Electrification of on-demand mobility in Delhi: Identifying Strategic Locations for Public EV Charging Stations

Summary for Policymakers

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Prepared by

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OLA MOBILITY INSTITUTE

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Ola Mobility Institute (OMI) is the policy research and social innovation think-tank of Ola, focused on developing knowledge frameworks at the intersection of mobility innovation and public good. The Institute concerns itself with public research on the social and economic impact of mobility as a service, electric mobility, climate change, future of work and the mobility economy, transit-oriented planning, digitalisation of mobility, accessibility, safety, and gender. All research conducted at OMI is funded by ANI Technologies Pvt. Ltd. (the parent company of brand Ola).

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Summary

India is expected to become[1] one of the global hotspots for electric mobility, supported by concerted efforts by governments at the national, state, and city levels to decarbonise the transport sector by adopting electric mobility and increasing India's reliance on renewable energy. Complementing the efforts being taken by the government, public and private sectors, this policy brief endeavours to address the most critical operational issue of the availability of a robust EV charging infrastructure in cities. This brief for policymakers is the summary of a joint study led by UCLA in collaboration with Ola Mobility Institute[2] to better understand the potential costs and savings of, and the charging infrastructure needed for electrification of on-demand mobility services[3]. This study identifies strategic locations for the installation of EV charging stations in Delhi, through scientific modelling and a data-driven approach, that is required to meet the same ride-sharing demand with a fully electric fleet. The framework developed in study can be applied to other cities and can help a city cater to the charging requirements of high-utilization vehicles such as on-demand mobility (offered by ride-hail and rideshare platforms). By strategically locating charging stations along high-demand corridors within a city, the government can also ensure high utilization of the charging stations. Overall, through the adoption of e-mobility, a city can witness reduction in air pollution and greenhouse gas emissions while reducing costs and increasing pay-offs for both drivers and transport network companies. E-mobility also has the promise to increase the reliance on renewable energy and introduce new revenue streams for the power sector. At the national level, e-mobility reduces reliance on import-dependent fossil fuels making the country energy secure, unlocks sustainable livelihood opportunities and makes cities more livable.

Delhi's E-Mobility Ambition

The Delhi EV policy, released in August 2020, is a landmark policy towards electrification of mobility in Delhi. Through its comprehensive and progressive policy framework, Delhi aims to accelerate the adoption of e-mobility, reduce the emissions from the transport sector, and improve its air quality. The policy provides the necessary impetus for Delhi to become India's EV capital and a role model for other cities and states. Delhi's EV policy prioritizes vehicle segments such as two wheelers, public transit and other shared transport vehicles, and goods carriers. The State plans to have 25% of all new vehicle registrations to be electric by 2024. Apart from providing financial incentives including tax subventions, the Delhi government shall establish a wide network of charging infrastructure comprising both fixed (point) charging stations and battery swapping stations. This will create an enabling environment for the provision of private as well as public charging infrastructure. A few key highlights from the Delhi EV policy on the plan to deploy charging infrastructure are mentioned below.

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1. World Economic Forum & Ola Mobility Institute. 2019. EV-Ready India Part 1: Value Chain Analysis of State EV Policies. October 2019. https://www.weforum.org/whitepapers/ev-ready-india-part-1-value-chain-analysis-of-state-ev-policies
2. Ola provided a representative data set of daily taxicab demand for New Delhi. However, no financial support was provided by Ola and the responsibility for underlying research rests solely with UCLA. The policy brief is authored jointly with Ola Mobility Institute.
3. The complete report is in the process of preparation for peer review. For further details please contact Prof. Deepak Rajagopal.

- The public charging stations will be located within 3 kilometres (km) travel from anywhere in Delhi. The stations will be installed in discussion with the DISCOMs to enable load management, without adding pressure to the grid.

- The government will provide concessional locations for setting up charging and swapping stations with bare minimum lease rentals. A list of these locations will be released in a phased manner by the Charging Infrastructure Working Group.

- Tariff concessions will be provided to all private charging points. Open access without the condition of having a contract demand of 1MW and above at every charging/ swapping station will be provided. The energy operators will be encouraged to set up captive renewable energy facilities and will be provided power banking facilities with the DISCOMs.

- An open, publicly owned database offering historical and real time information on public charging infrastructure (location of charger, number of charging points available, payment mode and details etc.) will be provided to be used in charging apps, maps and in-vehicle navigation systems.

Need for a Scientific Approach to Develop Charging Infrastructure

Charging stations are crucial for the mass adoption of EVs. Placing the right number of stations at the right place is key for maximizing the utilization of the station as well as ensuring ease of access for customers. In order to appropriately evaluate a spot for one charging location we need to take into account a host of parameters like traffic, land cost, power supply, vehicle mix etc. Replicating this for dozens of charging stations with the physical constraints of the city presents itself as a complex problem. Any manual and intuitive solution will fall short in satisfying all of the parameters and thus unlikely to be the one that optimizes investment and maximizes benefits. Hence, a clear data-driven, research-backed and mathematical optimization-based solution is needed which will account for multiple realistic scenarios and come up with the best possible recommendation. Given the large upfront investment of this undertaking and policy priority from the government, we need to get it right from the get go in order to maximize benefits to all the stakeholders and thereby to the society.

Methodology

In the study summarised in this policy brief, we have developed a modeling framework which is applicable broadly to planning electrification of shared mobility services. We have integrated an agent-based modeling framework with ride hailing trip data, travel time data, vehicle cost data, electricity generation and demand profile. Based on this, we have developed simulations to test the capability of ride-hailing vehicle fleets to serve trip demand in New Delhi under a range of scenarios for BEV adoption, charging infrastructure and battery range. Using data on trip origins and destinations provided by Ola, potential charger locations have been identified using a clustering algorithm that is designed to group all the locations in groups/clusters according to proximity to each other. We identified both the charging station locations and the number of chargers at each location.

To account for real-world constraints that may prevent chargers from being sited based on trip locations alone, we also conducted a range of simulations with scenarios where chargers were sited more randomly. Given that policymakers could design infrastructure plans by assigning quotas for chargers to different districts or regions, we conducted a series of simulations wherein the Delhi metropolitan area is divided into differing number of zones, and each zone is assigned a quota for charging locations and charge points based on trip demand. Within each zone, these chargers and stations are sited randomly. Hence the fleet performance is not dependent on locations of individual chargers down to latitude and longitude; certain number of chargers located randomly within a zone will satisfy the fleet operations to meet the demand. Through this analysis, we have estimated the potential reductions in cost and emissions arising from electrification, along with minimum requirements for charging infrastructure and battery range at each stage of BEV adoption.

Findings of the Study

Specific findings with regard to Charging Infrastructure Planning:

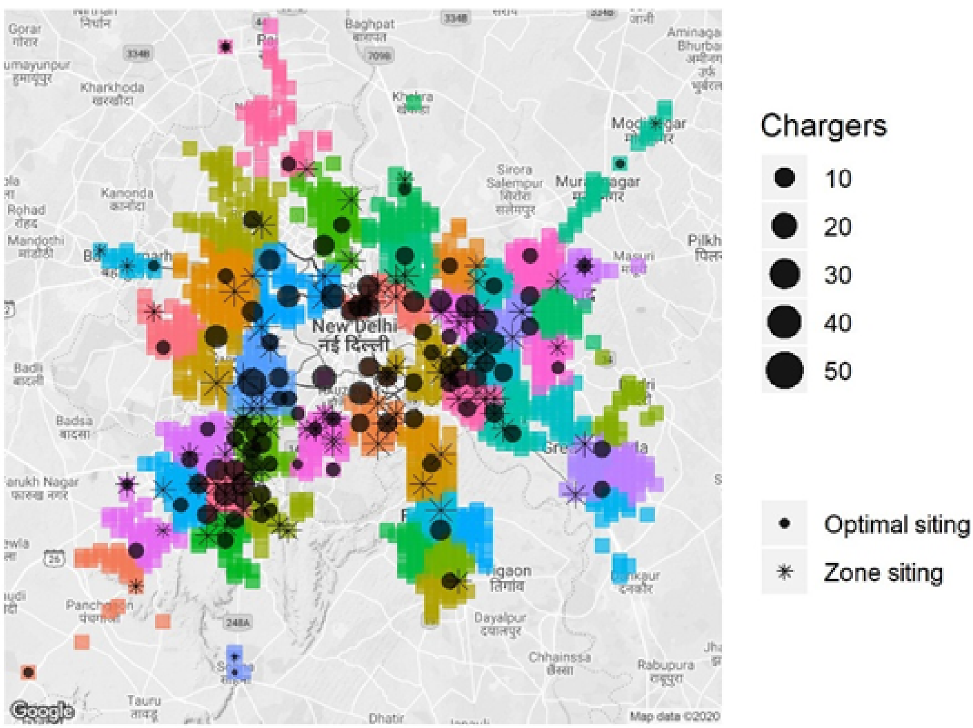

Figure 1: Comparison of siting chargers randomly within each zone (stars) with optimal siting based on trip demand (circles) for 50 zones

We find that dividing the city into 50 zones is sufficient for optimum fleet performance as increasing the number of zones further and making them bigger in size starts affecting fleet performance by increasing average distance a cab must travel to find a charger (Figure 1). While on the other hand, increasing the number of zones and making them smaller has diminishing returns. These zones are about 37 sq. km in area which is equivalent to a circular area with about 3.5 km radius.

Table 1 shows different wards in Delhi and the number of chargers to meet the demand for on-demand mobility rides (Table 1). We considered local electricity distribution capacity and land prices as real-world constraints while determining charging locations. We used the data from the State Load Dispatch Center[4] and found the closest substation to each charging location to estimate the impact of vehicle charging on total power demand. The data from substations show that peak Battery Electric Vehicle (BEV) charging demand for current trip demand is less than 1% of total peak grid demand, and that peak charging demand occurs at times when grid demand is lower than its peak. These results suggest that ride-hailing electrification should not have a major impact on the power grid in Delhi.

Even though residential real estate prices do not represent the actual cost of acquiring land for charging stations, they were used as an indicator of spatial-economic constraints to siting charging stations. We arbitrarily chose to avoid siting chargers in locations with land value exceeding INR 10,000 per square foot, which is the sole reason why some prominent central Delhi wards and locations do not feature in Table 1. We feel that relaxing this restriction might only marginally affect the spatial distribution of chargers we identify here. Lastly, installing public charging stations in costlier locations could be justified on other grounds such as for raising awareness, tourism and aesthetic considerations.

Table 1: List of wards in decreasing order of chargers required (High to Low)

Ward	Number of Chargers	Ward	Number of Chargers
Delhi Cantonment	76	Tilak Nagar	26
Dev Nagar	38	Kasturba Nagar	22
Nanak Pura	36	NDMC	22
Shapur Jat	35	Tekhand	21
Pahar Ganj	33	Tughlakabad Extn	21
Matiala	32	Khanpur	19
Raja Garden	31	Lajpat Nagar	19
Bazar Sitaram	28	Mahipalpur	18
I.P Extension	28	Yamuna Vihar	18
Kashmere Gate	28	Okhla	17
Ghondli	27	Sahibabad Daulat Pur	17
Adarash Nagar	26	Dabri	16
Saraswati Vihar	26	Mayur Vihar Phase II	16

4. delhisldc.org

Ward	Number of Chargers
New Ashok Nagar	11
Nilothi	10
Alipur	9
Mehrauli	9
Bhati	7
Kishangarh	7
Roshanpura	7
Mundaka	4
Aya Nagar	3

Other findings of the Study:

The study finds that battery electric vehicles can serve trip demand at lower cost relative to both diesel and CNG vehicles (some subsidy is needed for latter today) while substantially reducing emissions (certainly at the point of use but also on a life cycle basis). For New Delhi, our study proposes a network of about 1100 50kW chargers distributed across 100 different locations in and around the city (see the table below). The study finds that electrifying a fully CNG-powered vehicle fleet yields more than 15% reduction in levelized cost of driving and almost 10% reduction in emission intensity. On the other hand, electrifying a fully diesel-powered vehicle fleet yields more than 35% reduction in levelized cost of driving per km and more than 40% reduction in (CO_2 equivalent) emission intensity per km. 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.

Conclusion

The experience of cities and countries around the world indicates that availability of charging infrastructure is a key driver for large-scale adoption of EVs. One of the key objectives of Delhi's EV policy is to create an enabling ecosystem for the deployment of private as well as public charging infrastructure. To support its e-mobility ambition, Delhi government has recently announced[5] to set up 200 EV charging points in the next one year. Recognizing the urgent need to adopt a scientific approach to charger siting, we have conducted the study summarized in this policy brief.

Our data-driven analysis has taken into account the 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.

A major finding is that the complete electrification of on-demand mobility will have no significant impact on Delhi's power grid. This is because the peak BEV charging demand is less than 1% of the total peak grid demand and tends to occur at times of day when demand is not close to peak.

Another finding from the planning perspective is that concerns of spatial mismatch between chargers and trip demand are overestimated. Thus a large city such as Delhi can be divided into 50 administrative zones of 37 sq. 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 citing of chargers within a zone yields diminishing returns.

The findings from the study can be used by the government, businesses and urban planners, among others, to effectively plan Delhi's charging infrastructure.

5.https://auto.hindustantimes.com/auto/news/delhi-and-central-government-to-start-identifying-locations-for-ev-charging-41600396777215.html