DEPLOYING EV CHARGING INFRASTRUCTURE

PROCEEDINGS FROM ROUNDTABLE DISCUSSION

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Context and Background

The Government of Maharashtra (GoM), Pune Municipal Corporation (PMC), and Rocky Mountain Institute (RMI) co-hosted a roundtable discussion on electric vehicle (EV) charging infrastructure for Pune and Maharashtra at the Municipal Commissioners Office in Pune on June 14, 2018. This workshop and resulting document were designed to specifically address transportation electrification. We find it prudent to note that electrification is one subcomponent of urban mobility in India. Effective and efficient mobility solutions must take a holistic and integrative approach to mobility, incorporating all aspects of the system including public transit, first- and last-mile connectivity, non-motorized transit, and other new mobility solutions not mentioned here.

The objectives of the roundtable discussion were to:

- Provide support to the Government of Maharashtra in soliciting feedback and inputs from local stakeholders on barriers and opportunities to deploy EV charging infrastructure in Pune and Maharashtra. These inputs will feed into the Government of Maharashtra's comments in response to solicitation for comments from the Department of Heavy Industries, Ministry of Power, and other ministries of the Government of India.
- Gather insights on local conditions and plans for EV charging infrastructure buildout to inform the Urban Mobility Lab in Pune
- Share global best practices for EV charging infrastructure planning and deployment
- Foster connections and collaboration across a broad network of relevant stakeholders and decision makers that will shape the future of EV infrastructure in Pune and Maharashtra

About this document:

This report serves three primary purposes:

1. Identify the various mobility use cases that require different approaches for planning and deployment of charging infrastructure
2. Identify key barriers associated with deployment of charging infrastructure for each use case

3. Share best practices for EV charging infrastructure planning and deployment globally, and emerging best practices for India

Participants:

This roundtable discussion was attended by representatives from the Government of Maharashtra, senior officials from various departments of the Pune Municipal Corporation, national and state level transportation companies, officials from multilateral organizations, and local think-tanks and civil society organizations. A detailed list of participants can be found in the Appendix of this document.

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Transport Electrification Use Cases in India

Public Transport Buses (State Transport Undertakings, private bus operators, bus aggregators)

Buses operate on fixed routes, usually on predetermined schedules both for intra- and inter-city transportation needs. Buses could be owned by private operators or by State Transport Undertakings (STUs). Buses owned by private operators usually run on contract carrier licenses, while buses owned and operated by STUs run on stage carrier licenses. Public transport buses normally run on CNG and diesel, though multiple STUs are planning on introducing e-buses into their fleets.

Commercial Three-Wheelers (traditional auto rickshaws and autos on ride-hailing platforms [e.g., Ola, Uber, and Jugnoo])

Auto rickshaws (autos) are small, open carriage, three-wheeled vehicles used in cities and towns for short distances to provide cheap and efficient transportation. These could run on contract carrier licenses or at times on fixed routes. Autos normally run on petrol, CNG, or diesel and seat four including the driver. e-Autos and electric rickshaws are becoming more popular and increasingly available from several Indian and Chinese manufacturers.

Commercial Four-Wheelers (taxis and cars on ride-hailing platforms [e.g., Ola and Uber])

Commercial four-wheeled vehicles (cars) are hailed from the street, hired from a taxi stand, or hailed from a mobile app. All taxicabs are required to have a fare meter installed. These vehicles usually run on petrol, diesel, or CNG. Ola has piloted electric cars in Nagpur, and both Ola and Uber have announced ambitious plans to deploy EVs in other cities across the country.

Commuting Services (for private-sector companies and those operated by aggregators [e.g., Lithium, Shuttl, and ZipGo])

Commuting services include privately owned and operated vehicles serving a fixed or semi-fixed route to provide employee transportation services to and from the place of employment. These services can be paid for by the employer or the employee and often make use of four-wheelers, vans, and AC buses.

Car-Sharing Services (e.g., ZoomCar)

Car sharing is a model in which people rent cars for a short period of time, usually by the minute or the hour, either from a fleet manager (e.g., ZoomCar) or from a peer-to-peer network (e.g., Turo). Car-sharing models can take the form of a fixed depot model or a free-floating model and provide the user with an all-in cost-per-hour covering insurance, car rental, and often fuel costs. Zoomcar recently announced a partnership with Mahindra Electric to deploy more electric vehicles in its fleet.

Private Vehicles

Private vehicles are those owned and operated by the user, and all costs (up-front and operational) are covered by the owner/operator. Private vehicles include:

- Motorbikes
- Scooters
- Cars
- SUVs

Barrier Identification

The following sections describes the outcome of a set of breakout sessions focused on understanding use-case specific barriers and challenges of EV infrastructure deployment.

Participants were asked to vote for the use case that city planners should prioritize in the near term for electric charging infrastructure deployment in Pune and Maharashtra. This process resulted in Group 1 focusing on commercial three-wheelers with a particular focus on the traditional auto market (non-Ola/Uber) and Group 2 focusing on public transport buses.

The following list contains challenges and barriers identified during the breakout sessions that are not unique to a single use case but apply across the broader set of electric vehicle use cases.

Non Use-Case Specific Challenges and Barriers

- *Lack of land availability*: Urban environments in Pune and Maharashtra are usually congested and relatively unplanned. With most urban land already built up and devoted to other use, finding appropriate sites for charging infrastructure where vehicles could be parked for the duration needed to charge can be challenging.
- *Cost for electrical infrastructure upgrades:* The state of transmission and distribution grid infrastructure is quite variable across Pune and Maharashtra. It is expected that infrastructure upgrades will be required to support peak and energy demand from electric vehicles, including upgrades to transmission lines, distribution substations, switchgear and circuit protection, and metering infrastructure.
- *Up-front cost of charging equipment:* Depending on the level and type of charging infrastructure, costs could vary quite significantly and present a significant barrier to charging infrastructure deployment.
- *Cost of installation:* The condition of the host site for EV charging infrastructure could vary quite significantly, and hence it is expected that the cost for installing the charging equipment—site preparation, wiring, trenching—could vary as well.
- *Access to financing charging infrastructure:* Deployment of a wide-ranging EV charging infrastructure will need to rely on a significant amount of patient capital as EV penetration will likely lag deployment of charging infrastructure.

- *Lack of trained technicians for EV charging infrastructure installation and maintenance:* A large number of trained technicians and labor will be required for installing and maintaining EV charging infrastructure.
- *Safe charging environment:* It will be necessary to ensure that charging infrastructure is protected against and is functional under a wide variety of environmental and ambient conditions such as variable supply of power quality, and extreme weather conditions.
- *Theft-proof infrastructure:* Ensuring that charging infrastructure is secure and protected could also be a challenge in Maharashtra's urban environments.
- *Existing grid pollution intensity:* Although electric vehicles have zero tailpipe emissions, their net impact on greenhouse gas emissions and other pollutants is directly associated with the pollution intensity of the local grid. It will be important to integrate the use of renewable power sources into the generation mix to minimize generation source emissions.

Group 1 identified two types of barriers for commercial three-wheelers:

1. <u>Challenges and barriers to the electrification of the three-wheeler segment broadly</u>

    - High up-front vehicle costs.
    - Lack of education and awareness around e-Auto economics and an inability to access lower total cost of ownership of electric vehicles.
    - Unclear and potentially non-aligned policy support for electrification at the city, state, and central levels of government.
    - Perception of battery quality and life: The first generation of e-rickshaws (in Delhi) were lead acid and died after only six months, far before drivers were able to recover their costs.
    - Uncertainty around payment systems in a cash dominated industry: There is a need for an integrated digital payment system that works seamlessly across all EV charging providers.
    - Lack of appropriately trained technicians to service electric three-wheelers.

- Political interests: The auto-rickshaw union is politically powerful and could create barriers to electrification if it is perceived to not be in the best interest of the drivers.
- Customer adoption of new technology: Auto-rickshaws went through a transition from petrol to CNG, which was somewhat painful for some.

2. Challenges and barriers to effective charging infrastructure deployment for three-wheeled commercial vehicles

- Unreliable supply of electricity to the charging stations.
- Unclear business model for charging infrastructure: Because of the dispersed ownership of three-wheelers, business models for three-wheeler charging-infrastructure ownership, operation, and maintenance are unclear.
- Stranded assets: Pre-determining the type of charging equipment (swap vs. conventional, power output, socket type, etc.) could pose a risk of stranded assets if the market does not develop as anticipated.
- Unsolved collection of payment for fueling, specifically for cash payments.
- The requirement of separate meters for each charge point will add costs to the network.
- Charging time is currently too long, eating into the earning potential of drivers if they need to charge during their shift.
- The current state of parking enforcement makes it challenging to supply dedicated charging space that is not encroached by non-EV drivers.

Group 2 identified barriers for public transport buses:

1. Challenges and barriers to the electrification of public transport buses broadly

- High up-front vehicle cost.
- Poor financial status of most public transportation service providers in Maharashtra.

- Insufficient institutional and personnel capacity to procure, deploy, and maintain electric buses in public transportation fleets.
- Perceived technological immaturity of electric buses.
- Lack of charging/swapping solutions: DC fast charging might be infeasible because of the poor state of the electrical grid and the high costs of equipment and infrastructure upgrades. The long charging time needed with Level 2 chargers may render conventional charging solutions operationally infeasible. At the same time, swapping is still untested and few e-bus manufacturers are manufacturing buses with swappable battery technology.

2. <u>Challenges and barriers to effective charging infrastructure deployment of public transport buses</u>

- Unclear costs, benefits, and challenges associated with different types of charging equipment (swapping vs. conventional, overhead charging infrastructure—pantograph). Investments in one over the other could pose risk of stranded assets if the market does not develop as anticipated.
- Institutional inertia to adopt electric buses, which will likely require retraining or hiring new technicians and maintenance staff, bus schedulers, drivers, and conductors.
- Charging/battery swapping at bus depots, which are often located outside the perimeter of the city, will add to dead-miles traveled for buses, and will likely require larger battery capacity.
- Frequent battery swapping might erode battery connectors, especially in extreme weather conditions.

<u>The groups also identified challenges and barriers to effective charging infrastructure deployment for four-wheeled commercial vehicles:</u>

- Will likely require fast-charging or swapping infrastructure resulting in potentially high cost and a need for investment in new grid infrastructure.
- Land availability for central hubs to house swapping or fast-charging infrastructure is not clear.

- Wider ranging network will be required to also serve major long-distance corridors for commercial four-wheeled vehicles.

EV Charging Infrastructure—International Best Practices

Emerging Considerations and Best Practices for Deploying EV Charging Infrastructure in India

1. Conventional charging and swapping are not an either-or choice, but instead represent solutions that are best-suited for different use-case applications and vehicle-types.
2. Greenfield development opens up ample opportunities for doing it right the first time. India can overcome factors that have hampered growth of EV charging infrastructure in other countries.
3. Support a phased approach for building EV charging infrastructure, starting with the most economic EV market segment and expanding to other segments based on their economic feasibility.
4. Institute uniform standards for infrastructure deployment to prevent balkanization of networks and ensure high-quality services.
5. Plan deployment of charging infrastructure, with coordination between different levels of governments, EV charging infrastructure operators, and other urban bodies to help with cost-effective and non-balkanized infrastructure deployment. Create public/private partnerships to deploy optimally utilized charging infrastructure.
6. Provide incentives and mandates for deployment, including building codes, direct subsidies, and access to finance—municipal bonds, development financing, loan guarantees, etc.
7. Conduct multiple pilots to help answer questions around ideal tariff structure, mix of swapping versus conventional charging, location of charging infrastructure, etc.
8. Build charging infrastructure with an eye on the future. Infrastructure should be able to capture EV-grid integration benefits, enable common digital payments, support open-communication protocols, and be compatible with demand-response capabilities.

Global Best Practices

Charging Capacity

- Because Level 1 charging takes eight hours or more to fully charge a fairly small-capacity four-wheeler EV battery, Level 1 charging is unlikely to play a primary role in the future of shared and connected e-mobility. However, Level 1 charging can play a role in private two-wheelers and smaller four-wheelers.
- Level 2 chargers present the lowest-cost option to serve residential and workplace charging needs, and offer the best opportunity to manage EV charging for grid benefits.
- Though considerably more expensive, DC fast chargers (DCFC) are necessary where vehicles need to charge quickly. These chargers will be essential to serve future mobility needs such as electrified public transit, fleets of ride-sharing vehicles and autonomous vehicles, and personally owned vehicles making long-distance trips.

Siting Considerations

- Site public charging stations where they will be used frequently. A high utilization rate is important to ensure a profitable business case.
- Site Level 2 chargers where drivers have a preference to charge over a longer interval (i.e., several hours), such as workplaces, residences, and shopping malls.
- Site DCFC where utilization will be high and the grid impact will be low.
- Hubs that provide a combination of Level 2 chargers and DCFC are likely to be the best way to serve public fleets, transportation network carriers, and autonomous vehicles.

Tariff and Rate Design

- Create dedicated tariffs for EV chargers.
- Slow and fast chargers require different tariffs in order to optimize utilization, station economics, and grid impacts.
- All EV tariffs should feature some level of time-variance or dynamic pricing in order to optimize charging patterns for grid services and reduced grid impacts.
- DCFC should be on tariffs with reduced, delayed, or no demand charges until the market matures and utilization rates are high enough.

- Consider creating specific tariffs for DCFC to promote a strong and sustainable business case for owners and operators.

Utility Involvement[1]

- Make-ready infrastructure—Allow utilities to install make-ready infrastructure and add it to their rate base, but with a lower guaranteed rate of return.
- Level 2 chargers—Require utilities that want to own Level 2 charging stations to offer a series of competitive solicitations for successive tranches of charging stations.
- DCFC—Because DCFC are expensive, and it could take time for the market to mature and utilization rates to rise to the point where an attractive business case exists for private-sector charging companies, utilities could be permitted to build, own, and operate public DCFC, but only earn a rate of return if the stations obtain a specified utilization rate that rises over time.

[1] Applicable to privately owned regulated utilities to minimize upward pressure on ratepayers cost.

Key Considerations for Station Location

Visibility, Accessibility, and Discoverability

- Charging infrastructure must be able to be located via apps and must be highly visible and well signed for easy discoverability to drivers.
- Locations must be accessible to all vehicle types and not behind parking barriers or gated areas.

Maximize Utilization and Network Optimization

- Asset utilization is paramount to efficient and effective (e.g., profitable) network operation. Initial siting and network expansion need to balance the need for highly utilized stations while not creating excessive queuing and ensuring a robust enough network to serve areas of lower charging demand.

Installation, Implementation, and Expansion

- The complexity and cost of installing and operating charging infrastructure (especially DCFC) can range widely across a small geography depending on utility rate structures, cost of land, ease of access, existing distribution system capacity, etc.
- Future proofing installations in a way that sites can be expanded and improved allows for lower long-term costs.
- Communication and control of stations is required to ensure system operators can capture potential benefits of EV charging and avoid future challenges with system peaks and congestion.

Utility Rate Design

- Working with utilities, regulators, and government to develop EV-specific rate structures can elevate operational costs while creating greater load flexibility for utility operators.

Network Planning Best

Evaluation of current and future demand

1. City needs assessment:
   - Population
   - Modal split
   - Income levels
   - EV penetration and forecast
   - Vehicle use analysis
   - Incentives (local and central)
2. Grid/Utility assessment
   - Utility rate structures
   - Local grid infrastructure
   - Grid mix and generation fleet
3. Demand forecast
   - Identify charging use case (e.g., commuting, fleet, municipal, etc.)
   - Evaluate expected demand for
     - L2 Residential
     - L2 Workplace
     - DCFC
   - Analyze potential system wide grid impacts (e.g., generation)

Analysis of charger count, type, and location

1. Expected charging patterns
   - Identify locations based on use cases and land availability
   - Assess expected charging patterns/frequency by use case
   - Determine the number and type of chargers at sites
   - Site charging stations close to other amenities
2. Network size
   - Evaluate expected utilization at sites across the network
   - Determine an acceptable range of utilization
   - Ensure popular sites have enough utilization to balance seldom-used cites
3. Network optimization
   - Analyze local grid impacts
   - Optimize charge use/utilization using price signals or other incentives
   - Determine initial high priority sites that meet current and near-term future demand for EVSE
   - Develop a network expansion plan to satisfy midterm EV growth

Data collection and network buildout

1. Observed charging patterns
   - Collect data on EVSE utilization (time, place, frequency, use case)
   - Analyze data and explore options to optimize existing infrastructure
2. Network size
   - Identify over/under utilized stations
   - Develop new infrastructure
3. Network optimization
   - Optimize utilization across network

Appendix

Global Charging Infrastructure—Standards, Levels, and Types

<table>
<tr><th rowspan="2">Classification</th><th rowspan="2">Level</th><th rowspan="2">Current</th><th rowspan="2">Power</th><th colspan="4">Type
(Connector and Communication Protocol)</th><th rowspan="2">Minutes to supply 80 km range</th></tr>
<tr><th>China</th><th>Europe</th><th>Japan</th><th>North America</th></tr>
<tr><td rowspan="3">Slow Charging</td><td>1</td><td>AC</td><td>≤ 3.7 kW</td><td colspan="3">Devices installed in private households, the primary purpose of which is not EV charging</td><td>SAE J1772</td><td>400–540</td></tr>
<tr><td>2</td><td>AC</td><td>> 3.7 and ≤ 22 kW</td><td>GB/T 20234 AC</td><td>IEC 62196 Type 2</td><td colspan="2">SAE J1772 Type 1</td><td rowspan="2">40–220</td></tr>
<tr><td>2</td><td>AC</td><td>≤ 22 kW</td><td colspan="4">Tesla Connector</td></tr>
<tr><td rowspan="3">Fast Charging</td><td>3</td><td>AC, triphase</td><td>22kW and ≤ 43.5 kW</td><td>SAE J3068 (Under Development)</td><td>IEC 62196 Type 2</td><td colspan="2">SAE J3068 (Under Development)</td><td>20–40</td></tr>
<tr><td>3</td><td>DC</td><td>< 400 kW</td><td>GB/T 20234 DC</td><td>CCS Combo 2 Connector (IEC 62196 Type 2 and DC)</td><td>CHAdeMO</td><td>CCS Combo 1 Connector (SAE J1772 Type 1 and DC)</td><td>3–40</td></tr>
<tr><td>3</td><td>DC</td><td>Currently < 150kW</td><td colspan="4">Tesla and CHAdeMO connectors</td><td>10–40</td></tr>
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List of Participants at the Roundtable Discussion

Name	Designation	Organization
Mr. Srinivas Bonala	Chief Engineer (Projects)	PMC
Mr. Ajri Babasaheb	RTO	Regional Transport Office
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Mr. Samir Sattigeri	Head	CIRT
Mr. Bedarkar	Chairman	Committee MCCIA
Mr. Mangesh Dighe	Environment Officer	PMC
Ms. Manisha Shekhetkar	Executive Engineer (Electrical)	PMC
Mr. Chetankumar Sangole	Head of Sustainability Desk	MCCIA
Mr. Armeet Narang	Chief Minister Fellow	PMRDA
Mr. Ameya Deshpande	Chief Minister Fellow	PMRDA
Mr. P. B. Dhamale	ACP Traffic	Traffic
Mr. Dattatray Tulpule	Executive Engineer	PMPML
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Mr. Kaekan P. S.	Electrical Engineer	PMPML
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Mr. Debi Prasad Dash	Director	IESA
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Mr. Ranjit Gadgil	Program Director	Parisar
Mr. Suvranil Majumdar	Operations officer, E vehicle	IFC
Ms. Sanskriti Menon	Program Director	CEE
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