shock.

Guidelines for Installation and Operation of Electric Vehicle Charging Infrastructure, 2024

1. **Urban areas:** By financial year 2030, there will be at least one charging station within a 1 km x 1 km grid in urban areas as notified by respective state governments.
2. **Highways:** Charging stations will be located every 20 km on both sides of highways, expressways, and major roads.
3. **Long-Range & Heavy-Duty EVs:** For long-range EVs and heavy-duty vehicles like buses and trucks, a fast-charging station (as per specifications in Clause 12 (7) of these guidelines will be located every 100 km on each side of the designated expressways, highways and major roads. Ideally, these stations will be situated within or near existing public charging stations. Cities/urban development authorities/states may locate these facilities in urban regions within areas such as transport hubs or bus depots.

7.2. Site Typology and Infrastructure Requirement

7.2.1. Site Identification

Charging station sites can fall under any one of seven site typologies. Infrastructure requirements can vary for each typology. These typologies are based on the land use and the potential users of the public charging infrastructure.

1. **Residential**

Gated community: Residential areas which are gated have restricted entrance and exits only for the members of that society or group housing and their guests. Access for the public is restricted. Group housing, housing societies and apartments are some examples of gated communities.

Non-gated community: In residential areas which are not gated anyone can enter the premises. Plotted settlements, sectors in city and non-gated housing colonies (which can include houses with or without parking facilities) are some examples.

2. **Institutional**

   Administrative: Administrative institutions including government institutes, legal institutes (courts), research institutes, government departments, hospitals, police station, banks and cultural institutes

   Educational: Educational institutes such as schools, colleges, university campus, vocational or technical institutes and training institutes

3. **Commercial**

   Retail: Shopping hubs, malls, departmental stores, independent stores, district centres and mixed-use buildings

   Offices: Office buildings such as single tenant, multi-tenant and high-rise office buildings

   Hospitality: Hotels, motels, resorts, restaurants and cafes

4. **Industrial**

   Industrial Area: Small scale industries, medium scale industries, large-scale industries existing in an industrial area or phase

5. **Transit stations**

   Transport hubs and interchange station such as bus terminals, railway stations, metro stations, ports and airports

6. **Filling stations**

   Filling stations such as petrol pumps, CNG pumps, gas filling stations etc.

7. **Depot/ Transport hubs**

   All types of depots and transport hubs where buses, trucks, LGV, MGV and other transport vehicles are parked and/or serviced.

7.2.2. Prioritisation of Chargers

After identifying the final site for installation of charging station, the next step is the prioritisation or selection of the slow, moderate, fast and rapid charging points. This can be determined based on-site typology of the charging station. Charging needs can vary by user and by types of vehicles, impacting the choice of the most effective charging infrastructure. The following table outlines different requirements associated with each vehicle type.

Site Typology		2W	3W	4W		Bus	Truck		
				Private	Commercial		LGV	MGV	HGV
Residential (Gated Community)	Slow								
	Moderate								
	Fast								
	Rapid								
Residential (Non-Gated Community)	Slow								
	Moderate								
	Fast								
	Rapid								
Institutional (Administrative)	Slow								
	Moderate								
	Fast								
	Rapid								
Institutional (Educational)	Slow								
	Moderate								
	Fast								
	Rapid								
Commercial (Retail)	Slow								
	Moderate								
	Fast								
	Rapid								
Commercial (Offices)	Slow								
	Moderate								
	Fast								
	Rapid								
Commercial (Hospitality)	Slow								
	Moderate								
	Fast								
	Rapid								
Transit Stations	Slow								
	Moderate								
	Fast								
	Rapid								
Filling Stations	Slow								
	Moderate								
	Fast								
	Rapid								
Depot/ Transport Nagar	Slow								
	Moderate								
	Fast								
	Rapid								

Table 10 - Prioritisation of chargers[31]

[31] *Source: Adapted from Grid Integration of Electric Vehicles, London's electric vehicle charge point installation guidance and A guide to electric vehicle infrastructure*
*Darker the colour, higher the suitability of charger

7.3. Infrastructure Requirements

		Residential (Gated)	Residential (Non-gated Community)	Institutional (Administrative)	Institutional (Educational)	Commercial (Retail)	Commercial (Offices)	Commercial (Hospitality)	Transit stations	Filling stations	Depots/ Transport hubs and industrial areas
Site typology	Public		✓			✓			✓	✓	✓
	Semi-public	✓		✓	✓		✓	✓			
Focus modes	Commercial					✓	✓	✓	✓	✓	✓
	Private	✓	✓	✓	✓	✓	✓	✓		✓	
	Public			✓							
Operation	App-based	✓			✓		✓				
	Open access		✓			✓			✓	✓	✓
	Card-based	✓					✓				
	Defined users			✓	✓			✓			
Payment mode	Scan and pay		✓		✓	✓	✓	✓	✓	✓	✓
	Auto deduct	✓		✓			✓				
	Manual										
Charging points with each charger	Multiple	✓	✓			✓			✓		✓
	Limited			✓						✓	
	Single				✓			✓			
Type	Overnight	✓	✓			✓		✓			✓
	Opportunity								✓	✓	
	Day			✓	✓	✓	✓				
	Top up									✓	

7.4. Site Layouts

The arrangement or layout of a charging station is influenced by factors such as its location, the number of charging points, space availability and the types of vehicles it accommodates. Based on the charging station's location, charging station layouts can be categorised into two types: off-street charging and on-street charging. Within these categories, different designs may be adopted based on the available space.

Parking spaces shall be provided in accordance with the local applicable building byelaws, ensuring compliance with the maximum allowable limits as prescribed by the local authority.

7.4.1. On-street Layout

On-street charging includes charging stations located in the multi-utility zone of streets, i.e. a designated zone at the kerb edge, to ensure minimal disruption to the movement of pedestrians and cyclists. The layouts of on-street parking are based on available space and the infrastructure is designed to ensure minimal disruption to the movement of road users. Providing charging facilities at off-street parking locations should be prioritised first. Charging should be provided on-street only when off-street parking facilities are not available to accommodate charging infrastructure.

Various on-street charging layouts based on parking type include:

- Perpendicular on-street charging layout
- Diagonal on-street charging layout (60-degree angle)
- Diagonal on-street charging layout (45-degree angle)
- Diagonal on-street charging layout (30-degree angle)
- Parallel on-street charging layout

On-street charging configurations cater to the diverse spatial constraints, optimising accessibility while maintaining traffic flow. The layouts further include variations such as perpendicular on-street charging, diagonal layouts at 60, 45, and 30-degree angles, and parallel on-street charging arrangements. The selection of a specific layout depends on the available space and the goal of seamlessly integrating charging infrastructure with the existing urban environment.

Parallel parking is recommended for four-wheelers on streets where parking is essential. It saves limited street space for public use and allows flexibility to accommodate perpendicular two-wheeler parking as well.

On narrow streets with high demand for two-wheeler parking, angular parking bays (1.2-1.5 m wide) are recommended.

Perpendicular on-street charging layout

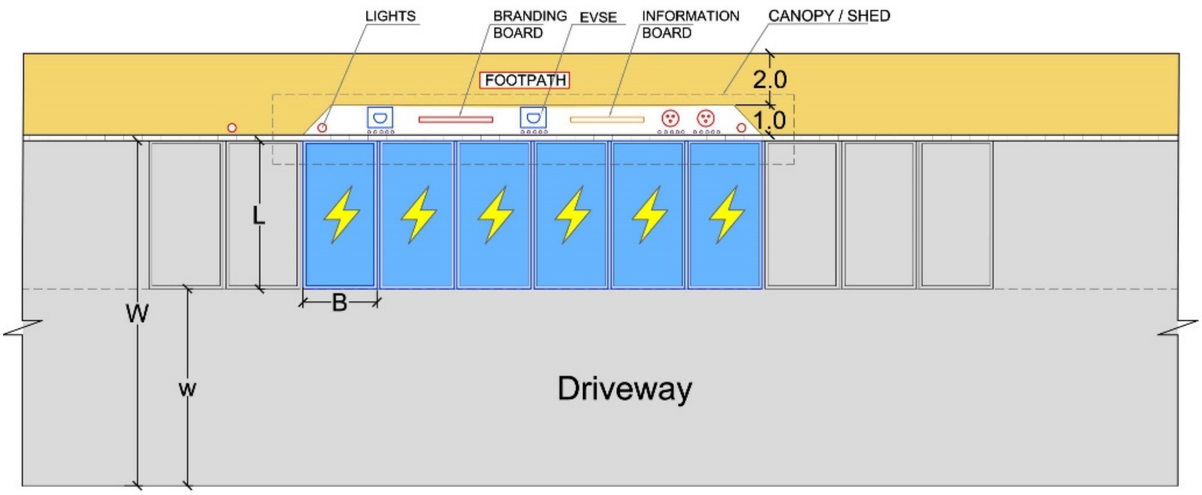


Figure 38 - Perpendicular on-street parking layout

Area of application

W ≥ 10m

Speed < 30 (40) km/h

Traffic Flow < 300 (400)PCU/peak hour

Dimensioning

L = 5m (with heavy volume of traffic on carriageway this may be more)

B = 2.5m

w ≥ 6 m

Diagonal on-street charging layout

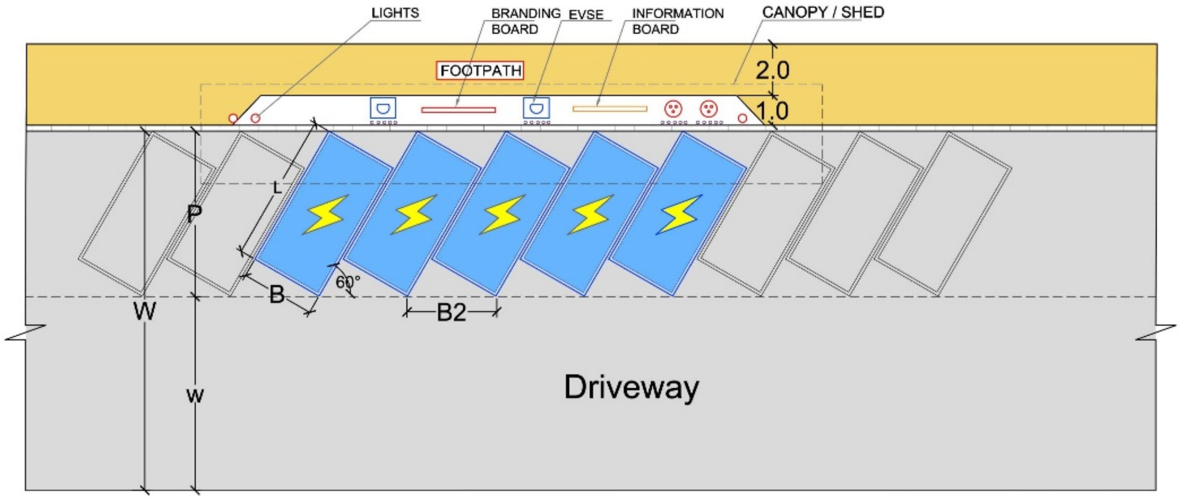


Figure 39 - Diagonal On-Street Charging Layout (60-degree angle)

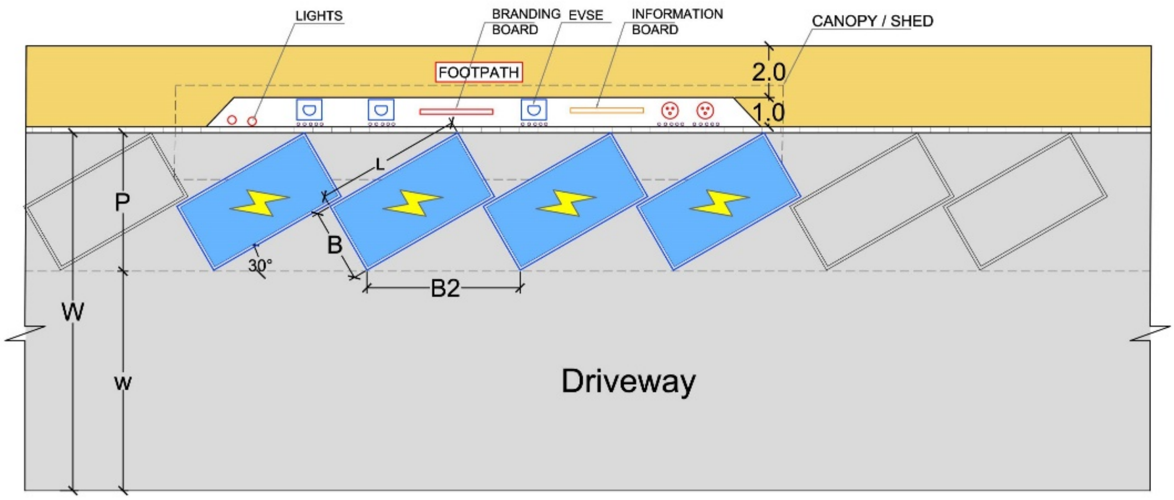


Figure 40 - Diagonal On-Street Charging Layout (30-degree angle)

Area of application

W ≥ 9.30m, at 60°

≥ 8.50m, at 45°

≥ 7.50m, at 30°

Speed < 30 (40) km/h

Traffic Flow < 300 (400)PCU/peak hour

One way traffic

Dimensioning (in m)

Angle	60°	45°	30°
B =	2.5	2.5	2.5
B2 (when B is 2.5) =	2.89	3.54	5.0
L =	5.0	5.0	5.0
P =	4.8	4.5	4.0
w ≥	6.0	5.5	4.5

Parallel on-street charging layout

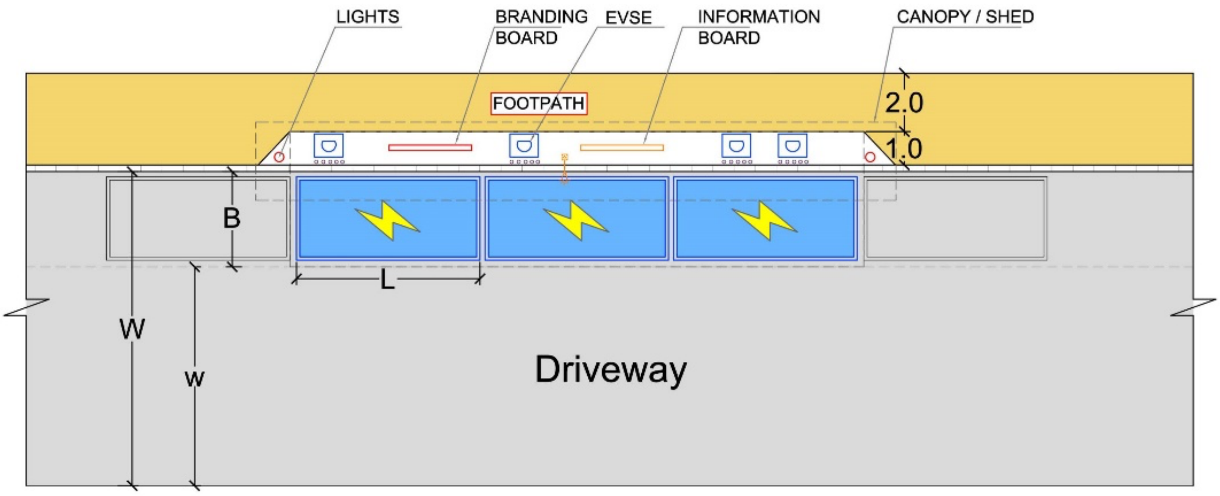


Figure 41 - Parallel On-Street Charging Layout

Area of application
W ≥ 4.80 m
Speed < 50km/h

Dimensioning
B = 1.8- 2m (with a heavy volume of traffic on carriageway this may be more)
L = 5.5 - 7m
w ≥ 3 m

Standards recommended for on-street charging

- **Placement of charging station:** The design of the charging station should align with the direction of traffic flow. It should not be placed at the intersections and should not hinder the pedestrian movement. It is advised that charging station access should be at a minimum distance of 50m from the intersection area.
- **Orientation of the parking bay:** If space permits, a diagonal or perpendicular orientation is recommended for the parking bay. In cases of space limitations, a parallel layout is advised.
- **Pedestrian access clearance on sidewalks:** To ensure unobstructed pedestrian movement, a minimum of 2m of clear space should be maintained between the EVSE and the nearest obstruction like a compound wall, fence, or vegetation. This space is to accommodate a footpath with barrier free links to the street pedestrian network for unhindered movement.
- **Charger clearance:** The EVSE should be positioned with a minimum clearance of 0.6 meters from the face of the kerb, and higher clearance if feasible.
- **Charger protection:** For perpendicular and diagonal layouts, it is imperative to safeguard the EVSE using bollards or guardrails. In parallel layouts, this can be optionally provided with kerbs separating the vehicle area from the charging stations.
- **Lighting requirements:** The charging station must be equipped with sufficient lighting to facilitate the operation of the EVSE. **Signage and pavement marking:** The charging station must be equipped with clear signage and pavement markings to provide clear guidance for use.

- **Information board:** The charging station should incorporate an information board or electronic sign displaying charger specifications, charging tariff and contact details for reporting any issues with the equipment.
- **Branding:** The charging should ensure branding designs and advertisement boards to provide educational information about EVs vehicles, to promote them and to generate revenue. The specification of such branding and advertisement should meet the local requirements and regulations. The branding should be installed in a way that it doesn't create dark spots on footpath and visually isolate the footpath
- **Existing underground infrastructure or services:** Before implementation, the chosen site should undergo an assessment to identify any pre-existing underground infrastructure or services.
- **Canopy:** To prevent water ingress and minimise the risk of short circuits during rain, the charging infrastructure should incorporate a canopy. This canopy should effectively cover both the EVSE and the vehicle either completely or partially. The charging point in the vehicle should be sufficiently protected.

7.4.2. *Off-street Parking*

Off-street charging infrastructure includes charging facilities situated outside the public right of way, including at fuelling facilities, parking spaces, and buildings such as malls or office parking areas. In off-street charging scenarios, various orientations of parking can be employed based on the available space at the site. Off-street parking layouts include:

- Perpendicular off-street charging layout
- Diagonal off-street charging layout (60-degree angle)
- Diagonal off-street charging layout (45-degree angle)
- Diagonal off-street charging layout (30-degree angle)
- Parallel off-street charging layout

Off-street charging infrastructure includes a spectrum of charging facilities located away from public thoroughfares, encompassing fuelling stations, parking lots, and structures like those found in malls or office complexes. The varied orientations of charging spots in off-street charging are adaptable to different space availabilities on-site. Off-street parking layouts include options such as perpendicular off-street charging, diagonal layouts at 60, 45, and 30-degree angles, and parallel off-street charging arrangements, offering flexibility to cater to diverse spatial configurations.

Perpendicular off-street charging layout

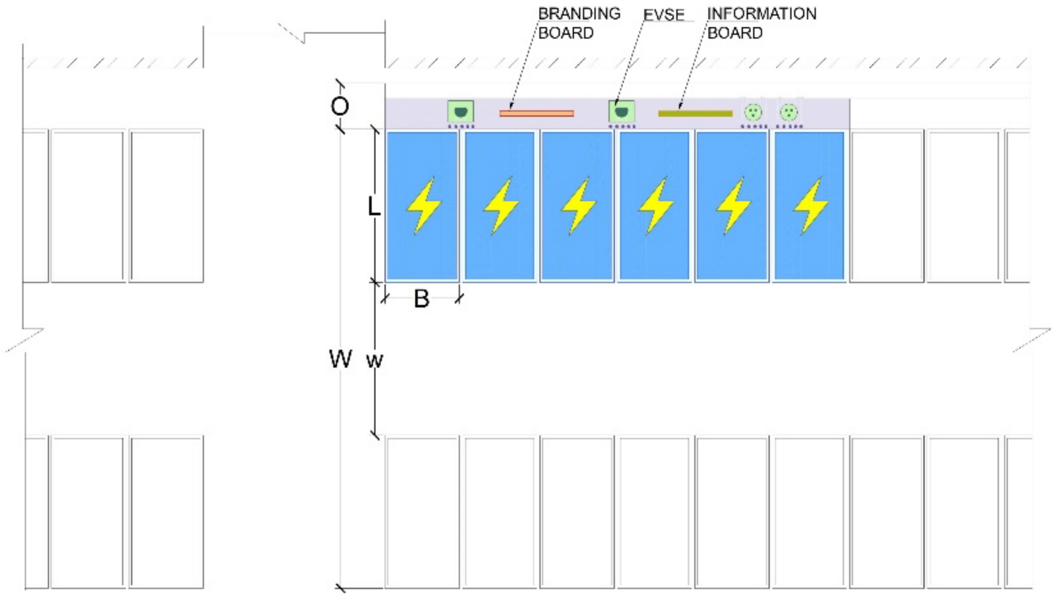


Figure 42 - Perpendicular off-street charging layout

Dimensioning

W ≥ 16m
L = 5m
B = 2.5m
w ≥ 6 m
O = 1.5m

Diagonal off-street charging layout

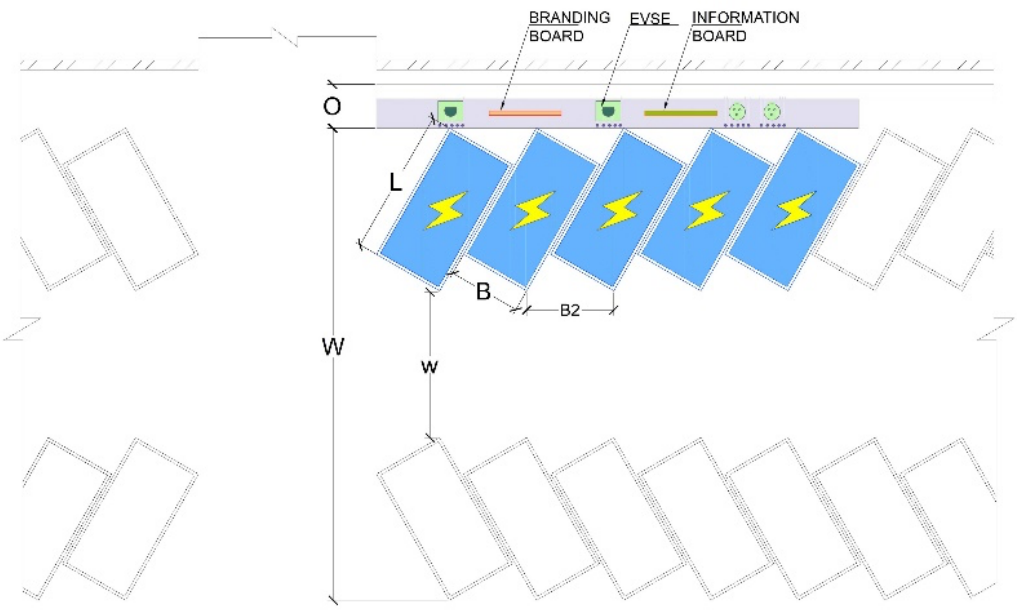


Figure 43 - Diagonal off-street charging layout (60-degree angle)

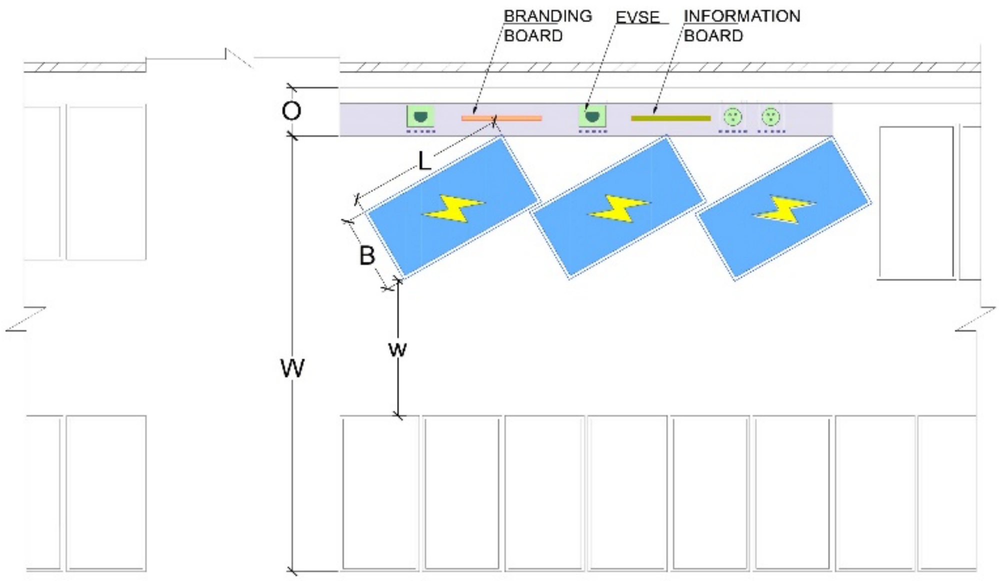


Figure 44 - Diagonal off-street charging layout (45-degree angle)

Area of application

W ≥ 14m, at 60°
≥ 13m, at 45°
≥ 11m, at 30°

One way traffic

Dimensioning (in m)

Angle	60°	45°	30°
B =	2.5	2.5	2.5
B2 (when B is 2.5) =	2.89	3.54	5.0
L =	5.0	5.0	5.0
P =	4.8	4.5	4.0
w ≥	4.5	4.0	3.5
O=	1.5	1.5	1.5

Parallel off-street charging layout

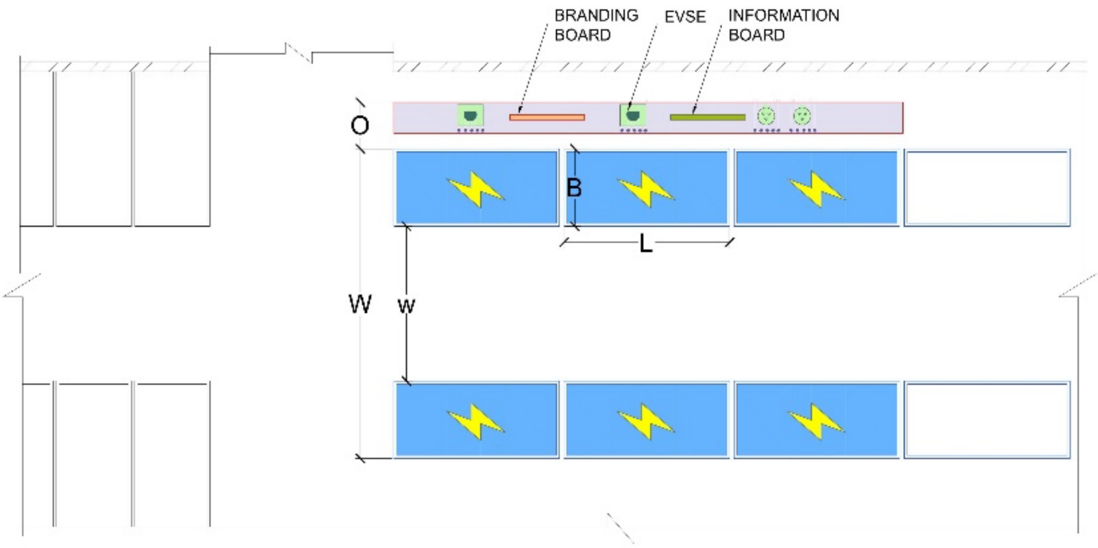


Figure 45 - Parallel off-street charging layout

Dimensioning
W ≥ 9.5m
L = 5.5- 7m
B = 2m
w ≥ 3 m
O = 1.5m

7.5. EV Charging Station Installation

7.5.1. *Application Process*

The application process for setting up EVCS (Electric Vehicle Charging Stations) in the case of a partnership between CPOs and Land-Owning Agency (LOA) can be summarised as follows:

1. **Proposal submission**

The CPO submits a proposal to establish and operate a specific number of public EV charging points at locations owned or operated by the Land-Owning Agency (LOA).

2. **Identification of locations**

Both the parties jointly select suitable locations based on space availability and feasibility of operation without disrupting regular activities.

Conducting a field survey in coordination with the Tamil Nadu Power Distribution Corporation Limited (TNPDCL) representative/engineer, based on the jurisdiction, is highly recommended to confirm power availability at the proposed locations.

3. **Investment commitment**

The CPO commits to investing in setting up and operating the charging stations, including necessary infrastructure like power connections, transformers, and meters, at their own cost in the agreed contract period.

4. **Compliance with guidelines**

The charging infrastructure installed must comply with guidelines and regulations set forth by the government or the MoP for performance, safety, and quality.

5. Statutory approvals

The CPO is responsible for obtaining all applicable statutory approvals and permissions from respective authorities for the charging stations.

The LOA can assist the CPO in obtaining consents, clearances, permits, and governmental approvals in a timely manner.

6. Safety measures

The CPO ensures all safety precautions are taken during the setup and operation of the charging stations. The LOA agrees to provide a safe and secure environment for installation and operation.

7. Encumbrance-free locations

The identified locations for charging stations must be free from encumbrances or hindrances. If any hindrance is identified during installation or operation, it must be addressed by the CPO, in agreement with LOA.

8. Joint planning and implementation

The parties can jointly plan, design, set up, and implement the projects. This includes planning and designing the infrastructure, investing in the projects, O&M, and managing them using cloud-based solution software.

9. Property rights

The projects and the charging system remain the property of the CPO. The LOA or any other party does not have any right, benefit, or interest in the project.

10. Power supply arrangements

The CPO shall apply for and obtain the electricity connection required for operating and maintaining the EV Charging Station at its own expense. The LOA shall provide the CPO with all necessary legal documents and approvals required for establishing such a connection.

11. **Brand partnership**

The LOA and CPO can agree to joint branding of the venture to create positive long-term association, market penetration, and boost the reputation of both parties in the project.

Overall, the process involves collaboration between the CPO and the LOA, with the CPO taking the lead in investment, setup, and operation of the charging stations, while the LOA provides necessary support.

7.5.2. Revenue-sharing Agreement

Payment terms, tax obligations, insurance requirements, and indemnification clauses are vital aspects of the revenue-sharing agreement between the CPO and the LOA for the deployment of EV charging stations.

1. **Payment terms**
    - The CPO agrees to pay the LOA a specified amount per kWh of billed units from the charging business within a set timeframe.
    - Transparency in revenue sharing is ensured through the provision of complete accounting details by the CPO to the LOA.
2. **Payment of taxes**
    - The CPO is responsible for paying all statutory levies and taxes related to the operation of EV charging stations.
    - Additionally, any increase in taxes or levies on the land area used specifically for charging stations imposed by local or statutory authorities is borne by the CPO, except property tax, which is the responsibility of the LOA.
3. **Insurance**
    - The CPO must obtain adequate insurance coverage for all risks associated with the operation of the charging stations, including third-party risks, fire, explosion, and riot risks.

Provision of public land at promotional rates for Public Charging Stations – 'Guidelines for Installation and Operation of Electric Vehicle Charging Infrastructure-2024', Ministry of Power

Initially, Public Charging Stations (PCS) may experience low usage due to the gradual increase in electric vehicles on the road. The combination of high land rent and uncertain future revenue streams can make setting up PCS financially unattractive. Therefore, the following provisions are made to lower the land cost.

1. Government/Public entities shall offer land for installation of PCS at a subsidized rate to Government/Public entity. This will be a revenue-sharing model where the land-owning agency receives 1 per kWh of electricity used for charging at the station, to be paid quarterly. The revenue sharing agreement may be initially entered by parties for a period of 10 years.

2. The Revenue Sharing Model may also be adopted by the public land owning agency for providing the land to a private entity for installation of Public Charging Stations on bidding basis with floor price of 1 per kWh.

7.5.3. Required Approvals

The installation of the EV charging stations shall adhere to several Acts, Rules, Regulations, and Standards as outlined below:

1. The **Electric Vehicle (EV) policy Tamil Nadu 2023** provides the overarching framework for the deployment of EV charging infrastructure within the state.
2. Relevant provisions of the **Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations, 2023**, and the **Electricity Act, 2003,** ensure compliance with safety and electricity supply standards at the national level.
3. The **Central Electricity Authority (Measures Relating to Safety and Electric Supply) Amendment Regulations, 2019**, and the **Central Electricity Authority (Technical Standards for connectivity of the Distributed Generating Resources) Amendment Regulations, 2019**, further specify safety measures and technical standards for electricity supply.
4. Guidelines and standards issued by the **Ministry of Power**, Government of India, including the revised guidelines and standards order N,12/2/2018-EV (Comp No. 244347) dated 14/01/2022, provide additional requirements for EV charging infrastructure.
5. Compliance with **IS 17017 Series of Standards** and **IS/ISO 15118** ensures conformity with internationally recognised technical specifications and protocols.
6. Compliance with **IS 732** is a requirement by the Tamil Nadu Electrical Inspectorate (TNEI) for safety certification of HT connections. Therefore, CPOs shall submit the **safety certificate** for HT connections, from Electrical Inspector authorised by TNEI. For LT connections, compliance with IS 732 may be limited to the general safety guidelines specified in the standard, and a self-declaration of adherence to these guidelines may be submitted by the CPO
7. Various orders and circulars related to EV charging stations published by the **Tamil Nadu government** supplement the regulatory framework with specific directives and requirements at the state level.

7.5.4. *Decision Flowchart for Charging Station Installation*

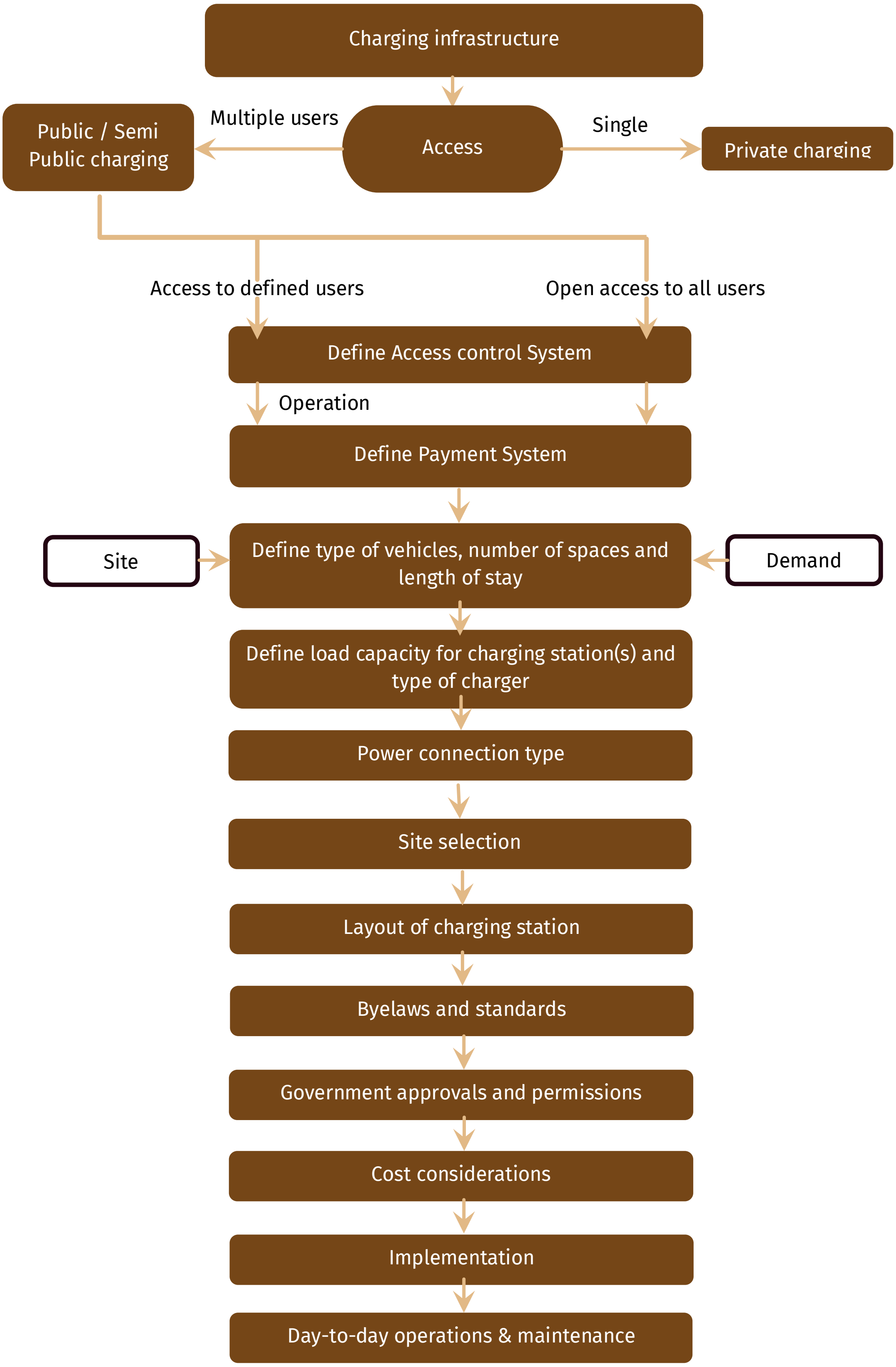


Figure 46 - Decision flowchart for Charging Station Installation

7.5.5. *Safety Precautions*

Installing a public charging station involves several precautions that need to be checked and fulfilled:

1. **Electricity supply**

   The safety and connectivity requirements for the EVSE should comply with the provisions outlined in the CEA; Measures Relating to Safety and Electric Supply Regulations of 2023, as amended periodically, as well as the Central Electricity Authority's (CEA) Technical Standards for Connectivity of Distributed Generation Resources Regulations of 2013, along with any subsequent amendments.

2. **Reliable wiring**

   Appropriate cabling and electrical work should be installed to ensure safety and proper operation of the charging station. It is recommended that the CPOs ensure the implementation of basic protection measures as per the National Electric Code of India, 2023, specifically addressing

   - Protection against electric shocks
   - Protection against thermal effects
   - Protection against overcurrent and short-circuit current
   - Protection against voltage disturbances

   The CPOs shall also comply with the applicable electrical installation practices outlined in IS 732: Code of Practice for Electrical Wiring Installations.

3. **Surge protection**

   Type-1 and Type-2 protection as per Indian Standard Code IS / IEC 62305-4 and IEC 61643-12 (© IEC: 2008, Edition 2.0, 2008-11) must be implemented to safeguard against electrical surges.

4. **Fire safety**

   Adequate fire protection equipment and facilities must be installed in accordance with relevant Indian standards. Charging stations should never be installed near fire sources, explosive materials, combustibles, or any other flammable sources.

Locations where gas or chemical explosions could potentially occur should be avoided.

5. **Weather protection**

   As per Clause 12.4 of BIS 17017 (Part 1), 2018, adequate protection of the charging station from adverse weather conditions should be ensured.

6. **Compliance with national and state regulations**

   All electrical equipment installed in EV charging stations should comply with Central Electricity Authority (CEA) regulations, specifically the Technical Standards for Connectivity of Distributed Generation Resources (2013) and Safety and Electric Supply Measures (2023), as amended from time to time.

   EV charging stations must also comply with state-specific regulations issued by TNERC, TNPDCL, or TNEI as applicable. Any changes in load after the commissioning of an EV PCS must be promptly communicated to the respective territorial engineer of TNPDCL.

7. **Compliance – Equipment testing**

   Each EVSE model with different power ratings and communication protocols must be type-tested by the Original Equipment Manufacturer (OEM) in accordance with BIS standards specified in Annexure I, in a NABL-accredited testing laboratory, and obtain valid type-approval certification from the Automotive Research Association of India (ARAI) as mandated under CMVR.

8. **Site hazard assessment**

   Hazardous conditions in or around the site should be checked, particularly areas near fuel pumps or fuel tank vents. EV charging stations should be installed at a safe distance from fuel handling and storage facilities. Specifically, they must be placed at least 3 metres away from the fill point of underground petroleum storage tanks, 4 metres from tank vents, and 6 metres from MS/HSD/ALDS/CNG/LNG dispensing units. In addition, the minimum clearance should be 9 metres from the fencing of ALDS and LNG installations, 6 metres from the fencing of CNG installations, and 9 metres from LPG and LNG unloading points, including the centre of tank truck unloading platforms.

9. **Proximity to water sources**

   Charging stations should be avoided near water sources, and the implications of rainwater and flooding should be considered.

10. **Underground infrastructure check**

    Before any excavation begins, the locations of existing underground infrastructure should be identified to prevent any damage.

11. **Ground connection**

    The charging station should always be connected to the ground to facilitate proper charging and prevent malfunctions.

7.5.6. *Charging Station Design*

A well-thought-out charging station design holds immense significance as it contributes to easy accessibility, high visibility, a pleasant environment for users, and minimises the likelihood of being obstructed by other vehicles. Effective design plays a pivotal role in promoting the adoption of electric vehicles and encourages the utilisation of public charging infrastructure. A well-designed EV charging station should have the following characteristics.

1. **EV charger options**: One or more EV chargers that comply with the standards specified in Annexure I should be installed.
2. **Clear instructions**: Charging stations should provide clear and straightforward usage guidelines, ideally through graphics. This is particularly beneficial for new drivers unfamiliar with the charging process.
3. **EVSE/Charger information**: Specifications of available EV chargers on the EVSE for user reference in public charging stations should be presented.
4. **Transparent pricing information**: Charging stations should provide clear and straightforward pricing details for the users' benefit.
5. **Lighting design**: Illumination sources should be strategically elevated. Specific focus should be given to lighting around the charging ports and/or control screens, aiding in signalling whether a car is actively charging or not.

6. **Dedicated parking**: Clearly marked and unobstructed parking spaces should be reserved specifically for EV charging at charging stations.
7. **Vehicle manoeuvring**: Adequate space for charging vehicles should be provided along with easy entry and exit.
8. **Canopy**: It is advisable for the charging infrastructure to incorporate a protective shed or canopy, that can protect from preventing water-logging and minimise the risk of short circuits during rainfall, ensuring safety in all weather conditions.
9. **Digital convenience**: Arrangements should be made for usage tracking, automatic billing, and convenient payment options.
10. **Inclusive cords/cables**: Charging stations should not only feature a charging port but also include the necessary cords/cables that drivers can plug in, without the need for them owning additional equipment. These should be in an integrated systems designed to keep cords and cables elevated off the ground, minimising the risk of tripping.
11. **Customer support information**: It is essential for charging stations to prominently display a 24/7 helpline phone number for users to receive assistance promptly in case they encounter any issues while utilising the charging infrastructure.
12. **Trained staff**: Trained personnel need to be employed for safe operation at charging stations with more than four EV chargers (optional).
13. **Accessibility features**: The charging station features should be intended to increase access for differently abled users.
14. **User security**: The customer care number of the Charge Point Operator (CPO), the Tamil Nadu Fire Safety Number (101), and the Women's Helpline Number (1091) should be prominently displayed at public charging stations.
15. **Security cameras**: Stations should be equipped with CCTV cameras that have a month's worth of data storage (optional).
16. **Minimum parking space**: Offices, commercial buildings, and resident welfare associations should set aside a minimum share of total common vehicle/parking capacity, as specified in the state building bye-laws.
17. **Branding/marketing/placemaking**: The charging station should incorporate strategies for placemaking, branding, and public education to emphasise the advantages of using electric vehicles (EVs) or renewable energy sources.

This approach helps create a distinctive identity, fosters awareness, and encourages public engagement with the benefits of EV technology and sustainable energy practices.

18. **Strong colours**: Incorporating bold, easily identifiable colours into the station can help capture the customer's attention.

7.5.7. *Key Design Considerations for EV Charging Stations*

1. **Accessibility:** Charging stations should prioritise convenience and ease of access to and from the charge points. This involves the following considerations:
   - **Barrier-free design**: The station should be barrier-free, without obstacles or impediments that might hinder access for all users.
   - **Universally accessible**: The station should aim for universal accessibility, accommodating a diverse range of users, including women, the elderly and people with disabilities or specific mobility needs.
2. **Proximity to entrances or elevators in parking lots**: In parking lots, charging stations should be strategically located near entrances or elevators to enhance convenience for users.
3. **Aesthetics:** The overall visual appeal of the charging station can significantly impact utilisation. Considerations from an aesthetic standpoint include clean site, scenic views or proximity to a park.
4. **Safety:** Ensuring the safety of the charging infrastructure is paramount, encompassing various aspects:
   - **Safe access:** The charging station should be easily accessible, avoiding the need to cross busy traffic and ensuring a secure route to the station.
   - **Safe environment for users:** A secure environment should be created for users to feel safe while sitting or leaving their vehicles unattended during the charging process.
   - **Safe charging spaces:** The charging car should be safe from potential hazards, including other vehicles, bicyclists, and pedestrians. Adequate lighting can contribute to achieving this.
   - **Minimise obstructions:** Reduce obstructions and potential tripping hazards in the vicinity of the charging station, promoting a clear and safe space for users.

5. **Protection from the weather:** The design of the charging station should prioritise safety when charging electric vehicles (EVs) outdoors, especially in the rain. It is advisable to either have an indoor charging station or use a canopy for an outdoor station with a shed to cover the EV being charged.
6. **Opportunities for recreation and relaxation:** Drivers typically spend between 20 minutes and several hours charging their vehicles. Positioning EV charging stations close to shopping malls, restaurants, and coffee shops, can offer recreation while also bringing business to these places.
7. **Off-Street EV charging locations:** Off-street charging facilities are preferred over on-street, and on-street stations will therefore charge a higher fee. This will encourage shorter use and ensuring greater availability and convenience.

7.6. Signage

Signage for EV charging infrastructure is an important consideration as it guides and help EV users to navigate and identify charging stations. Appropriate signage at charging infrastructure can help in the following ways.

1. **Navigation and identification:** Signage helps EV users navigate to and identify charging stations efficiently.
2. **Optimising infrastructure use:** Signage clarifies that parking spaces at charging stations are exclusively reserved for EVs, optimising infrastructure use.
3. **Policy information and enforcement:** Signage provides crucial information about policies (e.g., access, time limits), facilitating enforcement.
4. **Choose correct type of signages:** There are two main types of signage for EV Charging infrastructure: way-finding signage and station signage. Way-finding signage is essential to help EV users navigate to charging stations from their current locations, such as a highway exit. These signs, designed for way-finding purposes, can be enhanced with directional arrows to provide clear guidance and ensure a seamless journey to the charging stations. Station signage helps EV users identify charging stations and communicate and enforce policies related to the use of the charging infrastructure and associated parking spaces.
5. **Pavement markings:** Pavement markings, applied to the surface of a parking space, can complement signage for charging stations and provide additional visual reinforcement.

Electricity Supply for Charging Infrastructure

Electric vehicle (EV) owners and Charge Point Operators (CPOs) have several options for setting up electricity connections for EV charging points or facilities with multiple charging stations. The selection of the optimal solution depends on the specific needs and circumstances of the individual or organisation. The general guidelines for establishing EV charging infrastructure across commercial buildings, residential properties, community areas, and public facilities, such as bus depots are as follows[32]:

1. **EV charging at offices/commercial buildings**

   New connection: A building/office owner can request for a separate metered connection from the distribution licensee with a dedicated EV charging tariff. This will be installed within the timelines specified in Electricity (Rights of Consumers) Rules, 2020 as amended from time to time.

   Existing connections: A building/office owner may use their existing electricity connections to charge employee EVs at the workplace.

   Increased load: If necessary, a building/office owner can apply to their electricity distribution licensee for a higher power load to accommodate EV charging stations.

   EV charger selection: In consultation with the distribution licensee, commercial building owners can choose the types and number of workplace EV chargers to install based on employee needs.

2. **Charging at residence**

   New connection: Owners can request for a separate metered connection from the distribution licensee with a dedicated EV charging tariff. This shall be granted within the timelines specified in Electricity (Rights of Consumers) Rules, 2020 as amended from time to time.

   Existing connection: Owners can use their existing electricity connection to charge their EVs at home.

   Increased load: If the EV charging station requires more power than the current sanctioned load, the owner can apply to the distribution licensee seeking an increase in the sanction load.

   Charging rates: Domestic electricity rates will apply to charging EVs at home.

[32] Guidelines for Installation and Operation of Electric Vehicle Charging Infrastructure-2024

3. **Community charging for residents**

   New connection: A Resident Welfare Association (RWA), Group Housing Society (GHS), an owner of a flat, house in an association, any other consumer within a GHS, can request for a separate metered connection from the distribution licensee with a dedicated EV charging tariff. This will be installed within the timelines specified in Electricity (Rights of Consumers) Rules, 2020 as amended from time to time.

   Group Housing Societies (GHS): In consultation with the distribution licensee, Residential Welfare Associations (Society) can establish EV charging stations within their premises.

   Choice of EV chargers: Residents can decide on the types and number of community EV chargers to be installed.

   Visitor charging: Community stations can be equipped to allow charging for authorised visitor vehicles.

   Private charging points: Residents can install private EV charging stations in their designated parking spaces. The distribution licensee will ensure electricity supply through the residents' existing meter or a separate sub-meter depending on consumer's choice.

   Increased load: If a community EV charging stations requires more power than the current sanctioned load, then the GHS will apply to the distribution licensee seeking an increase in the sanctioned load.

   Community charging rates: The GHS will determine the charging fees for community charging based on the applicable electricity tariff and service ceiling limits laid down under these guidelines.

4. **Charging stations for e-buses**

   Distribution licensee connection: Bus depot operators can apply for electricity connections with their distribution licensee.

   Open access option: E-Bus depots can also choose to obtain electricity through open access within 15 days of submitting a complete application. This option involves paying a surcharge (not exceeding 20% of the tariff applicable to the category of the consumers seeking open access as per the Tariff Policy 2016), transmission charges, and wheeling charges. No additional fees will be applied beyond these. State Transport Undertakings may also explore potential integration of renewable energy sources (like solar energy) in bus depots.

   High-power EV chargers: E-Bus depots must install EV chargers with a minimum capacity of 240 kW, complying with Power Level 3 or 4 as defined in ANNEXURE I.

To successfully establish EV charging infrastructure, a well-planned approach to securing an electricity supply is required. This process involves assessing the power demand, selecting an appropriate electricity connection, and where feasible, integrating renewable energy solutions. The following steps outline the essential considerations and actions necessary for ensuring a reliable electricity supply for EV charging facilities:

i. *Step 1: Estimate the Required Power Demand in kilowatts (kW)*

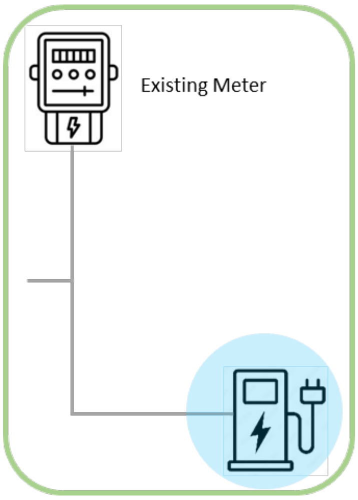
The initial step in arranging for the electricity supply for EV charging is to estimate the required power demand in kilowatts (kW). This estimation is crucial as it forms the basis for determining the necessary electrical infrastructure and capacity needed to support the charging facility.

The estimated power demand in kilowatts (kW) is equivalent to the sum of the rated input requirements of all the charging points that are part of the planned installation at a given location. This figure provides a comprehensive understanding of the collective power needs, guiding subsequent steps in the process of arranging for the electricity supply for EV charging.

ii. *Step 2 - Electricity Connection for the EV Charging Infrastructure*

Establishing a robust electricity connection is vital for the successful deployment of charging infrastructure. This section outlines three options for securing electricity supply to charging stations, catering to the diverse needs of CPOs and EV owners. By understanding the benefits and requirements of each option—utilising existing power connections, arranging new connections, or implementing captive renewable energy systems—stakeholders can effectively plan for the energy demands of their charging facilities while promoting sustainable practices.

Option 1 - Draw electricity from an existing power connection



In cases where semi-public or public EV charging stations are integrated within a host facility, the Charge Point Operator (CPO) may opt to access electricity from the existing power connection, by including a sub meter, post approval of host establishment.

Figure 47 - Electricity connection from an existing power connection

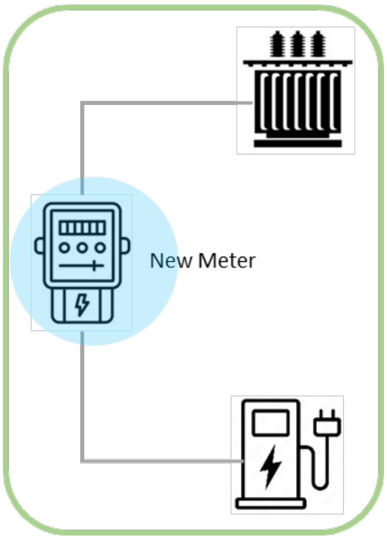
When linking the EV charging infrastructure to an existing power connection, it is essential to adhere to the following steps:

1. Verify the type of connection accessible at the host establishment and assess whether the estimated power demand of the charging infrastructure aligns with the available sanctioned load. Ensure that the sanctioned load is sufficient to accommodate the power requirements for EV charging.
2. If the sanctioned load of the current connection proves insufficient, the owner of the host facility must apply to the DISCOM (Distribution Company) to request an increase in the sanctioned load. It is important to note that this process may involve additional charges and a timeframe for becoming operational.
3. If the current connection type is single-phase LT or three-phase LT, and if the sanctioned load increase surpasses the permitted power demand threshold for the category (as outlined in the state supply code), the owner of the host establishment must apply for a three-phase LT connection or an HT connection, respectively. This process entails changing the meter, and the applicant will be required to cover specific fees such as Service Line cum Development (SLD) charges and charges for meter change.
4. To upgrade to a three-phase LT connection, it is essential to assess the available capacity of the serving Distribution Transformer (DT). If the DT is determined to be approaching its capacity threshold, the DISCOM may need to establish a new DT along with the required 33/11 kV cables. Alternatively,

the owner of the host facility may choose to install a dedicated DT on their premises at their own cost to expedite the process and avoid delays in grid augmentation.

5. In cases where an HT connection is required, the applicant will be responsible for installing their own DT and 33/11 kV cables. This process involves significant costs and time commitments on the part of the applicant.

(***Note:*** *This option is typically selected in cases where there is excess capacity in the sanctioned load of the existing connection, or in cases where competitive tariffs for EV charging are not an issue. It is best suited for private and semi-public charging, which is offered as an amenity by the host establishment for occupants and visitors.*



Option 2 - Arrange for a new electricity connection

CPOs or EV owners have the option to request a dedicated electricity connection specifically for EV charging, whether it's within a host establishment or for standalone charging facilities.

Figure 48 - New electricity connection

To avail special EV tariffs, the CPO must request a separate metered connection, specifically designated for EV charging (LT-VII or HT-V, depending on the demand load) and may opt for a pre-paid connection if available from the DISCOM. The application must follow the guidelines outlined by the State Electricity Regulatory Commission (SERC) and ensure the following:

1. The CPO or EV owner must verify if the estimated power requirement aligns with the specifications for single-phase LT, three-phase LT, or HT categories, and proceed to apply for a new connection accordingly.
2. In Tamil Nadu, if the power requirement of a charging station exceeds 150 kW, an HT connection becomes necessary. For an HT connection, the CPO is required to install their

own DT along with 33/11 kV cables. On the other hand, for an LT connection, the CPO should consider the available hosting capacity of the nearby DT when designing the charging installation and determining the required power demand at a specific site. This strategic consideration can help minimise the necessity for costly grid upgrades.

3. If a new DT is required to serve the new connection, the DISCOM may incorporate this installation as part of their planned grid upgrades. However, the CPO might be required to cover the costs associated with installing a new DT, particularly if it is exclusively designated for the charging facility's use.
4. In case the charging facility is housed within a host establishment, the CPO may not be able to apply for an exclusive connection if it does not have the ownership of the charging space. However, the CPO after consultations with the local DISCOM may apply for a separate EV charging connection (LT-VII or HT-V) for the charging facility up to a certain load, provided there is a formal consent and rent or lease agreement for the space with the owner and that such connections are permitted by the SERC concerned.

   Additional measures may be permitted by DISCOMs to enable the provision of EV connections within existing host establishments. These measures could involve practices such as minus metering and the provision of separate EV connections without demand charges.

1. **Minus metering**

   Large commercial and institutional buildings, such as malls, large office buildings, and entertainment parks, often possess their own HT connections equipped with exclusive DTs and a substantial sanctioned load. In such cases, it is convenient to establish a separate LT metered connection derived from the existing HT connection.

   DISCOMs have the option to implement minus metering, a system where an electricity connection exclusively for EV charging is derived from the existing host connection. The energy consumption for EV charging is measured using a submeter, and the corresponding charges are based on the applicable EV tariff. This arrangement is straightforward to implement and proves more cost-effective than establishing a new LT connection for the charging points.

2. **Use a captive renewable energy generation system**

CPOs have the option to partially or entirely fulfil the energy requirements for EV charging through captive electricity generation.

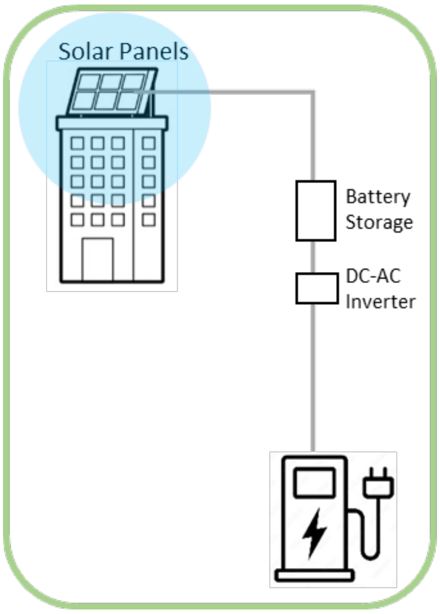


Figure 49 - Captive renewable energy generation system

However, the viability of this option should be evaluated on a case-by-case basis, considering factors such as site-specific conditions, regulatory considerations, and the overall feasibility of implementing and maintaining a captive generation system.

Captive electricity generation for EV charging is commonly facilitated through solar photovoltaic (PV) or solar-wind hybrid systems, complemented by stationary energy storage to ensure a consistent power supply. Key factors in evaluating the feasibility of this approach include the available surface area for installing the generation system, and site characteristics such as solar insolation and wind profile. Typically, an area of about 10 square meters is needed to establish a 1 kWp solar PV system. The design can be integrated as a solar roof over the charging facility for optimal space utilisation or mounted on the existing roof of the host establishment, where feasible. Additionally, the follow steps are needed:

1. A technical feasibility study is essential to assess the electricity generation potential and determine the necessary storage capacity at the site. This study would involve a detailed analysis of factors such as solar insolation, wind patterns, available space, and the energy demands of the EV charging infrastructure. By evaluating these parameters, the feasibility

study helps determine the viability and optimal configuration of a captive electricity generation system for EV charging.

2. Based on the outcomes of the feasibility study, the CPO should assess the portion of the necessary power demand for the EV charging installation that can be met through captive generation. In cases where on-site electricity generation and storage can only fulfil a portion of the power demand, the CPO must arrange for a secondary electricity supply source. This can be facilitated either through an existing grid connection, or by establishing a new metered connection to ensure the complete fulfilment of the power requirements.

Net metering

Net metering or net billing allows for the subtraction of on-site electricity generated from renewable sources from the total electricity consumed during the billing period. This mechanism aids in reducing the electricity bill for a 'prosumer', defined as an entity that both consumes electricity from the grid and has the capability to inject surplus electricity into the grid. The prosumer either pays for the net difference in units or receives compensation from the DISCOM for any excess units generated at the conclusion of the billing cycle, provided it is regulated and applicable in the state.

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The supply of renewable energy shall be ensured to public/private charging stations & public battery swapping stations on a preferential basis with applicable TNERC levies. The State has introduced a renewable energy-based 'green tariff' for HT services. The green tariff would be an additional 10% over the HT category's respective tariffs.

Additionally, the Government of Tamil Nadu seeks to encourage decarbonization in the charging network. Therefore, the cost of renewable energy equipment such as rooftop solar panels shall be considered as a part of the equipment and machinery cost for charging/swapping stations provided at least 75% of the energy produced is used by the charging station.

Hence, the renewable energy equipment with charging infrastructure projects in the State shall be eligible to avail of the incentives.

b. Charging Infrastructure Cost Considerations

One of the important considerations for setting up a charging station is the cost of installation, other costs like maintenance, operation, and security related, and the revenue that the station will generate after installation.

i. Charging Infrastructure Revenue

The main drivers of revenue are the price charged for energy or time, combined with the rate of utilisation of the charger. The main variable inputs are the price to the customer and the extent of utilisation. Adjusting these will help determine the sustainable operating costs.

Revenues can also be generated in other ways, such as:

1. **Advertising**: Display boards on the charging station can bring in revenue.
2. **Idling Charges**: An idling fee is an additional charge that may be imposed on a customer if their vehicle remains connected to the charging station after it has completed charging.
3. **Amenities:** These amenities can include paid toilets, cafes, convenience stores, restaurants, retail shops, and even entertainment options such as cinemas or gaming zones in the charging station.

ii. Core Elements in Balancing Costs & Revenue

Whether for a public or private entity, there are several proven ways to fund EV charging infrastructure and then generate revenue from it. It is important to have a clear understanding of the real costs and key cost drivers of these activities, and the sustainable business models.

The costs include:

- Fixed costs: Hardware, installation costs (capital costs), capacity charges
- Variable costs: Energy costs (energy and power), service, maintenance, operations (billing, invoicing)

The charging infrastructure encompasses various fixed and variable costs, including:

- Hardware & installation cost
- Charger Cost: Type 2 AC chargers, Fast DC chargers
- Capacity charges
- Energy cost
- Maintenance cost: The life-cycle maintenance cost of a charger is 20% of its cost. The life of a charger is around 8-10 years.
- Warranty cost
- Billing, invoice, and user support

The Capex and Opex of a PCS comprising of minimum infrastructure required as per the GoI notification are estimated below:

Type of charger	Number of chargers in PCS	Power output	Approx cost including GST @18%	Number of EVs that can be charged simultaneously	Maximum power sold to EVs per day (20 hours/day assumed) kWh
CAPEX					
CCS-2	1	120 kW	13,00,000	1	2400
CCS-2	1	60 kW	9,00,000	1	1200
Type 2 AC	1	22 kW	1,00,000	1	440
Bharat DC-001	1	15 kW	2,40,000	1	300
Bharat AC-001	1	3 x 3.3 kW	70,000	3	200
Swap station[33]	-	15 kW		-	300
New electricity connection (250 KVA), Transformer, Cabling (100 meters), Panels, Breakers, Energy Meter			21,50,000		
Civil work (Flooring, boards, painting, branding, shed/cover etc .)			2,50,000		
EVSE management software - Integration with chargers and payment gateway			40,000		
Maintenance			5,20,000		
CCTV setup			30,000		
TOTAL CAPEX			**56,00,000**		**4840**
OPEX					
Technicians (1 technician @25k/month considered for first 6 months)			1,50,000		
Site maintenance staff (1 personnel @15k/month throughout the year)			1,80,000		
Network service provider fee			6,000		
EVSE management software fee (considered 10% of net margin on electricity charges)				Refer Table on Revenue Projections	
Payment gateway fee (1-2% of total money collected)				Pass through to customer is considered	
Land lease rental @50000/month[34]			6,00,000		
Advertising @3000/month			36,000		
Total OPEX			**9,72,000**	**+EVSE software fee in first year**	
			8,22,000	**+EVSE software fee in second year**	

Table 11 - Charging infrastructure cost considerations[35]

[33] The cost of swap station is borne by the swap station technology proprietor. PCS provides space for a swap station in return of margin on sale of electricity.
[34] Land lease rental is assumed to be low as per Delhi EV policy guidelines on providing land at bare minimum lease rentals to charging infrastructure providers.
[35] Source: https://www.pluginindia.com/blogs/cost-estimates-and-revenue-model-for-a-public-charging-station-pcs

The revenue comes from a mixture of:

- Price per charge, kWh, minute/hour of charging, and/or minute/hour of parking
- Utilisation of the charge point

Other uses of charging station or area (advertising, amenities) The revenue projection from the PCS business is calculated in the following table based on the outlined assumptions:

1. Charging operations are conducted for 20 hours per day over 30 days each month
2. The Capacity Utilisation Factor (CUF) of the PCS setup is projected at 10% for Year 1, 15% for Year 2, 25% for Year 3, 40% for Year 4, and 60% for Year 5, under the optimistic scenario
3. The electricity tariff to the DISCOM is considered a pass-through cost to the consumer
4. In Scenario-A, a margin of Rs 2.5 on the electricity tariff is assumed
5. In Scenario-B, a margin of Rs 3 is assumed for the first and second years, Rs 2.5 for the third and fourth years, and Rs 2 from the fifth year onwards
6. The EVSE management software fee is considered 10% of the net margin on the electricity tariff

Description	YEAR-1 10% CUF	YEAR-2 15% CUF	YEAR-3 25% CUF	YEAR-4 40% CUF	YEAR-5 60% CUF	Total in 5 Years
Electricity sold to EVs/Year (kWh):	1,74,240	2,61,360	4,35,600	6,96,960	10,45,440	26,13,600
Estimated Revenue (INR)						
Scenario-A: Margin on electricity tariff - 2.5	4,35,600	6,53,400	10,89,000	17,42,400	26,13,600	65,34,000
Scenario-B: Margin on electricity tariff in 1st and 2nd Year - 3.0 3rd and 4th Year - 2.5 5th Year onwards - 2.0	5,22,720	7,84,080	10,89,000	17,42,400	20,90,880	62,29,080
OPEX from previous Table	9,72,000	8,22,00	8,22,00	8,22,00	8,22,00	42,60,000
EVSE Management Software Fee - 10% of net margin						6,70,680
Total OPEX Scenario-A						49,13,400
EVSE Management Software Fee - 10% of net margin						6,44,436
Total OPEX Scenario-B						48,82,908
Net Revenue: Scenario-A						**16,20,600**
Net Revenue: Scenario-B						**13,46,172**

For setting up a station, it is essential to procure EVSE hardware adhering to requisite specifications, depending on charging demand, charging patterns & required charging functionalities.

Centralised system management software also needs to be installed for the back-end network management, including user registration and permissions management, EV charger classification (by location and charger type), and remote monitoring.

08

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09

Annexure

a. Annexure I

The Indian standards for EV Chargers notified by Bureau of Indian Standards (BIS)

Power level	Type of EV charger	EV charger capacity	Charging device / protocol	EV - EVSE communication	Charge point Plug / socket	Vehicle inlet / connector
Power Level 1	Light EV AC Charge Point (for 2W, 3W and 4W - M1 Category)	Up to 7 kW	IS-17017-22-1	Bluetooth Low Energy	IS-60309	IS-17017-2-7, IS-17017-2-2
	Light EV DC Charge Point (for 2W. 3W Category)	Up to 12 kW	IS-17017-25 [CAN]		IS-17017-2-6	IS-17017-2-6
	Light EV AC/DC Combo (for 2W, 3W)	Up to 7 kW (AC) or up to 12 kW (DC)	IS-17017-31		IS-17017-2-7	IS-17017-2-7
Power Level 2	Park bay AC Charge Point (for 3W and 4W - M1 Category)	Normal Power -11 kW/ 22 kW	IS-17017-1	IS-15118 [PLC]	IS-17017-2-2	IS-17017-2-2
Power Level 3	DC Charging Protocol for 4W (M1 Category), Buses and Trucks (M3 Category)	DC 50 kW to 250 kW	IS-17017-23	IS-17017-24 [CAN] IS-15118 [PLC]	IS-17017-2-3	IS-17017-2-3
Power Level 4	DC High Power for e-Bus and Trucks Charging Station (M3 Category)	DC High Power (250 kW to 500 kW)	IS-17017-23	IS-17017-24 [CAN] IS-15118 (PLC]	IS-17017-2-3	IS-17017-2-3

Note: The terminologies 'Electric Vehicle Supply Equipment (EVSE)' and 'EV Charger(s)' have been used inter-changeably.

b. Annexure II

Grid Prioritszation - As discussed in Chapter 2 of Part II, an example of grid prioritisation using the grid prioritisation index method is presented here.

i. *Weighted Index Method Inputs*

1. Land Use Index

	Land Use Index					
	20%	***40%***	***30%***	***10%***	***0%***	**Weighted score**
	Public/Semi Public	**Commercial**	**Mixed**	**Residential**	**Others**	
1	30%	20%	10%	25%	15%	20%
2	30%	10%	10%	30%	20%	16%
3	10%	40%	10%	20%	20%	23%
4	40%	30%	10%	10%	10%	24%
5	10%	20%	5%	45%	20%	16%

2. Built-Up Area Index

	Built-Up Area Index			
	55%	**35%**	**10%**	**Weighted score**
	High density	**Moderate density**	**Low density**	
1	40%	20%	40%	33%
2	20%	30%	50%	27%
3	30%	30%	40%	31%
4	25%	35%	40%	30%
5	10%	50%	40%	27%

3. Road Network Index

	Road Network Index							
	45% **Arterial**		***35%*** **Sub-arterial**		***20%*** **Collector**		**Total Roads**	**Weighted score**
1	2.00	50%	1.00	25%	1.00	25%	4.00	36%
2	1.00	14%	2.00	29%	4.00	57%	7.00	36%
3	0.00	0%	1.00	17%	5.00	83%	6.00	41%
4	1.00	17%	2.00	33%	3.00	50%	6.00	35%
5	0.00	0%	0.00	0%	4.00	100%	4.00	20%

ii. Equal Index Inputs

Grid Number/ Name	Travel Pattern Index Tpi		Traffic Volume Index TVi		Transit Station Index TSi		Electric Sub-Station Index Ssi	
	Total trips	*Normalized TPi*	*Total TV (PCU)*	*Normalized TVi*	*Total TS*	*Normalized TSi*	*Total Sub-stations*	*Normalized Ssi*
1	265	-0.19	20000	-1.12	5	0.31	4	1.23
2	466	1.39	40000	0.12	4	-0.08	3	0.35
3	365	0.59	45000	0.44	1	-1.24	2	-0.53
4	200	-0.70	25000	-0.81	3	-0.46	3	0.35
5	150	-1.09	60000	1.37	8	1.47	1	-1.40

Grid Number/ Name	Public Buildings Index PBi		Parking Index PIi		Petrol Pumps Index PPi		Existing and Proposed Charging station Index Csi	
	Total PB	*Normalized PBi*	*Total Parking Capacity*	*Normalized PIi*	*Total Petrol Pumps*	*Normalized PPi*	*Total CS*	*Normalized Csi*
1	2	-1.43	150	-0.31	5	1.26	2	0.0
2	10	1.06	60	-0.80	3	0.00	0	-1.1
3	5	-0.50	100	-0.58	2	-0.63	5	1.6
4	7	0.12	520	1.71	1	-1.26	1	-0.5
5	9	0.75	200	-0.03	4	0.63	2	0.0

Overall Index = LUi+ BUi+ RNi+ TPi+ TVi+ TSi+ PBi+ Pi+ PPi+ SSi- CSi

Grid Number/ Name	Overall Index		Final Overall Index	Final Overall Index/ Grid Priority Score (Removing Negatives)
	Weighted Index Inputs total index	*Equal Index Inputs total index*		
1	0.89	-0.25	0.64	**3.73**
2	0.79	3.12	3.91	**7**
3	0.95	-4.04	-3.09	**0**
4	0.89	-0.52	0.37	**3.46**
5	0.63	1.69	2.32	**5.41**

From the above table, it is found that Grid 2 has highest priority for installing CS followed by Grid 5, Grid 1 and Grid 4. Grid 3 has the least or no priority.

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