

HOW TO MANUAL

SITING ELECTRIC VEHICLE CHARGING STATIONS IN INDIAN CITIES



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Foreword

India, home to a sixth of humanity, is embarking on a path to rapid economic growth decoupled with carbon emissions. The Prime Minister has recently announced India's pledge to reduce the emissions intensity of its economy by 45% from 2005 levels by 2030 and achieve the goal of economy-wide net zero emissions by 2070. Clean energy powered electric transportation remains critical to meet these targets. In a country with a fast-growing transportation needs, electric vehicles present a unique opportunity to provide access to clean mobility while helping improve air quality, health, and energy independence.

For electric vehicles to be the dominant mode of transportation in the country, we need to establish a robust charging infrastructure that caters to the need of the nation. To support the deployment of charging infrastructure in the country, the Government of India has allocated a total fund of INR 1000 crore under the FAME II Scheme. Under the public procurement, Department of Heavy Industry (DHI) has sanctioned 2877 charging stations in 68 cities across 24 States/UTs. EV charging is a delicensed activity in India and the Ministry of Power (MoP) has published revised guidelines for Charging Infrastructure for Electric Vehicles to facilitate the deployment of charging Infrastructure. For wider deployment of Charging Infrastructure across the country, NITI Aayog recognizes the need for commercially viable Market driven charging stations and . Hence, charge point operators generally prioritize areas with high vehicle density and low operational costs. At the same time, for increasing consumer confidence, even areas of low demand need access to some level of charging infrastructure. Siting an optimal location for setting charging stations, therefore, assumes utmost importance.

I congratulate Natural Resources Defense Council (NRDC) and the Administrative Staff College of India (ASCI), for releasing this manual that complements the recent Handbook of EV Charging released by NITI Aayog. The Manual has informative case studies on international and national best practices in siting EV charging infrastructure landscape.


(Amitabh Kant)



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Executive Summary

Increasing the fleet of electric vehicles (EV) and charging infrastructure in India are key to improving air quality in cities, enhancing energy security by reducing dependence on imported crude oil, and fighting climate change. India aims to have at least 30 percent of new vehicle sales be electric by 2030 and could potentially have 102 million EVs on the road.¹ A widespread, accessible public charging infrastructure network is needed to support a robust EV market across India.

A stepwise approach is needed to ensure the efficient and timely implementation of EV charging infrastructure, such that it meets local requirements and is optimally integrated within the electricity supply, transportation networks and land availability. A well-planned charging network will reduce drivers' fear of running out of charge and be more financially viable, which is important given the high upfront cost of building charging infrastructure. Identifying the right location is a priority consideration for siting EV charging infrastructure. Siting for charging infrastructure involves choosing the right location and, within the location, identifying the specific spot for the infrastructure. Other considerations for siting charging infrastructure are to maximize usage, minimize costs, and increase accessibility.

Given the numerous considerations and stakeholders involved in siting, Natural Resources Defense Council (NRDC), Administrative College of India (ASCI) and EV Advisors developed a stepwise approach that Indian cities can follow to site EV charging infrastructure. These stepwise considerations can be applied to help stakeholders review and rank potential sites for their viability. NRDC and ASCI engaged with stakeholders in Hyderabad to develop siting criteria for use across Indian cities.

Based on these consultations, the following seven steps are recommended for siting EV charging infrastructure in Indian cities:

1. Choose location and carry out preliminary site feasibility;
2. Determine the use cases and charging infrastructure requirements (type rating, and number of chargers);
3. Conduct a site visit for feasibility, take thorough site photographs (from all angles, observe for underground infra (drainage pipes, type of surface area etc.), power infrastructure, nearest distributional transformer, entry and exit ways, any proximate consumer amenities (food joints/utilities etc.), and develop a draft site plan;
4. Determine the feasibility and financial viability of the physical space;
5. Determine the feasibility on the power distribution side (including the least-cost option for energizing the site);
6. Determine the site's accessibility and scope for future expansion; and
7. Review for safety, threats and develop a detailed site plan.



India is among a handful of countries that support the global **EV30@30 Campaign** which aims to have at least 30 percent of new vehicle sales be electric by 2030.

Introduction

India has one of the lowest motorization rates in the world with about 22 four-wheelers per 1,000 people.² However it is set to take off in a similar trajectory as China and the U.S. where four-wheelers make up a large share of the market. Currently, two wheelers (e.g., motorcycles, scooters, and mopeds) accounted for about 80 percent of total vehicle sales in 2020 in India.³ Data for 2019 to 2020 show that three wheelers constituted about three percent of all domestic automobile sales.⁴

Forecasts estimate that sales of electric two-wheelers could reach between eight and nine million by fiscal year 2030, accounting for about 35 to 40 percent of all two-wheelers sold.⁵ Electric three-wheelers sales are likely to surpass half a million by fiscal year 2030, accounting for about 60 to 65 percent of all three-wheelers sold.⁶

Following the national lead, several Indian states are setting strong policy incentives for EVs and EV infrastructure. State and central demand incentives that are currently available are sufficient to collectively ensure price parity for electric two-wheeler and three-wheeler segments compared to their internal combustion engine (ICE) counterparts. As battery pack costs come down, there is likely to be an increase in the deployment of electric four-wheelers which continue to remain expensive for the Indian market. Estimates suggest that it is possible for EV sales penetration to reach 70 percent for commercial cars, 30 percent for private cars, 40 percent for buses, and 80 percent for two- and three-wheelers by 2030 if aggressive policies and investments are made.⁷ This includes an aggressive scale-up of charging infrastructure across India is needed to achieve these EV sales goals.



Electric three-wheelers sales are likely to surpass half a million by fiscal year 2030, accounting for about **60 to 65 percent** of all three-wheelers sold.

The uptake of EVs has been slower than expected primarily because of range anxiety, the fear of running out of battery power before being able to recharge. This concern is amplified in areas with limited charging infrastructure. As policymakers in India establish incentives and programs, one crucial question is where to logistically site the initial set of charging stations⁸ in a manner that is easily accessible to stimulate further growth and adoption of electric vehicles.

Siting studies are nearly always the first step in the complex process of building out an effective charging network. A healthy ratio between the number of EVs to charging stations is important to encourage early-adopters and to relieve drivers of range anxiety. Given the large upfront costs to establish a charging station, optimal charger siting maximizes utilization, minimizes capital cost, improves user experience, and increases value for all stakeholders.⁹

This issue brief reviews the importance of siting and highlights successful approaches for the siting for EV charging infrastructure. It provides for a stepwise approach that Indian cities can follow to build state of the art charging infrastructure for powering the next generation vehicles. Further given the vast number of considerations involved it informs regulators, city government authorities on designing charging infrastructure schemes. Besides that, it also aware charge point operators, power utilities involved in siting the charging infrastructure. It also applies the proposed step wise approach for siting charging infrastructure for the city of Hyderabad.

Importance of Siting: Paramount for Infrastructure Planning

Finding suitable areas for charging infrastructure and installing an adequate number of charging points remains vital for accelerating the transition to zero emission vehicles. Robust siting analysis is the first step for building out an intelligent and equitable charging infrastructure network.

While siting analyses vary in method and technical sophistication, they share the common themes of identifying charging gaps and locations where many EV drivers will visit. Siting studies help establish a benchmark to measure the success of charging infrastructure deployment in terms of charger quantities and geographic coverage.

A siting analysis is a logical initial step in implementing state EV plans, which typically include the supporting charging infrastructure policies. EV plans provide guidance to governments on what policies and practices under their jurisdiction and purview can support EV charger deployment. The results of these studies (often with maps for local or city-level planning) can then be communicated to local and municipal jurisdictions which have control over consequential regulations such as land use policy, permitting and inspection procedures, building codes, parking enforcement. The jurisdictions can convene key stakeholders such as electric utilities and local businesses to coordinate on infrastructure development. Siting studies can indicate where there may be opportunities for private charger development by identifying areas with expected demand for charging services. These supporting policies and practices are critical to ensuring that once located, chargers can be deployed in an efficient and cost-effective manner.

How Siting Studies Have Evolved Overtime in Their Scope and Objectives

Early siting studies significantly focused on minimizing range anxiety, however focus has shifted in recent years. For example, in the U.S.¹⁰ siting studies now concentrate on supporting EV drivers that live in multifamily housing, equity focus to identify charging gaps in underinvested communities, and daytime charging opportunities that coincide with peak solar power production.¹¹

Siting studies are successful at providing high-level data to integrate EV charging and on where to locate charging infrastructure. However, they generally need to be complemented by on-the-ground assessments, such as local power capacity at a potential site, site accessibility, or willingness on the part of site hosts to install chargers.

How State and Local Governments Can Support Siting of Charging Infrastructure

- Coordinate with local utilities and engage them early on in planning process.
- Adopt EV-friendly local land use laws and ordinances (zoning) to allow charger installations.
- Conduct outreach to private site hosts in priority charger locations. Those hosts may not be aware of the opportunity to charge vehicles at their location, nor might they be aware of available incentive funding. Cities can provide crucial assistance informing them about the business opportunity and available resources to support charging deployments.
- Streamline the site permitting and inspection process. Current site permitting processes might not be well suited for charging development and can add unnecessary time and costs to charger development. Cities should ensure that site inspectors, permitting officials, electricians, and building contractors are trained on new charging infrastructure permitting processes.
- Update parking regulations for EV charging.
- Adopt design standards for signage, wayfinding, and support charging apps.
- Adopt EV-ready building codes for new or remodeled commercial and residential construction.



Indian government owned electric cars are being charged at the charging stations near Indian parliament house in New Delhi. Source : Shutterstock

Siting Approaches

A key question among city planners and stakeholders is how to site and locate EV charging infrastructure.¹² Siting analyses can range from highly technical modelling to a “local knowledge” on-the-ground approach or a combination of both. Based on international practices, three approaches to siting EV charging infrastructure: “local knowledge” stakeholder approach, modeling approach, and hybrid approach.

“Local Knowledge” Stakeholder Approach

For smaller communities with limited budgets and/or with limited data availability, a “local knowledge” based approach that engages stakeholders can be an effective methodology to conduct the planning while meeting budget or data constraints. The approach involves decision-makers to convene local experts with knowledge on traffic patterns and urban space.

There are four steps for the “local knowledge” stakeholder approach: 1) engage and educate, 2) determine vision, goals, and objectives, 3) identify preferred locations, and 4) identify promising sites. Depending on the size of the planning area, and the timeframe of the planning exercise, the identification of locations and sites can be done together.

Modeling Approach

Communities with extensive data on traffic patterns and vehicle use, often utilize an approach with extensive modeling. This model-based approach usually requires less local human knowledge in specific areas but requires datasets of considerable size on locations and potential vehicle travel trajectories. The use of modeling may work well if the planning area is too big for the planning body to purely rely on local knowledge, and when good data is already available or can be easily collected. It is potentially more transparent as well, particularly if the data inputs and the model are transparent. As planning goes from the regional scale to the local level, additional stakeholder voices and factors may need to be considered, necessitating human knowledge and decisions.

Hybrid Approach

A hybrid approach is when both stakeholder participation and technical modeling with limited available data is applied in the planning. Modeling results are usually applied to transform sizable data into human-interpretable siting suggestions for the area, and then local knowledge is used to verify and refine the siting solution from the model, while considering stakeholder inputs and site-specific factors.

Takeaways of Siting Approaches

Leveraging local knowledge in the stakeholder approach works for small-scale planning. For larger-scale regional or city-wide planning, models can be used to process available data into initial location recommendations, reducing the human resources needed.

An advantage of the hybrid approach is that it makes initial planning for bigger areas more manageable by employing a small group of modelers, rather than a large gathering of stakeholders. In the later phase before implementation, stakeholder engagement and local knowledge will still be needed to fill in the gaps between the modeling results and reality.

Gauging the Viability of EV Charging Network and Scope for Expansion: Useful Metrics

Maximize Utilization and Minimize Cost

Utilization of a charging station is a beneficial metric to indicate how well an EV network is serving its vehicle population and if additional chargers are needed. To maximize utilization, public charging infrastructure should be sited in areas where there is demand for charging. Public charging demand at a given location will depend on multiple parameters, including population and employment densities, parking availability, traffic volumes, presence of points of interest such as commercial establishments, transit stations or tourist destinations, etc. It also depends on the availability of other private or semi-public charging facilities in the area. Promising ways to increase charging station utilization include siting charging stations strategically, enhancing charging station accessibility by supporting multiple charging standards, and encouraging EV adoption through incentives such as tax credits.

Because charging stations can be installed to support the current EV market or built for a future EV market, utilization is not necessarily always the best metric to gauge financial success for a charging operator. An alternative metric could be the ratio of the charging network to the number of EVs in the applicable geographic region.¹³ This metric is more suited for the uptake of EVs and for charge point operators to decide their future investments.

The cost of public charging infrastructure primarily depends on three factors: the costs of the EV supply equipment (EVSE), land (inclusive of installation and civil infrastructure costs), and power supply. All three would vary depending on the charger rating and power criteria.

Accessibility

Increase accessibility by making it as easy as possible to find and get to public charging facilities from any location. This includes areas of low estimated charging demand, which still need a minimum provision of charging infrastructure. Network planning and site selection play a role in improving EV charging accessibility. A greater number of distributed charging points in an area reduces the average distance EV users must travel to access public charging. Accessibility is

also influenced by the visibility of charging facilities, ease of entry and egress at charging sites, if the facility is open 24 hours and seven days a week (24 x 7), and their proximity to major and local roads.

It is critical to understand how cities and states have applied the methodologies of various siting studies to assist them in setting up EVSE networks. The following section looks at some of the international best practices in siting studies.

International Siting Case Studies

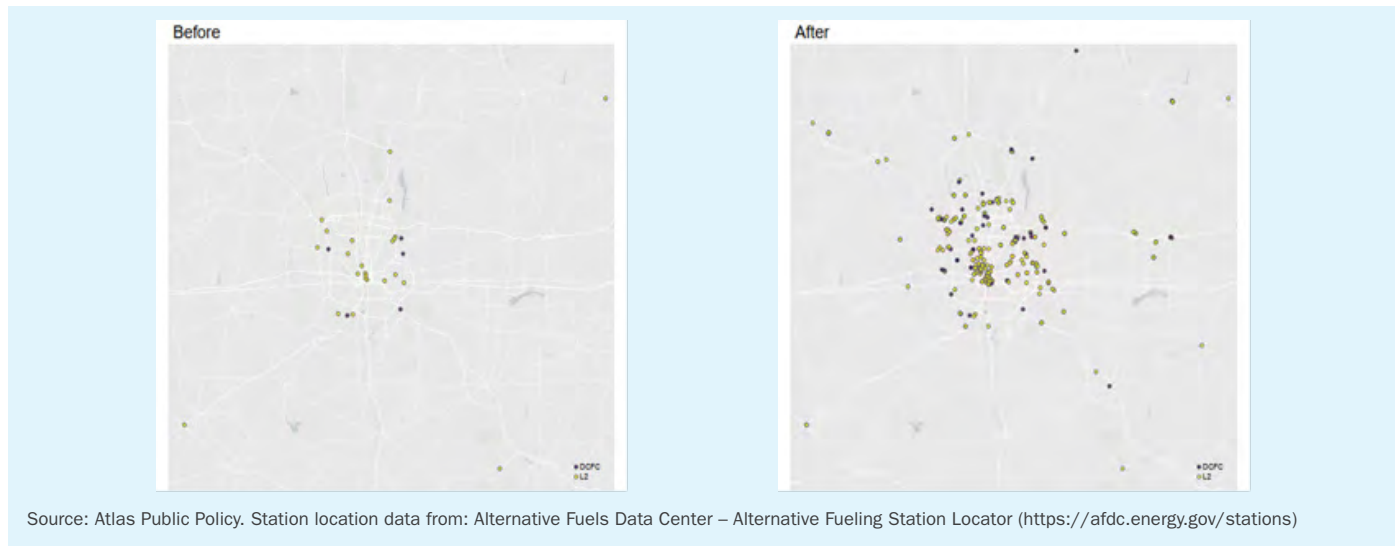
Columbus, Ohio, United States

To accelerate the adoption and use of EVs, the National Renewable Energy Laboratory (NREL) completed an infrastructure siting study for Columbus in 2018.¹⁴ NREL used a modelling approach for the siting study, employing their EV Infrastructure Projection (EVI-Pro) model.¹⁵ The EVI-Pro model takes inputs on travel data and vehicle/charging attributes to simulate driving and charging behavior across the modeled geography. Charging demand derived from those simulations is then processed to estimate potential charger utilization across space and time and the number of chargers needed to supply that usage. This process results in a spatially explicit inventory of needed charging infrastructure which can be used to inform where charging infrastructure should be placed. A study challenge included the potential for error in the input data. For example, the presence of a company that leased vehicles nationally made it look in the data as if many EVs had been adopted in an area when in fact they were located elsewhere. Secondly, data on workplace charging installations was hard to come by because most workplace charging installations are not well tracked. Columbus collected data with a field survey and captured information about new charging locations from utilities and vendors. Ultimately, electric power availability was identified as a significant constraint.¹⁶

Impact for the Columbus region following the siting analysis:

- **Swift roll out of charging infrastructure.** Over four years from 2016 to 2020, about 914 chargers were installed at public sites, multifamily housing, and workplaces across the Columbus city. Figure 1 shows the region's charging network expansion. Each dot represents a charging station, wherein the left image refers to the scenario before the siting study and the right image showcases the scenario after the installation of charging infrastructure network, basis the siting analysis.

Figure 1: Charging network expansion for Columbus, OH, U.S.¹⁷



Source: Atlas Public Policy. Station location data from: Alternative Fuels Data Center – Alternative Fueling Station Locator (<https://afdc.energy.gov/stations>)

- **Increased number of EV registrations.** Since 2017, the cumulative new EV registrations in the Columbus region have increased by 121 percent. Columbus' growth in new EV registrations outpaced the 82 percent expansion in the Midwest region and 94 percent seen across the U.S. over the same two-year period.¹⁸ The increased availability of charging points although was not the sole factor but it complemented other state specific incentives, in accelerating EV penetration in the region.

Because Columbus had insight from NREL's siting study, it was able to act swiftly and lay out the building blocks of EV transition. The Columbus case study highlight the important role of utilities when it comes to siting, and how strengthening the power distribution network can help in siting charging infrastructure at high priority locations.

Sacramento, California, United States

In 2017, Sacramento released its EV Strategy report to implement priority EV initiatives and expand charging

infrastructure in the region.¹⁹ At the same time, the city collaborated with the County of Sacramento, the local utility, and other regional governments to develop an EV readiness plan and siting study for Sacramento County.²⁰ Since then, Sacramento has engaged in multiple siting methodologies, including convening community stakeholders to identify priority sites through local knowledge, identifying high traffic charging locations using travel data and spatial forecasts of EV adoption and multi-criteria analysis of spatial data at the census tract level (small geographic boundary).²¹ Sacramento's siting criteria included: demographics and housing:

population, percentage renters, household incomes, number; employment: jobs per square mile, workplaces; EVSE and EV deployment; travel patterns: trip destinations, parking dwell time; and presence of city-owned facilities. Sacramento prioritized deployment in places where infrastructure would serve low income and historically underserved communities to ensure that those residents were not left behind in the EV transition. Sacramento also heavily weighted supported renters and residents of multifamily dwellings in recognition that they might face difficulty obtaining a charge at home.

Impact of Sacramento's siting and EV planning efforts:

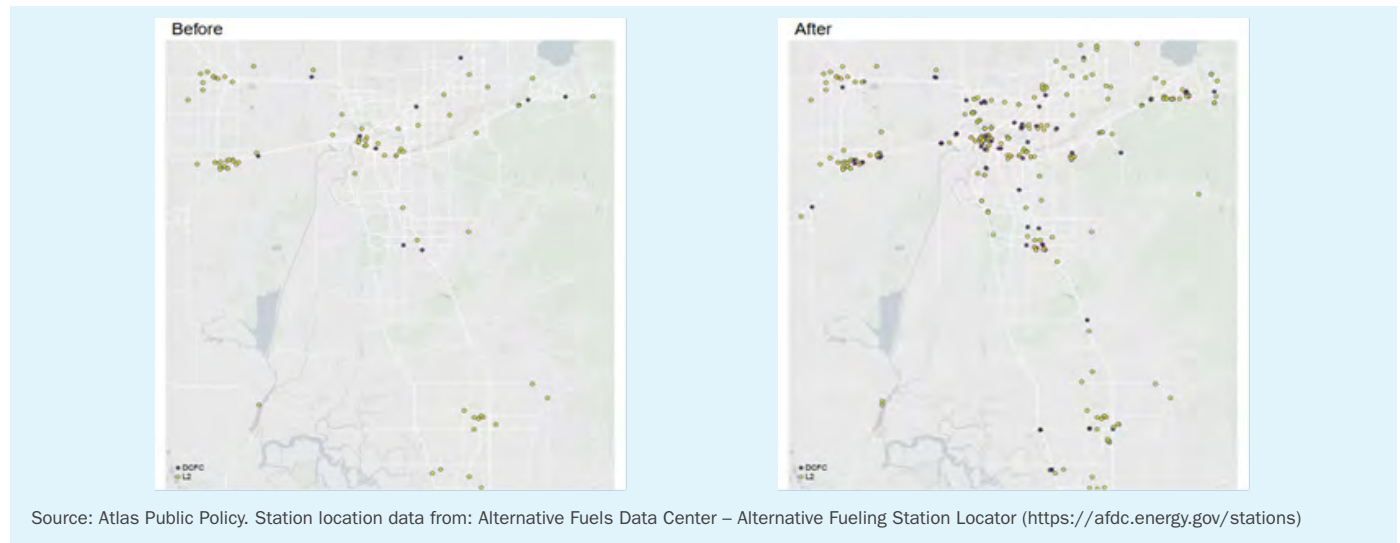
- **Swift roll out of EV charging infrastructure.** In the two years between the release of the 2017 charging report and the first progress report published in 2020, Sacramento added 252 public charging ports, 106 of which were DC fast charging. In addition, over 400 public chargers were due for installation by 2021. The city also added 77 chargers at city facilities for either public use or city employee workplace charging.²² Between January 2018 to January 2020, Sacramento

saw a 38 percent increase in the number of public EV chargers. Figure 2 depicts the evolution of charging infrastructure network in Sacramento; wherein the left image refers to the scenario before the siting study and the right image showcases the scenario after the installation of charging infrastructure network; basis the siting analysis.

onsite without expensive transformer upgrades. Spending that money to increase charging at the parking garage would detract from available funds that could build many more chargers at other locations.

- Sacramento anticipated providing more curbside parking within city right-of-way but found that to

Figure 2: Evolution of charging infrastructure network in Sacramento, CA, U.S.²³



- **Improved utilization levels.** The chargers are used for an average of four plus sessions per day each (an average of 25 plus sessions daily for the entire site/plaza).²⁴
- **Supporting increased number of EV registrations.** Sacramento has realized a 52 percent increase in levels of zero emission vehicles (ZEV) ownership and remarkable deployments of public and private investments in infrastructure.²⁵ In the first ten months of 2018, more than 1,600 new ZEVs were registered in Sacramento, and the market share of new car sales increased from two to eight percent.²⁶

However, the siting analysis encountered some limitations as several sites that were well located did not work out because of on-the-ground conditions. These limitations included:

- Installing high-power chargers proved difficult at city-owned locations because they would often trigger high demand charges, which would adversely affect city utility bills.
- Local power capacity was a major barrier for charging installations. In Sacramento, one city-owned parking garage showed high promise for workplace charging. However, due to onsite electrical grid limitations, fewer than the ideal number of chargers could be installed

be impractical in many situations due to parking configuration and other physical constraints. Constraints included meeting other city standards such as around trees/ vegetation, adequate space for approximately mechanical equipment enclosures (risk and safety requirements), and the availability of angled parking spaces, which can support a greater range of vehicles. Additionally, sites needed excess availability of angled parking spots for accessibility improvements, to meet requirements of the Americans with Disabilities Act (ADA), risk and safety for equipment in the right-of-way, siting of electrical equipment, on-street parking enforcement, and consideration for metered parking. Other issues included on-street parking enforcement and consideration for metered parking.²⁷

Both the Columbus and Sacramento case studies found that local power capacity limits were a key barrier when locating specific site hosts to install chargers in a priority location as determined by the siting analysis. Because information on utility distribution network capacity is not readily available to planners, locating sites that are both ideally suited to satisfy charging demand and able to host the significant electrical load that can accompany large or high-power charging infrastructure installations can be a challenge.

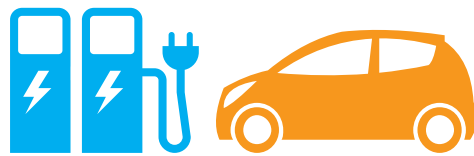
Siting for EV Charging Infrastructure in India for a Swift and Just Transition

Transitioning to EVs is critical for India to achieve its climate and air quality goals. A switch to EVs is only possible with an aggressive scale-up of charging infrastructure. As of FY20, India had about 1,827 charging stations but will need an estimated 2.9 million public charging stations to meet its 2030 EV targets.²⁸ However to motivate drivers to switch to EVs, optimally sited charging stations are needed, not just more charging stations.

Siting Approaches – Indian Context

For the limited charging infrastructure currently sited in Indian cities, charge point operators have used the hybrid approach with active stakeholder involvement. With most of the infrastructure yet to be built, it is critical to develop a more scientific and implementable siting methodology that can be deployed across India. To facilitate a siting methodology and accelerate EV uptake, NRDC, ASCI, and partners have actively engaged with charge point operators, power companies/utilities, land owning agencies, and other relevant stakeholders

Ola Mobility Institute and University of California, Los Angeles conducted a siting analysis for installing charging stations in strategic locations in Delhi.²⁹ The data-driven analysis considered vehicle flow, high traffic zones, high demand routes, existence of commercial and private establishments, and infrastructure availability to identify the strategic locations for setting up charging stations in Delhi. The study found that concerns of



As of FY20, India had about **1,827 charging stations** but will need an estimated 2.9 million public charging stations to meet its 2030 EV targets.

spatial mismatch between chargers and trip demand are overestimated. A large city such as Delhi can be divided into 50 administrative zones of 37 square km each wherein chargers can be randomly sited allowing some flexibility in accommodating constraints such as space availability, land prices, and local electricity infrastructure. A more careful siting of chargers (increasing the number of zones and making them smaller) within a zone yielded diminishing returns. Targeting high mileage vehicle users (both private and commercial) and lending financial and regulatory support for the creation of robust and wide-spread charging infrastructure will minimize the need for vehicle subsidies and reduce burden on public finances.

Stakeholder consultations with charge point operators are essential to develop a stepwise approach on how to site charging infrastructure in Indian cities. These consultations provide a better understanding of on the ground challenges and implementable solutions.



Electric cars are being charged at the charging stations. Source : Pixabay

Case Studies from India

Energy Efficiency Services Limited (EESL) has been at the forefront of the EV charging roll-out in India.³⁰ Their first step to siting is location scouting; wherein EESL prioritizes locations where: 1) footfall is relatively high, 2) parking space is readily available, 3) infrastructure setup requires limited civil construction, and 4) adequate power load is readily available. Following location scouting, EESL conducts a joint survey with distribution utility companies (DISCOM) and land-owning agencies to check the power load availability at the shortlisted sites. Post which Municipal corporations and the power work departments assesses the potential site for regulatory approvals for charging infrastructure and metering. Following the joint survey, ideal shortlisted sites may unfortunately prove to be not commercially viable and/or difficult to energize. The type of charger was decided based on an assessment of EV availability in the market. Given that most public charging will be opportunity charging, EESL installed chargers that would support fast charging and has standardized their methodology for future scale up efforts in New Delhi and beyond. In 2019, EESL initiated a large-scale deployment of public charging stations in the New Delhi Municipal Council (NDMC) area, with its role as the owner and operator.³¹ The collaboration with NDMC allowed for a reduced transaction cost in terms of having a single authority to coordinate with for both land and power. EESL selected the NDMC area based on high traffic and footfall, ease of coordination, and complementarity with the national smart cities mission.

Fortum is a leading charge point service provider in Hyderabad and a handful of other Indian cities. Unlike EESL, which prioritizes sites basis the cost structures (civil and power infra required) and foot fall, Fortum gives more weightage to convenience (seamless/comfortable user experience) and believe that customers/users are willing to pay a delta extra for services offered. Siting approach varies with the use case requirement; for instance, for commercial use cases, Fortum chooses the location based on travel patterns by mapping major pick up and destination points whereas for private use cases, it prioritizes convenience (e.g., proximity to utilities or restaurants), accessibility (ease of access when entering/exiting), and if there are major hotspots or destinations nearby (e.g., on the way to the airport). Fortum reports two major challenges when siting for EV charging infrastructure: 1) getting power connections in a timely manner, particularly on highways, and 2) high capital expenditure burdens on charge point operators. In several instances the cost of getting upstream power infrastructure was more than the cost of charging equipment. For example, to install chargers and get an electricity load of 20 kilowatts (kW), the cost would be

₹1.5 to ₹2 lakhs (\$2,700) for the DISCOM/power utility fee and another ₹1.5 to ₹2 lakhs (\$2,700) to draw a cable from the nearest transformer. These costs increase greatly for higher electricity loads; it would require ₹11 lakhs (\$150,000) to get the power infrastructure in place for a 100 kW power load.

BluSmart is India's only 100 percent electric ride hailing fleet provider. Currently it operates a fleet of over 600 electric cars in the National Capital Region (NCR) and aims to have 3,000 cars by March 2022. BluSmart operates 165 fast charging points in Delhi-NCR and is expanding at a rate of 80 to 100 fast chargers per month. BluSmart plans to have 1,800 chargers in use by March 2022. From a fleet use perspective, the company prefers to set up charging hubs that can support 30 to 100 cars, rather than set up single charge points. When siting for its charging infrastructure, BluSmart prioritizes different criteria than if siting for public charging. Parameters that are weighted more heavily while siting are power load availability, scope for expansion, accessibility (two-way access to pull up to a specific charger) and safety.

Figure 3: Two-way access can improve charger utilization (source: BluSmart and NRDC, 2021).



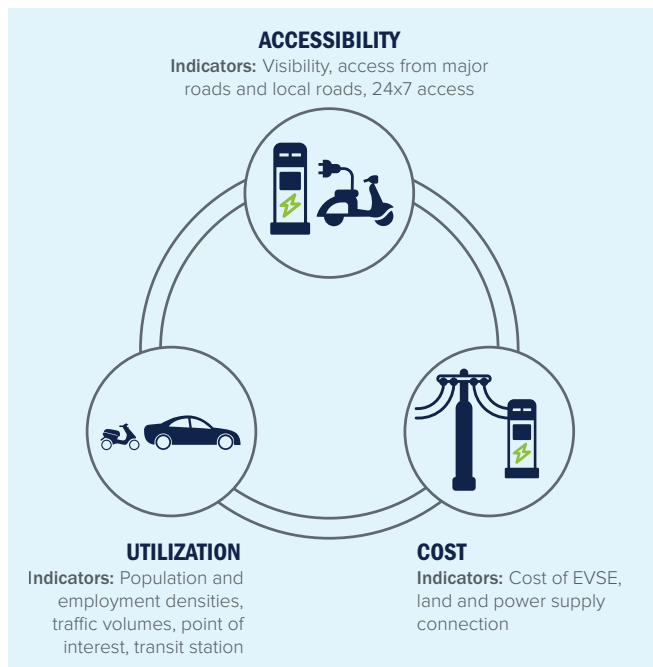
Because most of BluSmart's charging sites are in basement garages (indoors), the safety criteria differ from that of outdoor sites. For indoor sites, additional safety parameters need to take care of issues of water logging, air circulation, and fire-safety and entry/exits points (sites with multiple entry/exit points are preferable).

Indian charge point operators (CPOs), like their U.S. counterparts, continue to face challenges related to the power infrastructure and associated costs. This highlights the need for investing in the grid for an EV ready future. Additionally, a lack of clear policy regarding standardization and interoperability remains challenging for a large scale roll out of charging infrastructure.

Stepwise Approach for Siting EV Charging Infrastructure in Indian Cities

There are seven recommended steps for siting EV infrastructure: 1) choose location and carry out preliminary site feasibility; 2) determine use case and charging infrastructure requirement (type rating, and number of chargers; 3) conduct a site visit for feasibility, take photographs, and develop a draft site plan; 4) determine the feasibility and financial viability of the physical space; 5) determine the feasibility on the power distribution side (including the least cost option for energizing the site); 6) determine the site's accessibility and scope for future expansion; and 7) review for safety threats and develop a detailed site plan.

Figure 4: Principles of location planning for public EV charging (source: adapted from NITI Aayog, 2021).³²



Step 1: Choose location and carry out preliminary site feasibility

The first step in siting is to choose the right type of location, which will dictate the type of charging (e.g., fast or slow) and number of chargers to install. NITI Aayog and partners recently released the Handbook for EV Charging Infrastructure Implementation, which identifies three principles for selecting locations for EV charging: accessibility, utilization, and the cost of installing EVSE.³³

From an accessibility standpoint the potential location should be assessed for if it meets any of the following conditions is it a major arterial road; fall within an urban center; is proximate to public spaces, such as a mall, hospital, a highway; proximate to a residential complex, existing fuel pump, small commercial establishments (providing suitable charge requirement for last mile delivery) or other privately owned spaces (e.g., offices). From the utilization angle, potential sites should then be reviewed for traffic fluctuations and volume, and if the site is proximate to a major trip origin or destination site (e.g., taxi stop). Lastly as part of selecting the right location, assess the location for the cost of installing EVSE, and whether legal owner and building byelaws allow for building charging infrastructure.





Step 2: Determine the use-case and charging infrastructure requirements

The second step in siting is to consider the shortlisted sites under four broad use-case scenarios. Consider the site for whether it is 1) a travel corridor; 2) falls in the city/urban center, or outskirts; 3) a commercial, or residential area; or 4) a major trip start, or destination point. Then assess the shortlisted site for its travel pattern and predominant vehicle segment plying in nearby area (two-wheeler, three-wheeler, four-wheeler). Determine the charging solutions and technology for the site, which includes the number of chargers, type of charger, such as fast or slow, and the charger rating. The travel use-case and widely used vehicle segment in the respective use-case will determine the type and number of chargers needed. The type of charger installed is critical to meeting a customer's needs as they charge batteries at different speeds. Therefore, it is essential to understand the charging requirements and customer behavior across use cases and vehicular segments. Table 1 provides a summary of the typical charging characteristics of different vehicle segments.

Table 1: Charging behavior across different vehicle segments (source: RMI India, 2020).³⁴

Vehicle Segment	Level of flexibility	Typical charging behavior
Private two-wheeler	High	Day and night
Private four-wheeler	High	Day and night
Three-wheeler, commercial car, commercial two-wheeler	Low	Slow speed at night High speed during the day
Bus	Medium/low	Slow speed at night High speed during the day

Table 2: Charging power and energy requirements of different segments (source: RMI India, 2020).³⁵

Vehicle Segment	Battery size	Power level (slow charging)	Power level (fast charging)
 Two-wheeler	1 - 3 kWh	0.5 - 1 kW	2 - 3 kW
 Three-wheeler	3 - 7 kWh	0.5 - 1 kW	2 - 3 kW
 Car	15 - 80 kWh	3 - 7 kW	15 - 100 kW
 Bus	100 - 400 kWh	7 - 50 kW	50 - 500 kW

Charging methods: EV charging uses direct current (DC) to power the battery pack.³⁶ However, electricity distribution systems supply alternate current (AC) power, and a converter is required to provide DC power to the battery. Conductive charging can be AC or DC. In the case of AC EVSE, the AC power is delivered to the onboard charger of the EV, which converts it to DC. A DC EVSE converts the power externally and supplies DC power directly to the battery, bypassing the onboard charger.

End-user charging behavior has critical ramifications for peak power demand, associated load profiles implying that tailored policy instruments need to be designed for managing demand both in time and space to optimize overall costs and bringing in systemic efficiency. Unless encouraged to charge at a specific time or location, most EV owners will default to a charging behavior that is easiest and most convenient.

As a next step, charge point operators need to choose which charger type/capacity needs to be installed keeping in mind standardization and interoperability considerations. Current international standards that are prevalent and used by most vehicle manufactures internationally are CCS and CHAdeMo. Hence, public charging stations shall have one or more electric kiosks/boards with installation of all the charger models as shown in the table below:

Table 3: Ministry of Power technical guidance (source: Ministry of Power Guidelines).³⁷

Charger type	Charger connectors*	Rated voltage (volts)	Number of connector guns	Vehicle type (W = wheeler)
Fast	CCS (minimum (min) 50 kW)	200 - 750 or higher	1	4W
Fast	CHAdeMO (min 50 kW)	200 - 750 or higher	1	4W
Fast	Type-2 AC (min 22 kW)	380 - 415	1	4W, 3W, 2W
Slow/moderate	Bharat DC-001 (15 kW)	48	1	4W, 3W, 2W
Slow/moderate	Bharat DC-001 (15 kW)	72 or higher	1	4W
Slow/moderate	Bharat AC-001 (10 kW)	230	3; 3.3 kW each	4W, 3W, 2W

*In addition, any other charger as approved by Bureau of Indian Standards.

While most Indian-made EVs cannot presently accept 50 kW fast charging, it is expected that fast charging capability will be standard in the global EV market. However, going forward electric four wheelers are expected to charge at 50 kW and higher.³⁸

Choices for EV charging service providers

The Bharat chargers are smaller and can be more easily installed, while a 50 kW charger is about the size of a refrigerator and installation is more expensive and complex. The various chargers require different amounts of power. The 122 kW units can be effective at corridor locations as well as community locations, however due to their larger size installing them in retail parking lots can be more difficult.³⁹ Landlords will typically require that sightlines to the stores not be blocked and can often see an EV space as a lost parking space, particularly where parking is limited.

There are three levels/types of interoperability:

- Plug type is of critical importance to drivers because without the right type of connector they will not be able to charge. One best practice is to illustrate the different plug shapes on apps and even on the chargers themselves because many drivers may not know the technical name of the plug.
- Charger-to-network interoperability is relevant only to the owner of the hardware, and this type of interoperability offers the owner the ability to swap network providers.
- Network to network interoperability, enables drivers with credentials for one network to authenticate and receive a charge on a different network. Private networks often prefer not to allow drivers to roam, but drivers very much like to be able to use a single credential on multiple networks. Requiring this is a best practice in public policy.

Open standards or open protocols signal interoperability and ensure that EV charging systems speak the same language.⁴⁰ Certification is separate for hardware and software. Factors to consider when choosing a hardware original equipment manufacturer (OEM) include price, experience, reliability, ease of servicing and repair, quality of internal components, spare parts availability, whether technicians must be specially trained, build-quality, Open Charge Point Protocol (OCPP) compliance and certification, and warranty.⁴¹ OEMs have been pushing to have one single card that works across all networks, regardless of brand.

Factors to consider when choosing a network provider include the ability to process and respond to trouble tickets, types of credentials that can be handled, hardware monitoring capabilities, customization options, call center capabilities, ability to dispatch and manage service technicians, credit card capabilities, reporting capabilities, compliance with OCPP and Open Charge Point Interface (OCPI), and price.⁴² Increasingly in the U.S. and Europe, the approach is for open access with credit card readers in addition to tap cards for the general public beyond the normal subscription/sign up process.⁴³

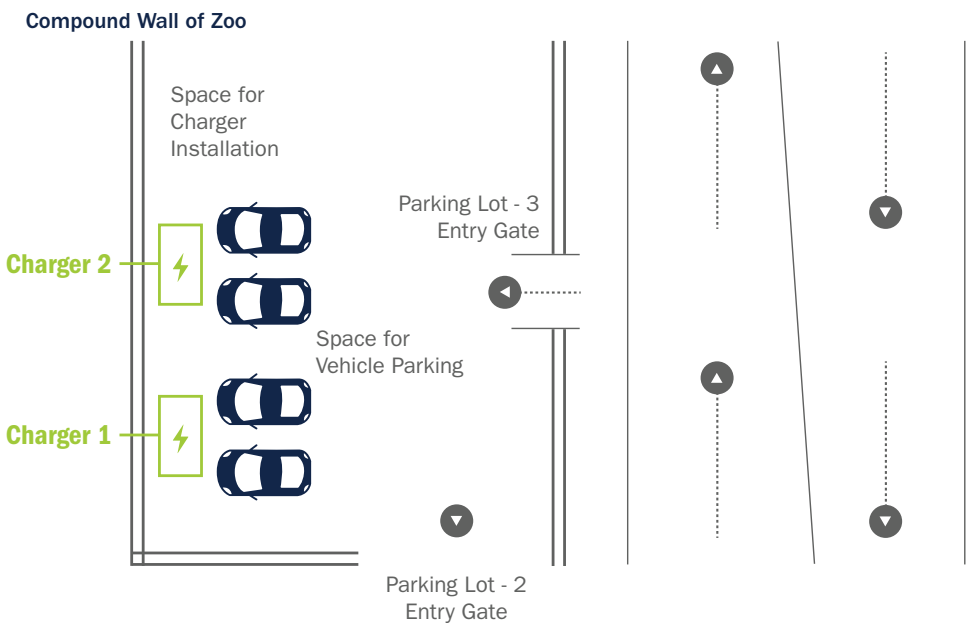
Step 3: Develop a preliminary site plan and take photographs.

As a next step, carry out preliminary site survey of the potential locations, click photographs from all angles and develop a draft site plan. Figure 4 shows a preliminary site survey and photo of siting in Hyderabad. However, for a complete feasibility check, observe for any physical underground infrastructure, such as drainage pipes, nearby infrastructure, business activities, and distance from the nearest power distribution transformer. Also, there is a need to assess the site for future scope of expansion, in terms of the maximum number of chargers that can be sited at the location, which is discussed in more detail in Step 6.

Energy operators should also note the site and distances for trees and vegetation. Although all EV chargers are International Protection (IP) IP 67/ IP 68 certified, but charge point operators should also take care of potential water drippage issues onto the charging and charging-related infrastructure.

Site planning is an important component of locating EV charging in parking areas. CPOs should work with site owners to adhere to the planning guidelines.

Figure 5: Photo and site plan for siting charging infrastructure at Nehru Zoo Park in Hyderabad (source: ASCI, 2021).



Step 4: Determine the feasibility and financial viability of the physical space.

At any EV charging facility, adequate space must be allocated for vehicle parking and movement (space for vehicles to enter and exit the charging bays). The physical space must also account for the installation of charger(s), signage and barriers, and any upstream electrical infrastructure that may be required. The required space for a car parking bay is generally 5 meters (m) by 2.5 m. Including the vehicle circulation space, the equivalent car space for car parking is 23 square meters (m²) to 32 m², depending on whether it is open parking or basement parking.⁴⁴ This can be used as a rule of thumb to determine the number of chargers to be provided. Depending on the parking location and the charger specifications, wall-mounted or pedestal-mounted chargers may be deployed, which will add to the required space in the parking area.

The on-site space requirements for installation of EVSE and upstream electrical infrastructure is provided in the Table 4.

Step 5: Determine the feasibility on the power distribution side to electrify the site.

Accessible, reliable, and affordable electricity is a prerequisite for adequate charging infrastructure provision. The charging requirement (type and number of chargers) at each site determines kind of electricity load and connection is required to power the site. The required sanctioned load determines the type of connection, such as single-phase low-tension (LT), three-phase LT, or high-tension. The type of connection directly impacts the cost and time for energization/ connection, the tariffs, and the need for additional upstream infrastructure like DTs. For a rapidly scalable EV charging network, the ubiquitous LT electricity distribution infrastructure should be leveraged wherever feasible to provide electricity connections for EV charging.⁴⁶

Given the limited EV penetration and low levels of utilization, from a viability perspective CPOs needs to evaluate and decide on the least cost option for energizing the site. Each site should be assessed to determine what infrastructure and ancillary hardware, such as a breaker panel, disconnect, and transformer, can be supported. Also cost of laying power cable from nearest distributional transformer needs to be assessed for. Although being

Table 4: Space requirements (in square meters) for installation of EVSE and upstream electrical infrastructure (source: NRDC, 2021 and NITI Aayog, 2021).⁴⁵

Foundation space only for charger	1 m x 0.8 m
Foundation space for charger plus canopy	1.5 m x 1 m
Space for installing LT panel	0.5 m x 0.5 m (usually a height of 1.5 m)
Space for installation of transformer, breaker	10 m x 6 m
Estimated load of 100 kW to 300 kW, installation of one 11 kV pole or plinth mounted DT	4 m x 4 m (pole) 8 m x 5 m (plinth)
Estimated load of 300 kW to 700 kW, installation of one 11 kV plinth mounted DT	9 m x 5 m
Estimated load of 700 kW to 1,500 kW, installation of two 11 kV plinth mounted DTs	10 m x 8 m

DT = distribution transformer; m = meters.

Exclusive distribution transformers (DTs) are not a universal requirement and are typically required only in case of high-tension electricity connections with multiple high-power charging points. To determine the cost of civil infrastructure requirements at potential locations, CPOs should also take note of the type of surface (whether it's concreted or mudded), any underground physical infrastructure (such as drainage pipes etc.) that can create potential blockages.

located near an existing transformer or electrical room is most economical however, the trade-off for low-cost installation is a lack of visibility. Charging sites in locations that are hard to access, inconvenient, or too far from main road end up with low levels of utilization.

Step 6: Determine the site's accessibility and scope for future expansion.

As a next vital step, the potential site is assessed from user accessibility perspective and scope for future expansion.

From an end user perspective, the following parameters need to be factored in: (i) whether the charging stations is accessible freely or is there are parking/convenience fee; (ii) whether charging services are available 24 x 7, (iii) convenient entry and exit, two-way access; (iv) if the terrain of site is flat or steep; (v) proximity to amenities/utilities when end user can spend time while their vehicle is getting charged. Accessibility for drivers with physical disabilities is required in the U.S. and is a best practice even if not required. This requires, among other attributes, an access aisle, which could cause the loss of a parking space unless an existing space can be widened by expanding into a drive aisle or greenway.

Additionally, assess the site for the potential for expansion by factoring how many four-wheel vehicles could be parked and charged at the same time. Generally, a car parking

bay requires an area of around 5 m by 2.5 m, for adding more charge points curbside land availability needs to be checked.

Station layout is an important consideration because there is no standard for where a vehicle's charging port is located. The result is that, depending on the cord length and the location of the charge port, drivers wishing to charge may need to pay close attention to which plug they can access from which parking space and which direction they must face the vehicle. Cords can be purchased in various lengths; longer cords offer more options for parking, but they are more prone to wear and tear because they experience more dragging on the ground; certain types of cords are also quite heavy and inflexible, making this another attribute to consider in selecting a configuration. Indicative station layout plans both for off street and on-street public parking are depicted below:

Figure 6: Sample site plan for off-street public parking charging sites (source: NITI Aayog, 2021).⁴⁷

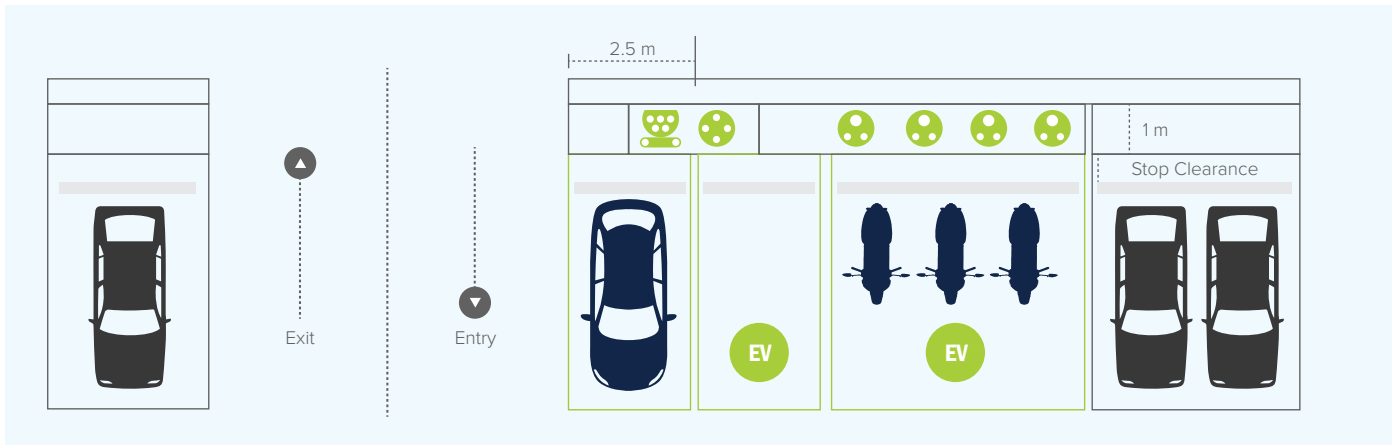
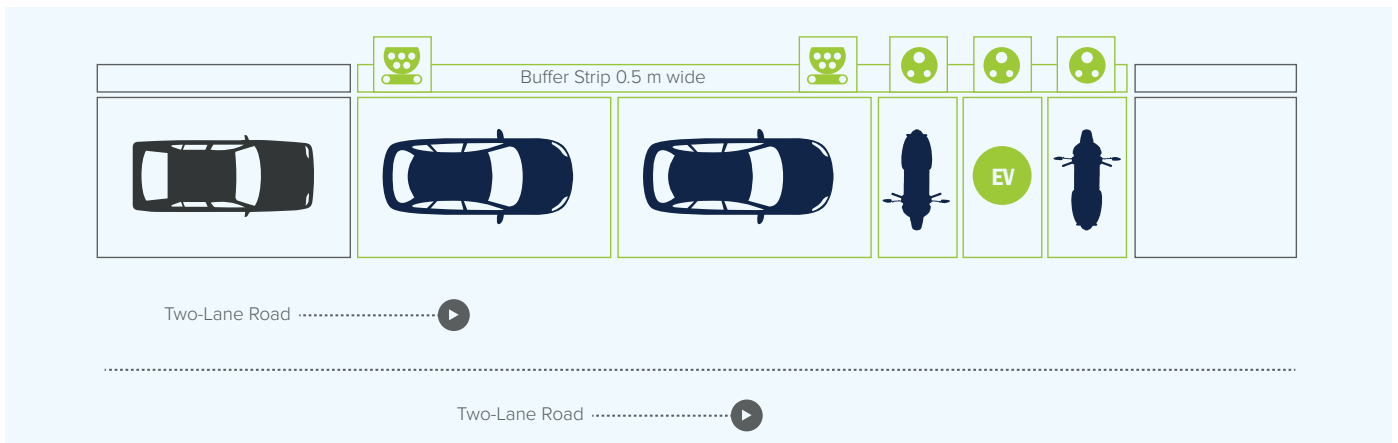


Figure 7: Sample site plan for on-street public parking charging sites (source: NITI Aayog, 2021).⁴⁸



Step 7: Review for safety threats and detailed site plan.

The site should then be assessed from an environmental and user safety perspective. Also, reconfirm that the legal owner of the property possesses the right to allow you to build. It is important to include the landowners in the conversation and obtain their consent on the site location. Often a chosen site may not be acceptable to the landowner and needs to be moved.

Site safety considerations for the end user should also be considered. These include: if the area is visible and secure, are there lights or security cameras, will there be a permanent security guard, is there anything nearby that an assailant could hide behind, have there been other crimes at the property, and is the charging site visible from the road. Safety parameters should address water logging, air circulation, and fire-safety and entry/exits points (sites with multiple entry/exit points are preferred).

EV charging sites are prioritized based on multiple criteria, which include the ease of parking, power availability, distance from nearest power source, civil infrastructure work, and visibility/ footfall. A stepwise approach for siting charging infrastructure in Indian cities is shown in Table 5.

Table 5: Stepwise approach for siting charging infrastructure in Indian cities (source: NRDC, 2021).

	Steps for siting charging infrastructure	Parameters
STEP 1	Choose the location and preliminary site feasibility	A. Determine where the location is: 1) an outer ring road, 2) a dense inner-city pocket, 3) a public space, 4) a highway, 5) a residential complex, 6) an existing fuel pump, 7) or another privately owned space/office.
		B. Note the level of traffic and traffic patterns.
		C. Is it a major trip origin or destination site?
STEP 2	Determine the use case and charging infrastructure requirement	A. Note if the location/site under consideration is 1) a travel corridor, (2) whether it falls within the main city boundaries (urban), or outskirts; (3) whether it is a commercial, or residential area, or (4) if it is a major start/destination point.
		B. Note the basis of the travel pattern and the widely used vehicle segment (2W, 3W, 4W, or bus) to determine the appropriate type and number of chargers.
		C. The charging technology solutions and choices.
		D. Determine the targeted end-users, which are likely to use charging station (office goers/visitors/commuters/fleet operators).
STEP 3	Feasibility and financial viability of getting the physical space	A. Evaluate the site for space available for installation of EVSE, upstream power infrastructure (including distributional transformer, breaker, low tension panel).
		B. Scope for future growth in addition to chargers and land available curbside.
		C. Is physical underground infrastructure (drainage pipes, power cabling) evident?
		D. Mention the type of surface (concrete) and area existing of the site.
		E. Estimate the cost of civil works.
STEP 4	Feasibility on the power distribution side including cost optimization	A. Determine the power load availability at the nearest distributional transformer.
		B. Measure the distance from site to pole, site to transformer to pole, and pole to pole.
		C. Measure the cable length distance from the nearest transformer.
		D. Estimate the cost of laying power cable from transformer to charger point.
		E. Estimate the cost of upstream power infrastructure at various levels of electricity load (160 kVA, 100 kVA, 63 kVA, 25 kVA).

	Steps for siting charging infrastructure	Parameters
STEP 5	Accessibility and scope for future expansion	A. Note the exact location (latitude, longitude) and/or nearest landmark.
		B. Note the number of 4Ws that could park and charge at the same time.
		C. Note if the location is on-street or off-street, and if there is curbside land availability.
		C. Note the potential for future growth.
		D. Can the user access the charging site for free or is there a parking fee? Note if the location is a parking site.
		E. Is the site terrain flat or sloped (steep slopes would hinder buses and multi-utility vehicles)?
		F. Is there is easy and two-way access and egress (access from main driveway, visible from main drive aisle, close to store entrance)?
		G. Will the location be available for consumer access 24 hours 7 days a week?
STEP 6	Safety and threats	A. Confirm that the legal owner of the property possesses the right to allow you to build.
		B. Note the security of the location. Are there lights, security camera? Is there anything nearby such as a wall or bushes that an assailant could hide behind? Obtain crime report for the property.
		C. Is there a permanent security guard in the location/ near the charging equipment?
STEP 7	Detailed site visit, site photographs, and site plan	A. Develop a site plan (note any physical underground infrastructure such as drainage pipes etc.), take photos, and note the distances to the nearest trees and power distributional transformer.

Siting Consideration Takeaways for India

Siting for public charging infrastructure is essential to building a robust EV charging network and accelerating EV deployment. A strong charging network by reduces users' fear or running out charge. Given the numerous stakeholders and vast number of considerations involved in siting, a stepwise approach that Indian cities can follow will facilitate charging infrastructure deployment. It also indicates that funds for public infrastructure projects will be used judiciously. NRDC and partners developed a comprehensive approach for cities to follow when siting for EV infrastructure. This approach underscores the need for coordination between all stakeholders (e.g., regulators, charge point operators, land owning agencies, power utilities) involved in the siting process. It minimizes any duplication of efforts and ensures a swift roll out of EV charging infrastructure. Basis on international case studies and Indian siting efforts we found at that power infrastructure costs standout as the single largest cost component for setting up EVSE network, which presents the larger need for greater involvement by power utilities across India. State-specific utility programs and EV plans should focus on enhancing the power grid to enable a faster EV transition. Further power utilities should leverage demand

side management (DSM) measures for encouraging managed or controlled charging by EV users. Regulators can account for siting parameters when designing charging infrastructure schemes. CPOs can adopt the approach to innovate ways that provides financial viability for the EV charging business. An accessible public charging infrastructure network is needed for India to reach its EV targets, reduce air pollution, and achieve its climate goals.



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Highlighted Reports



Plugging into a Clean Energy Future: Effective Deployment of Telangana's Electric Vehicle Policy

<https://www.nrdc.org/sites/default/files/plugging-into-clean-energy-future-report-202104.pdf>



Transitioning to Electric Mobility in Gujarat: Impacts and Benefits - Report

<https://www.nrdc.org/sites/default/files/gujarat-electric-mobility-202102.pdf>



Stakeholder Driven Solutions for Financing Electric Mobility: Perspectives from Indian States - Issue Brief

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Location Is Everything: Approaches to Siting Electric Vehicle Charging Infrastructure for the Indian Context - Issue Brief

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Scaling up Electric Vehicle Charging Infrastructure - Report

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Charging Forward on Powering Vehicles - Issue Brief

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Highlighted Blogs

- **Utilities and EV Dreams in India, Anjali Jaiswal, Nitish Arora and Jessika Korsh, October 2021**
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- **Energizing Indian Cities: EV Charging Infrastructure Siting, Sameer Kwatra and Nitish Arora, August 2021**
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