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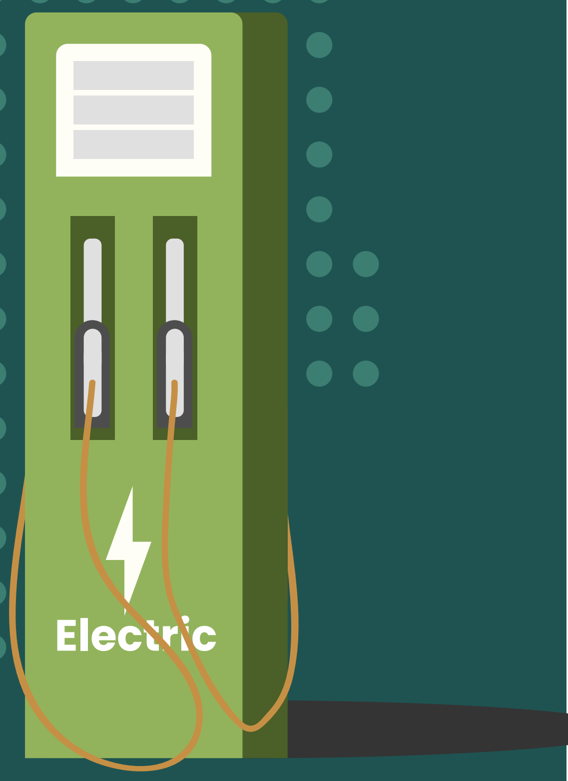
Public Charging Infrastructure

Pocket Guidelines



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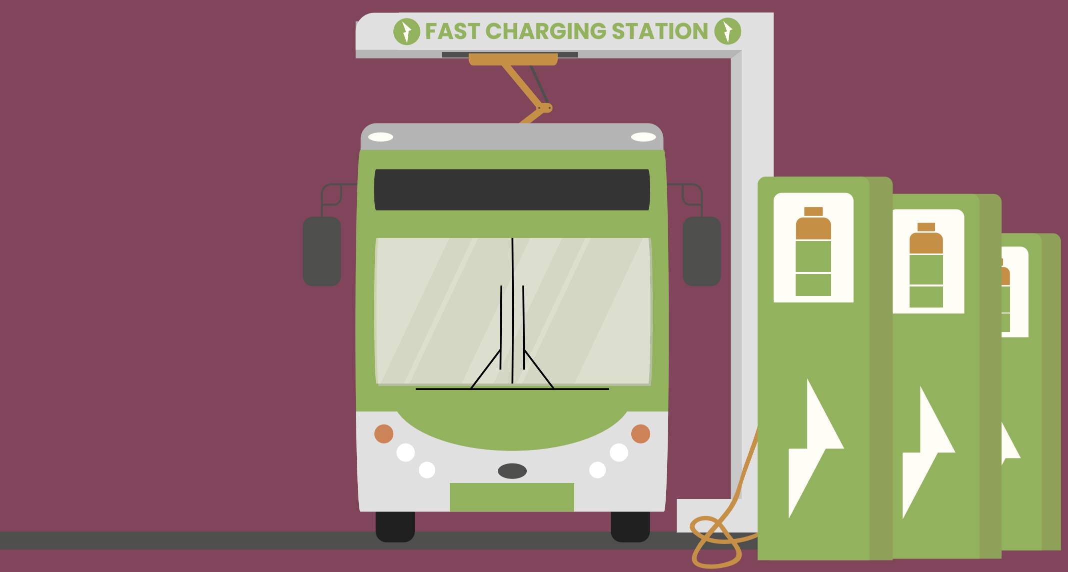
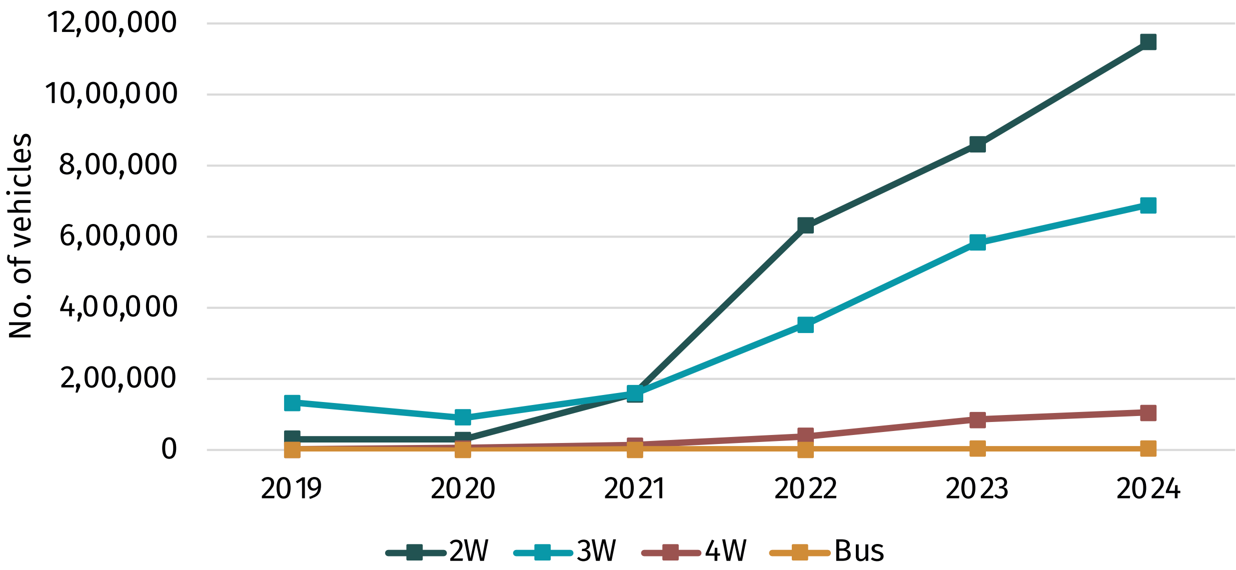
Introduction to EV Charging Infrastructure

India's electric vehicle (EV) journey is rapidly gaining momentum, with close to 55 lakh EVs registered between 2014 and 2024. While EVs currently constitute just 1.7% of all registered vehicles, the landscape is set to transform, with projections indicating that over 30% of new vehicle registrations will be EVs by 2030.

This shift underscores the urgent need to accelerate the development of public charging infrastructure to keep pace with growing demand. However, planning this infrastructure isn't straightforward—it requires a nuanced understanding of the current and future EV market, including vehicle types, usage patterns, and charging specifications.





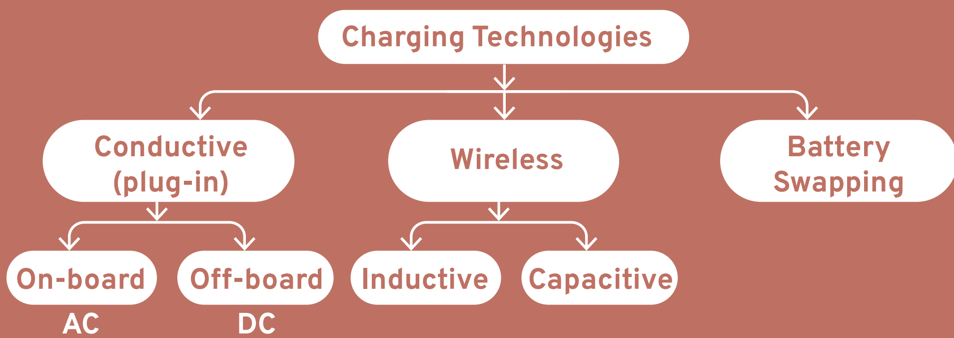
EV Registrations in India
Source: Vahan Dashboard

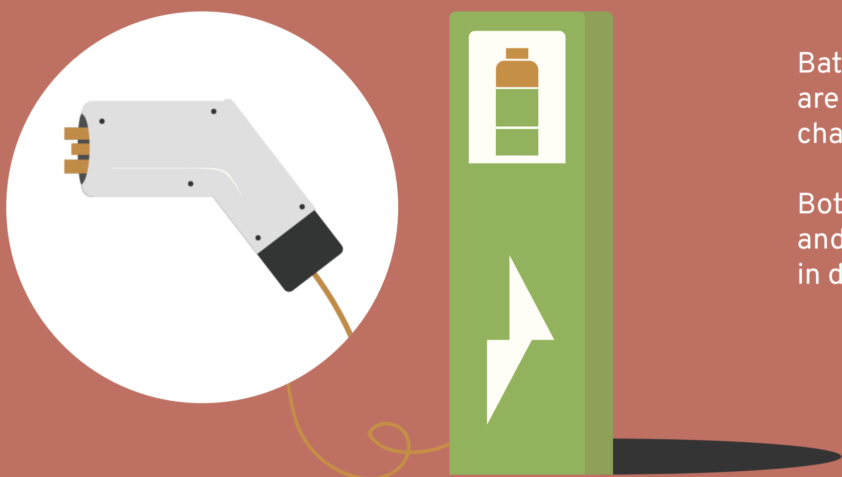
India's EV market is unique, dominated by electric two-wheelers (E-2Ws), which account for 51% of sales, and passenger electric three-wheelers (E-3Ws, including e-rickshaws), making up 39%. These segments have diverse charging needs, influenced by variations in battery capacity and power input requirements. Developing efficient and accessible public charging infrastructure tailored to these needs will be pivotal for supporting India's transition to sustainable mobility. The report aims to provide guidelines for developing a robust and adaptable public charging infrastructure to support India's growing EV ecosystem.

Technologies and Components of Charging Infrastructures

Before understanding the guidelines involved in setting up charging infrastructure, an understanding of the various kinds of charging infrastructure is critical. Charging infrastructure can be distinguished from one another using multiple criteria like technology, vehicle type, ownership, etc. This section will elaborate on the three major criteria to distinguish charging technologies.

Types of Charging Infrastructure by Technology: On the whole, EV chargers in the current global market can be distinguished from one another by the kind of technologies used as conductive, wireless and battery swapping.



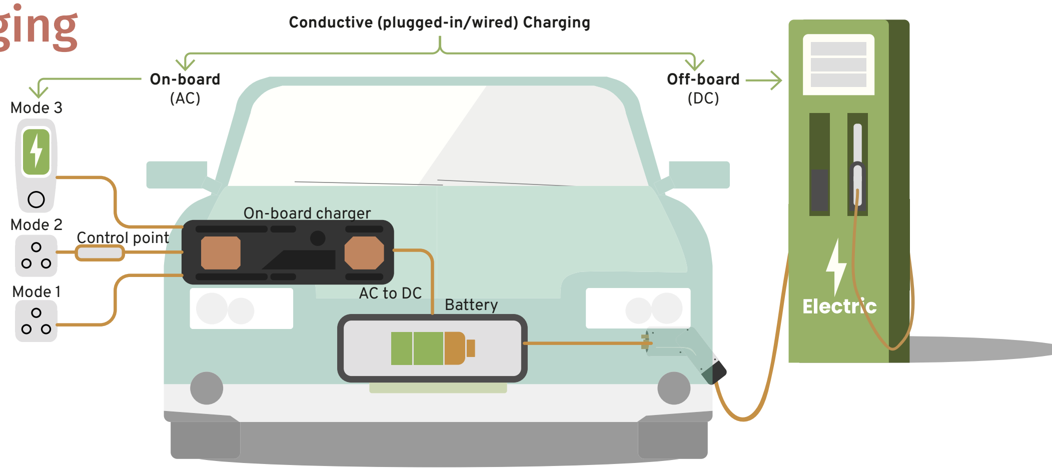


Battery swapping and Conductive charging are currently available in India while wireless charging is not commercially available.

Both of these technologies have specific uses and are applicable to different segment of EVs in different scenarios.

Conductive Charging

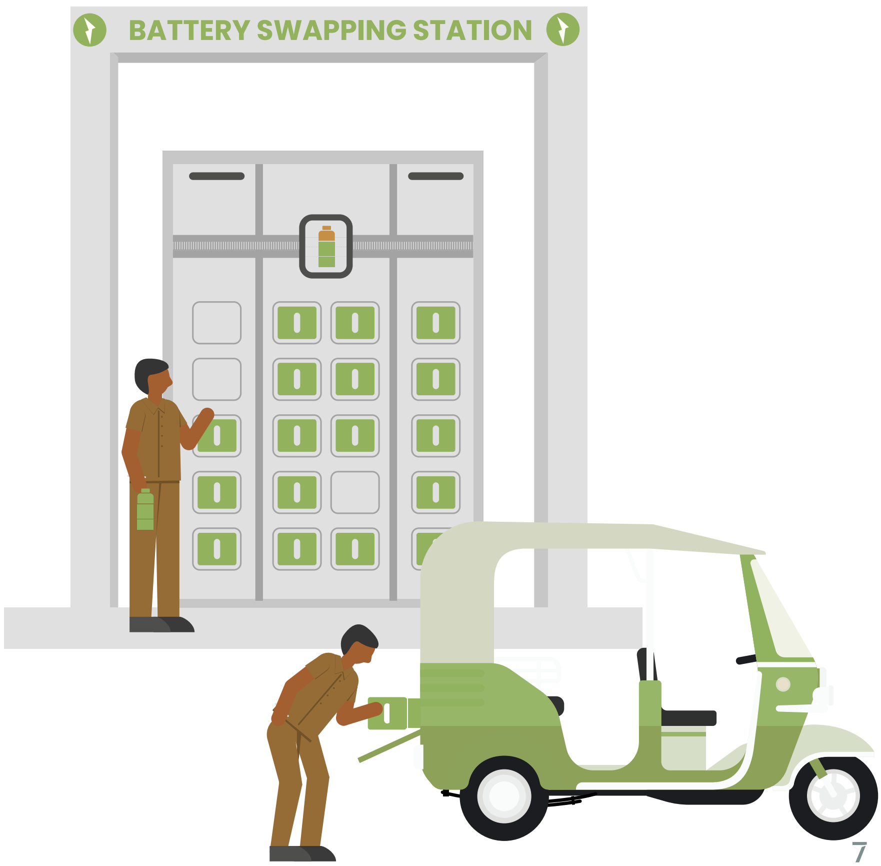
Conductive or plug-in charging can use either Alternating Current (AC) or Direct Current (DC) power. The difference here is that if a vehicle has an on-board charger, AC power is used to convert it into DC power for the battery.



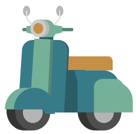
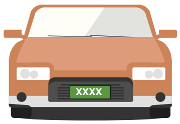
In the other variant of vehicles, DC power is directly supplied to the vehicle's batter by an Electric Vehicle Supply Equipment (EVSE). An EVSE is the core unit of charging infrastructure, which draws power from the grid and safely recharges EVs. Supplying via an EVSE allows faster charging.

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.

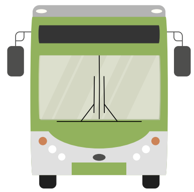


Electric Vehicle Charging by Vehicle Typologies

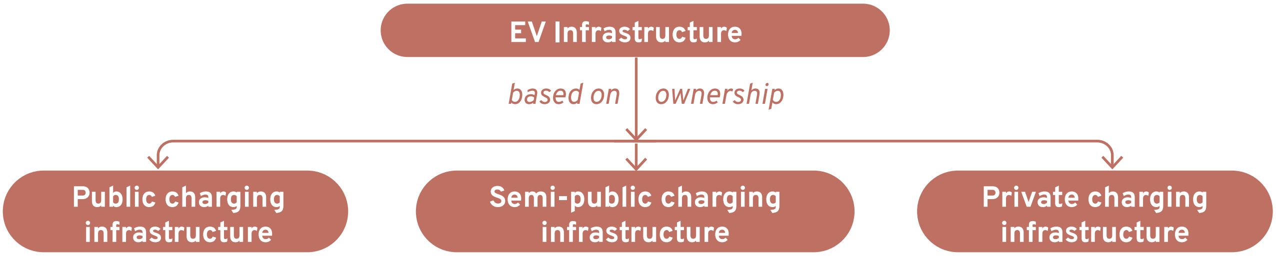
   

	Two-Wheelers	Three-Wheelers Passengers	Three-Wheelers Goods	Car Personal
Type of charger (AC/DC)	AC/DC	AC/DC	AC/DC	AC/DC
Share of charging demand met by public charging	10%	20%	20%	10%
Typical charging behaviour	Day time and night time	Slow charging speed at night Fast charging during the day		Day time and night time
Desirable charging location	Private Residences	On-street/Off-street		Residences/ Offices
Desirable charging station type	Private/ Semi-Public	Public/ Private night charging		Private/ Semi-Public

Charging needs of users differ based on factors like location, station type, charging behaviour, and reliance on public chargers. For example, personal EVs primarily charge at home or offices, while commercial EVs rely more on public or semi-public facilities.
When planning public charging infrastructure, it is essential to understand which vehicles are likely to use it, their specific requirements, and where they are most likely to access the service.
Each vehicle type has distinct needs, as detailed below, which categorises EVs (private or commercial) and their charging requirements.



Car Commercial	Four-Wheelers (LGC and MGV)	Trucks	Buses
AC/DC	DC	DC	DC
25%	20%	70%	70%
Slow charging speed at night Fast/High charging speed during day		High charging speed both at night and day	
On-street/ Off-street	Off-street	Transit Station	
Private/ Semi-Public	Public		Private/ Semi-Public



Ownership	Travel Mode	Location	Parking
Municipal authorities, PSUs, CPOs, host properties	All vehicles except passenger public vehicles	Public parking lots, on-street parking, charging plazas, petrol pumps, highways, metro stations.	Standalone public charging infrastructure
Host properties	Passenger public vehicles, private passenger vehicles, commercial passenger vehicles, goods carriers	Apartment complexes, office campuses, gated communities, shopping malls, hospitals, universities, government buildings, public vehicle fleet depots/ parking, etc.	Combined with parking
Individual EV owners, EV fleet owners/ operators	Any private vehicle	Independent homes, dedicated parking spots in apartments or offices	

Norms, Bye-Laws, and Standards

Types of Authorities

To ensure safe, compatible, and interoperable EV charging infrastructure, it is important to understand the norms and bye-laws set by various authorities. These are formulated and enforced by:

Concerned Authorities for EV Charging

Policy Making/Regulatory Authorities

These are authorities responsible for formulating necessary policies, regulations, norms, bye-laws and establishing standards and specifications on both national and state level.

National Level

- Ministry of Power (MoP)
- Ministry of Housing and Urban Affairs (MoHUA)
- Bureau of Indian Standards (BIS)
- Ministry of Road Transport and Highway
- Central Electricity Authority (CEA)
- Ministry of Heavy Industries and Public Enterprises
- NITI Aayog
- Department of Science and Technology

State Level

- Industries, Investment, Promotion and Commerce Department
- GUIDANCE- Tamil Nadu
- Housing and Urban Development Department – Tamil Nadu
- Tamil Nadu Electricity Regulatory Commission (TNERC)

Implementing/Executing Authorities

They are 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 their implementation.

National Level

- Bureau of Energy Efficiency (BEE)
- Department of Heavy Industry (DHI)
- Power Grid Corporation of India Ltd

State Level

- Tamil Nadu Power Distribution Corporation Ltd (TNPDCL)
- Tamil Nadu Green Energy Corporation Ltd (TNGECL)
- Energy Department – Tamil Nadu
- Transport Department – Tamil Nadu
- State and Regional Transport Authorities
- Municipal Corporations and Municipalities

The complete list of policy making or regulatory authorities on national level and the documents prescribed by each authority are presented below

Authority	Prescribed Document	[Type of Document] Remarks
Ministry of Power (MoP)	Charging Infrastructure for EV - Revised Consilidated Guidelines and Standards (2022, 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)
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 electric vehicle 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)

Provisions for Public and Semi-Public Charging

by Ministry of Power and Ministry of Housing and Urban Affairs

In its Charging Infrastructure Guidelines and Standards, the Ministry of Power (MoP) provides the following minimum requirements for the location of public charging stations.

For Public Charging

At least one charging station should be available in a grid of 1km x 1km.

One charging station to 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 will 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 shall be provided for EVs at 20% of all 'vehicle holding capacity' or 'parking capacity' at the premises.

The building premises will have to 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.

EV Charging Infrastructure Demand Assessment

To successfully ascertain the demand for EV charging infrastructure in an area, multiple approaches are needed. First one must calculate the demand for charging infrastructure by the vehicle population in the market, then determine the density based on the location/site. Both these approaches can give a comprehensive idea to exactly determine how much, where, and what kind of charging infrastructure is needed.

Demand Assessment for Vehicle Types

The demand for EV charging infrastructure depends on the penetration and utilisation of EVs. Assessing charging demand by EV vehicle types divided into segments is a foundational step in planning charging infrastructure. This helps to guide decisions on the required number and type of charging points.

Segmenting EVs by Vehicle Type: EVs are categorised into types such as two-wheelers (2W), three-wheelers (3W passenger and goods), personal cars, commercial cars, goods vehicles (light, medium, and heavy), trucks, and buses. This categorisation is based on unique operational characteristics like battery capacity, charging speed, and daily utilisation.

Determining EV Characteristics: For each segment, operational traits like energy efficiency, range, charging frequency, and public charging share are documented. For instance, personal cars rely on public chargers for 10% of their charging needs, while trucks and medium goods vehicles depend on them for 70%.

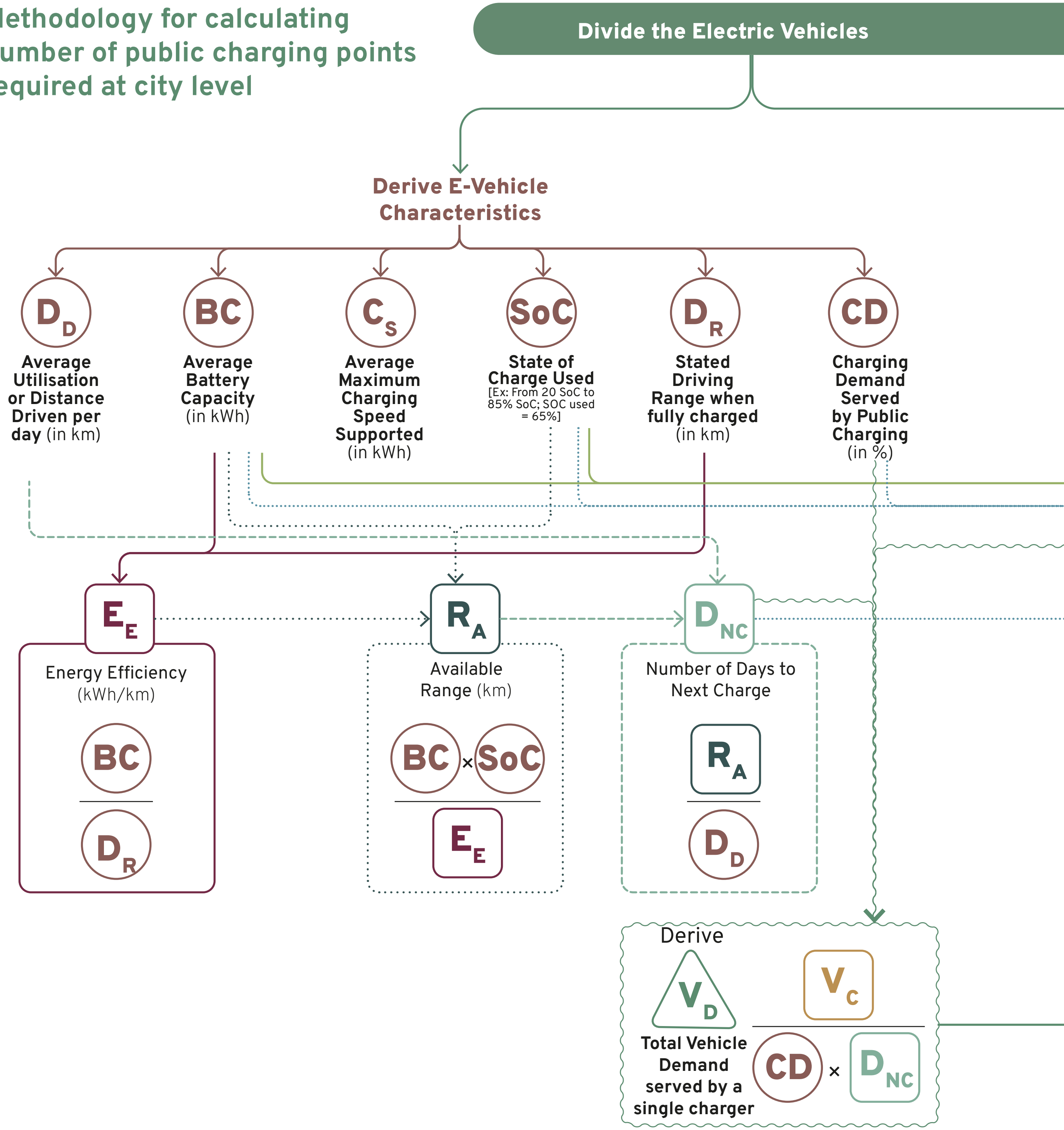
Deriving Charger Characteristics: The analysis includes charger speed, efficiency, operational time, and idle time to estimate the number of vehicles a single charger can serve daily. Charging time and total vehicles charged are calculated using specific equations that factor in battery capacity, state of charge (SoC), and charger speed.

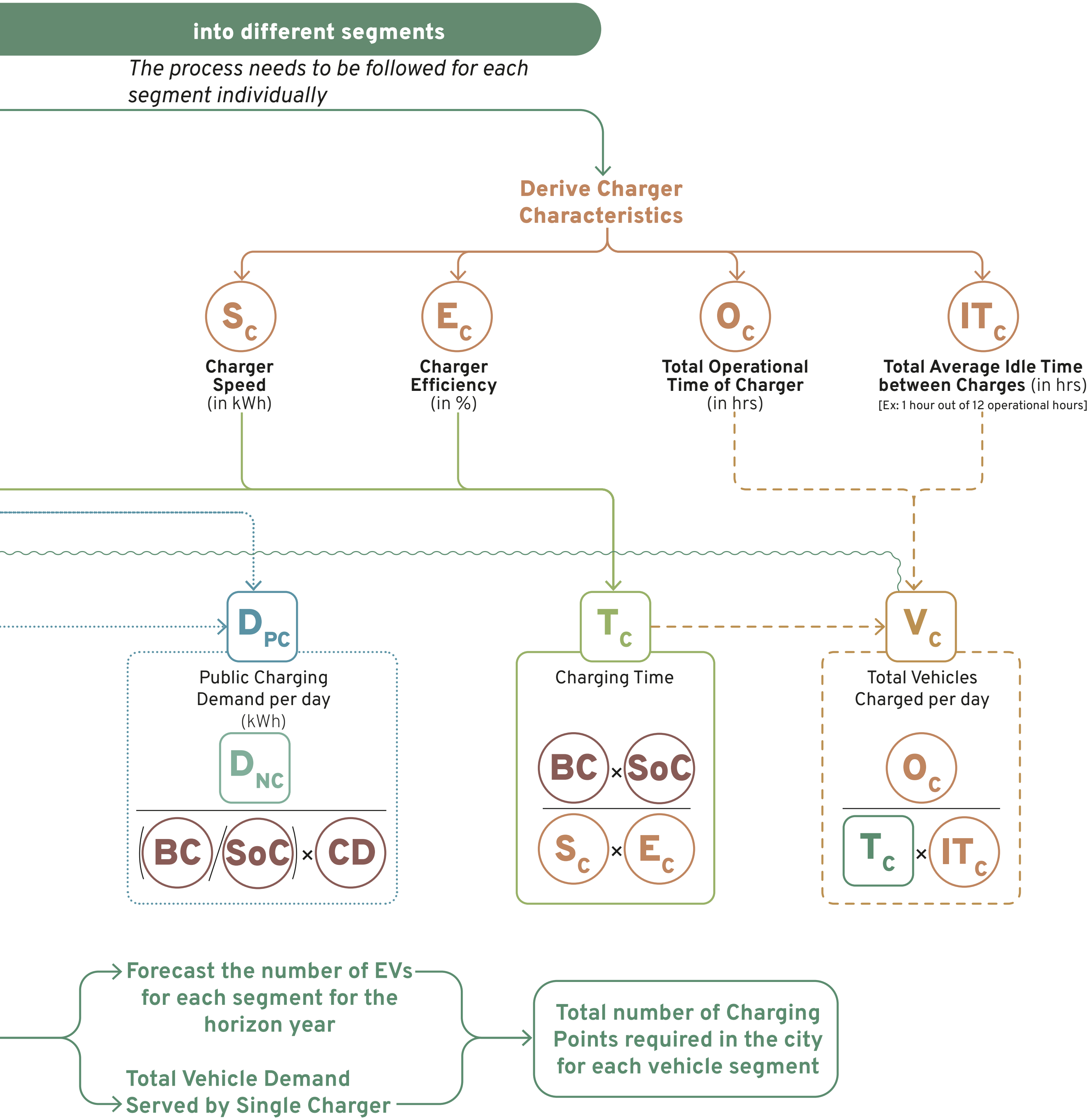
Forecasting EV Growth: Using estimates of EV sales, penetration rates, and future targets, the number of EVs in each segment is projected for a given horizon year.

Calculating Required Charging Points: Combining forecasts with the capacity of single chargers, the total number of charging points required for each vehicle segment is determined. This ensures the infrastructure aligns with future EV adoption trends.

Once these are computed, the results, including segment-specific charging point estimates, are visualised in graphs for practical application in urban, regional planning efforts. These provide actionable insights into developing EV-friendly infrastructure for target years.

Methodology for calculating number of public charging points required at city level



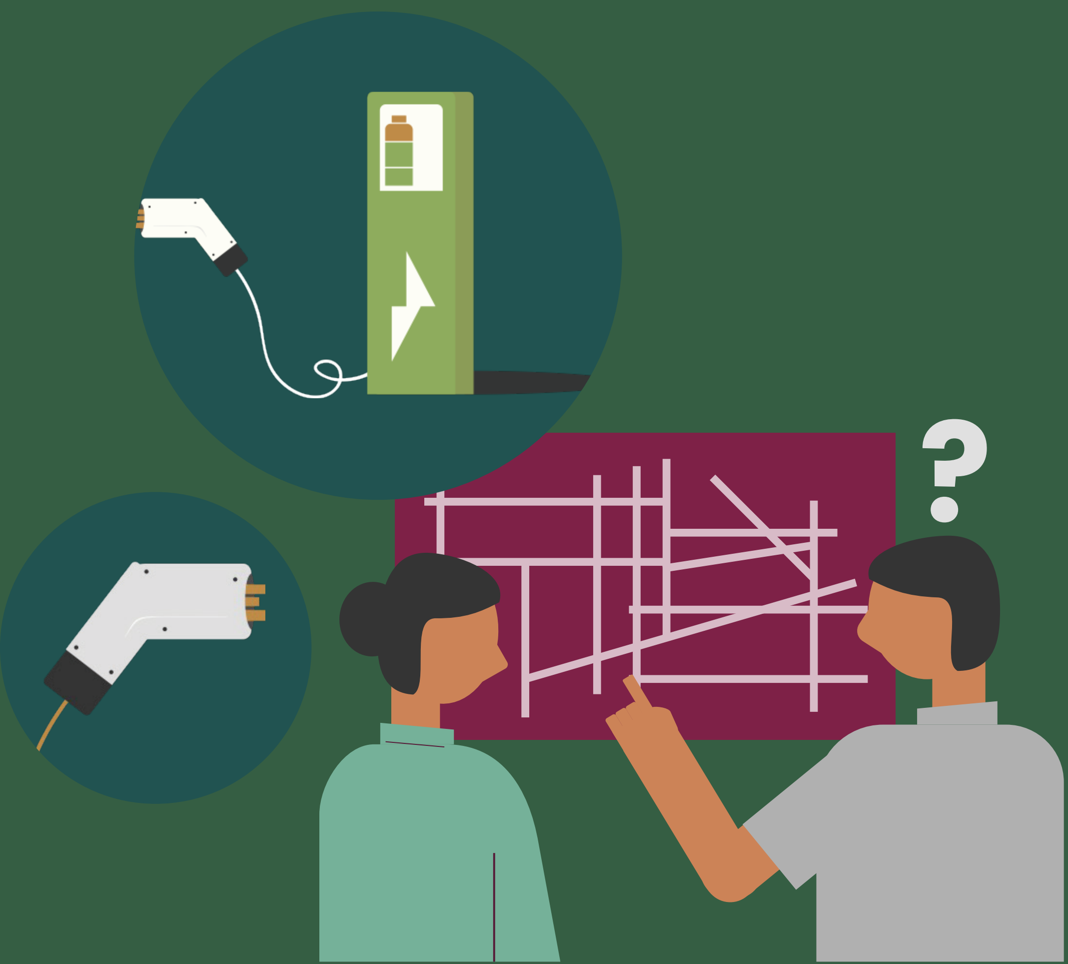

into different segments
The process needs to be followed for each segment individually
Derive Charger Characteristics
S_C
Charger Speed (in kWh)
E_C
Charger Efficiency (in %)
O_C
Total Operational Time of Charger (in hrs)
IT_C
Total Average Idle Time between Charges (in hrs)
[Ex: 1 hour out of 12 operational hours]
D_{PC}
Public Charging Demand per day (kWh)
$D_{PC} = \frac{D_{NC}}{(BC / SoC) \times CD}$
T_C
Charging Time
$T_C = \frac{BC \times SoC}{S_C \times E_C}$
V_C
Total Vehicles Charged per day
$V_C = \frac{O_C}{T_C \times IT_C}$
Forecast the number of EVs for each segment for the horizon year
Total Vehicle Demand Served by Single Charger
Total number of Charging Points required in the city for each vehicle segment

Demand Assessment using Geographical Parameters and Fleet Estimation

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

Step 1 | Estimating the minimum charging stations required based on the size of the city/region

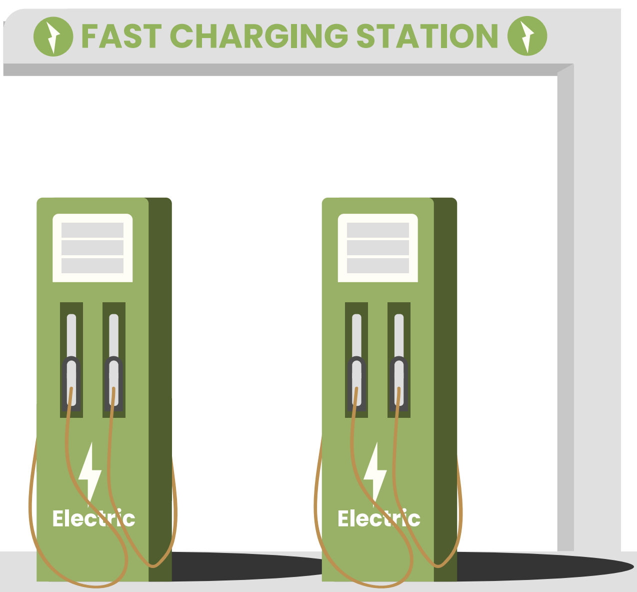
Step 2 | Estimating the total number of charging points required in the city/region based on number of vehicles and the charging point capacity



Minimum Charging Stations

Determine the minimum number of stations based on city/region size. As per MoP guidelines 2024 , at least one charging station is required for every grid of 1km x 1km.

$$\frac{\textbf{City size} \text{ (in sq. km.)}}{\textbf{1}} = \textbf{Minimum no. of charging stations required}$$

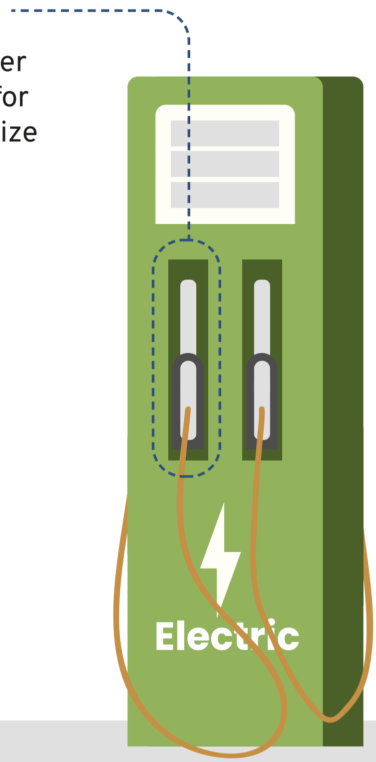


Total Charging Points

Calculate the required charging points based on the EV fleet size, vehicle types, and charger capacity. Steps to Estimate Charging Points:

Step 1: Project EV fleet size for different travel modes based on sales, penetration rates, and future projections.

Step 2: Calculate the number of charging points needed for each mode based on fleet size and charger capacity.



EV Charging Infrastructure Location and Site Identification

This section outlines a comprehensive three-step process for identifying optimal EV charging station locations in cities, focusing on accessibility, demand, and infrastructure efficiency. The approach integrates detailed data analysis and strategic planning to meet growing EV charging needs and support sustainable urban mobility.

Step 1

Site Identification Methodology

Data Collection: Gather maps for built-up density, land use, traffic volume, road networks, and prominent locations.

Primary Locations: Identify high-priority sites where multiple demand factors overlap.

Secondary and Tertiary Locations: Address unmet demand through grid-based identification and prioritisation of additional locations.

Grid Prioritisation: Rank grids using a weighted index of land use, density, road network, traffic volume, and other key factors.

Final Selection: Refine and finalise site locations within a 300-meter buffer, considering proximity to transformers, land availability, and safety.

Step 2

Site Typology and Infrastructure Needs

Classify locations based on land use and user groups. Each typology has distinct infrastructure needs and charging priorities.

Residential: Gated and non-gated communities.

Institutional: Administrative and educational facilities.

Commercial: Retail hubs, offices, and hospitality zones.

Industrial: Industrial parks and phases.

Transit Stations: Bus, railway, metro, ports, and airports.

Filling Stations and Depots: Petrol pumps and transport hubs.

Step 3

Typical Site Layout

Provide recommendations for site design:

Align charge points with parking layouts for seamless user experience.

Ensure visibility and proximity to key infrastructure (e.g., transformers).

Avoid hazards like flood-prone areas for safety and reliability.

> Accessibility, visibility, land availability, and safety are key factors in choosing EV charging station sites. The infrastructure should offer a mix of slow, moderate, and fast charging to meet user needs. The above methodology ensures stations are well-placed, scalable for future growth, and integrated with urban mobility.

A quick guide on the various specific areas where different kinds of charging depots can be placed.		**Residential** (Gated)	**Residential** (Non-Gated)	**Institutional** (Administrative)	**Institutional** (Educational)
Site Typology	Public		✔		
	Semi-Public	✔		✔	✔
Focus Modes	Commercial				
	Private	✔	✔	✔	✔
	Public			✔	
Operation	App-Based	✔			✔
	Open Access		✔		
	Card-Based	✔			
	Defined Users			✔	✔
Manual	Scan and Pay		✔		✔
	Auto Deduct	✔		✔	
	Manual				
Charging Points per Charger	Multiple	✔	✔		
	Limited			✔	
	Single				✔
Type	Overnight	✔	✔		
	Opportunity				
	Day			✔	✔
	Top Up				

Commercial (Retail)	Commercial (Offices)	Commercial (Hospitality)	Transit Stations	Filling Stations	Depot/ Transport Nagar and Industrial Areas
✔			✔	✔	✔
	✔	✔			
✔	✔	✔	✔	✔	✔
✔	✔	✔		✔	
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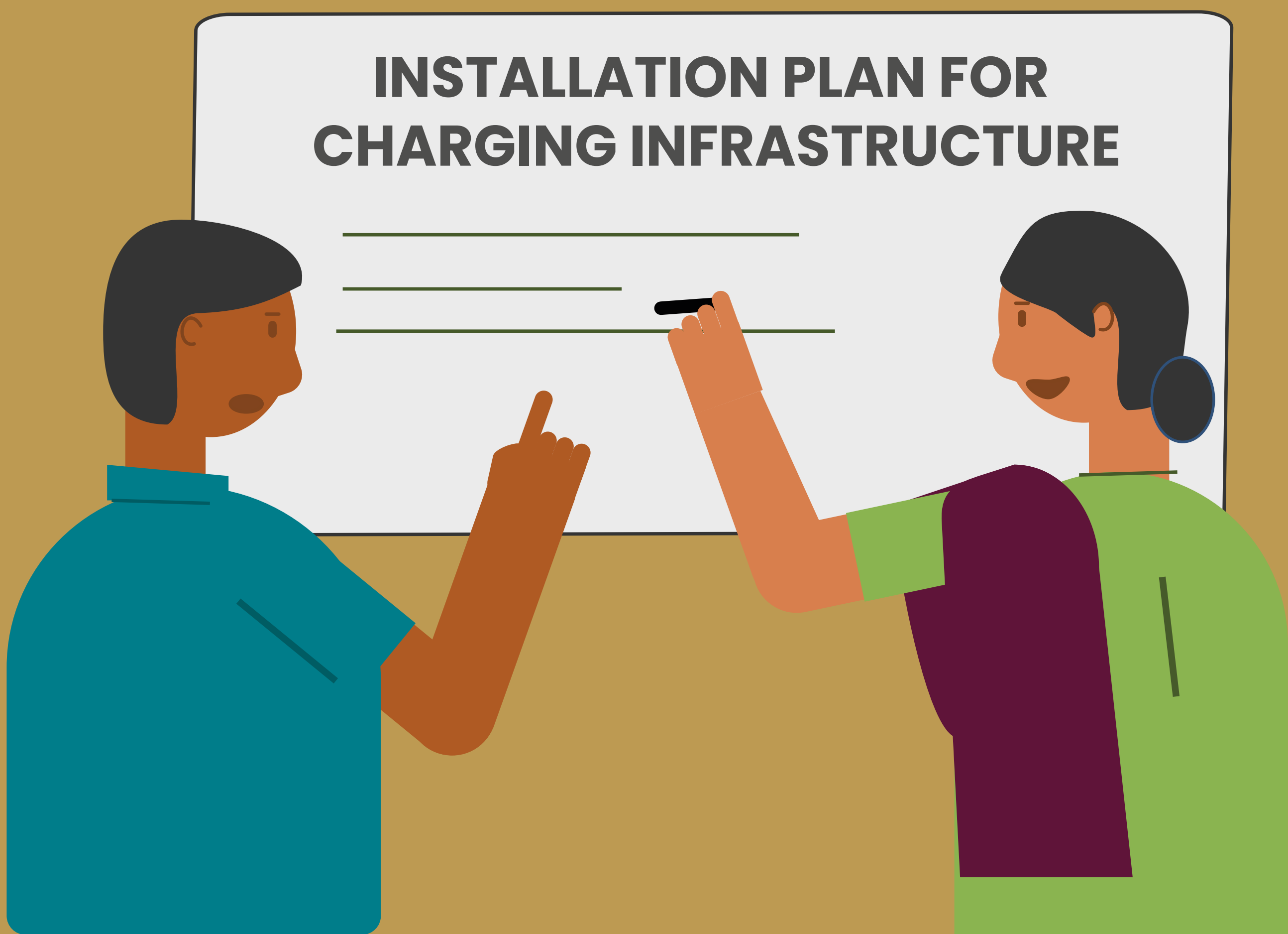
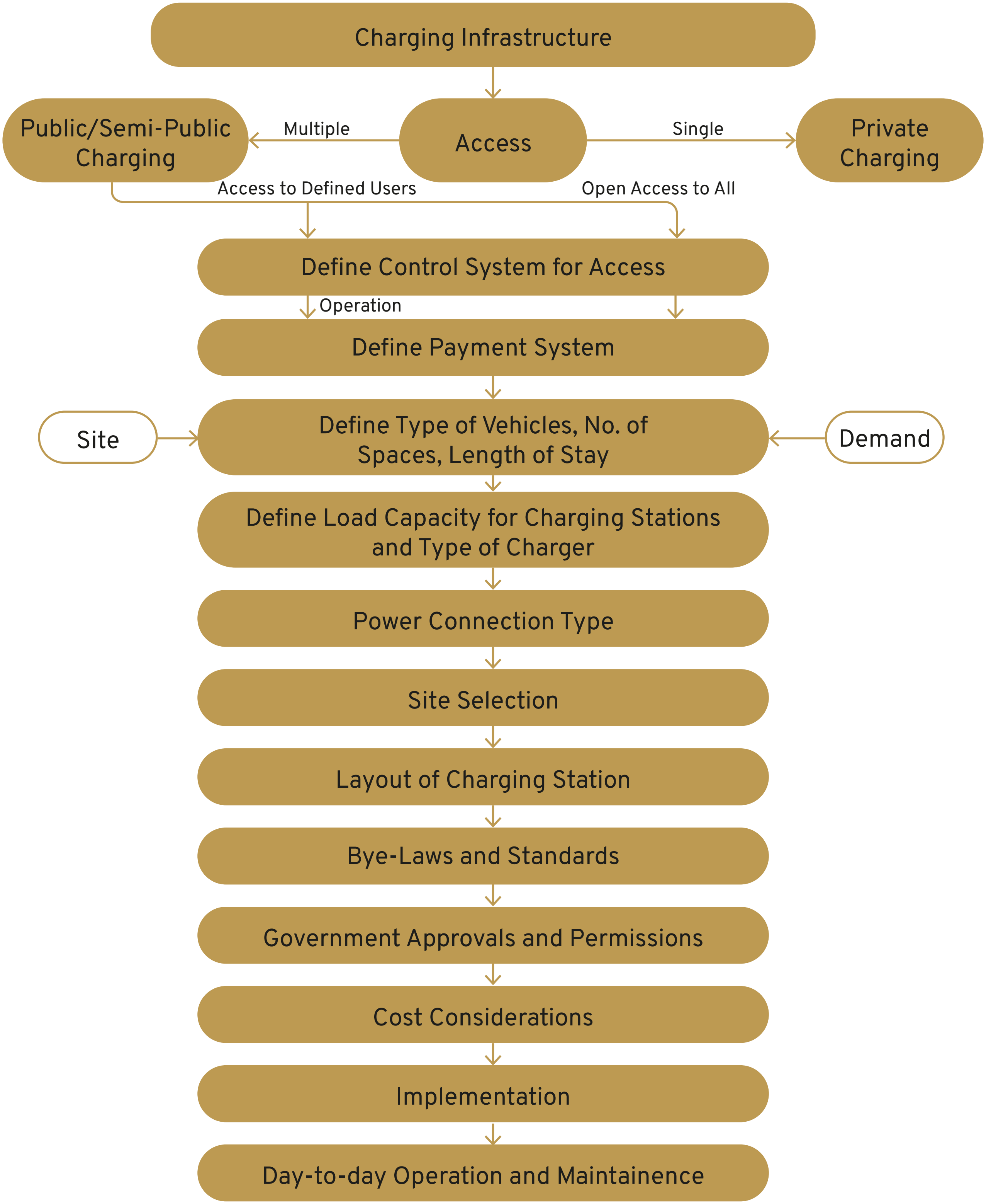
Guide to Decide on Charging Station Installation

The Chargin Point Operators (CPO) ultimately will be the ones taking multiple decisions around installation of charging stations. Be it public charging stations or private, they will have to take multiple operational decisions and permits to set up. Following figure gives a quick step-by-step guide:




Charging Infrastructure
Access
Multiple
Single
Public/Semi-Public Charging
Private Charging
Access to Defined Users
Open Access to All
Define Control System for Access
Operation
Define Payment System
Site
Define Type of Vehicles, No. of Spaces, Length of Stay
Demand
Define Load Capacity for Charging Stations and Type of Charger
Power Connection Type
Site Selection
Layout of Charging Station
Bye-Laws and Standards
Government Approvals and Permissions
Cost Considerations
Implementation
Day-to-day Operation and Maintainence

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