May, 2020

BSES Rajdhani Power Limited

Consumer Insights For Electric Vehicle Charging Programs- Delhi

Consumer perception and behaviors will determine the success of EV charging facilities

India E-Mobility Finance Facility

About This Study

The "BSES Consumer Centric Electric Vehicle Charging Program Study" has been conducted for BSES Rajdhani Power Limited (BRPL) one of Delhi's electricity utilities, by the India E-Mobility Finance Facility (IEMF) which is a not for profit initiative for accelerating Electric Vehicle adoption in India. This study has been completed in 2 parts. The first part is a consumer survey to understand consumer requirements. The second is the program design study that followed the results of the consumer survey to make recommendations on feasible programs for the city. This report covers the first part- insights into consumer perceptions about EVs.

This study has been completed by a joint team of BRPL and IEMF

India E Mobility Finance Facility (IEMF)

India E-mobility Finance Facility is a not for profit Project Preparatory Facility (PPF) for catalyzing flow of finance into electric mobility projects. Our beneficiaries include utilities, financing institutions, private and public companies working towards bringing innovative electric mobility services for public good. IEMF supports projects through all stages of development. IEMF selects projects for support through an interactive platform. It then develops these projects, bringing together the right skills to create implementable projects, garner financial support, and identify and partner with the right partners to create a winning ecosystem of public good. Finally it also supports public awareness building programs for EVs.

BSES Rajdhani Power Limited

BSES Rajdhani is Delhi's largest electricity Distribution Company (DISCOMs). BRPL distributes power to an area spread over 750 sq. km with a customer density of ~3100 per sq km. It's over ~2.4 million customers are spread in 21 districts across South and West areas including Alaknanda, Dwarka, Hauz Khas, Jaffarpur, Janak Puri, Khanpur, Mundka, Najafgarh, Nangloi, Nehru Place, Nizamuddin, Palam, Punjabi Bagh, R.K. Puram, Saket, Sarita Vihar, Tagore Garden, Vasant Kunj, Vikas Puri, Uttam Nagar & Mohan Garden. BRPL is among the most successful electricity utilities in the country and has launched a number of highly beneficial programs for reducing its climate change impacts including promotion of energy efficiency appliances, promotion of residential solar rooftop installations etc. BRPL is known to be a highly consumer focused DISCOM, always striving to improve its services for its customers.

Content

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Acronyms

2WH	2 Wheelers, like Bikes, scooters etc.
3WH	3Wheelers, like autos, rickshaws, e-rickshaws
4WH	4 Wheelers, like cars, vans etc.
Avg.	Average
BRPL	BSES Rajdhani Power Limited, a Delhi DISCOM
CEA	Central Electricity Authority of India
DERC	Delhi Electricity Regulatory Commission
DISCOM	Electricity Distribution Companies, electric utilities
DSM	Demand side management
e-2WH	Electric 2 Wheelers, like Bikes, scooters etc.
e-3WH	Electric 3Wheelers, like autos, rickshaws, e-rickshaws
e-4WH	Electric 4 Wheelers, like cars, vans etc.
EV	Electric vehicles
FAME	Faster adoption and manufacturing of (Hybrid and) Electric Vehicles Scheme
hrs	hours
ICE	Internal Combustion Engine Vehicles
IEMF	India E-Mobility Finance Facility
km	kilometers
kW	kilowatt, unit for load/power
lacs	One hundred thousand
OEMs	Original Equipment Manufacturers
PCS	Public Charging Stations
Rs/INR	India Rupees
RWAs	Residential Welfare Associations
Yrs	Years

Definitions

Curbside Charging	EV Charger is installed by the roadside for charging the vehicle, not in a private garage
Poleside Charging	EV Charger is installed along existing electricity poles on roads, without a strictly private or strictly public mode of usage
Swapping Stations	A place where an EV user can replace/swap out his discharged battery with a charged battery, this is model for battery ownership as well as charging

1. Executive summary

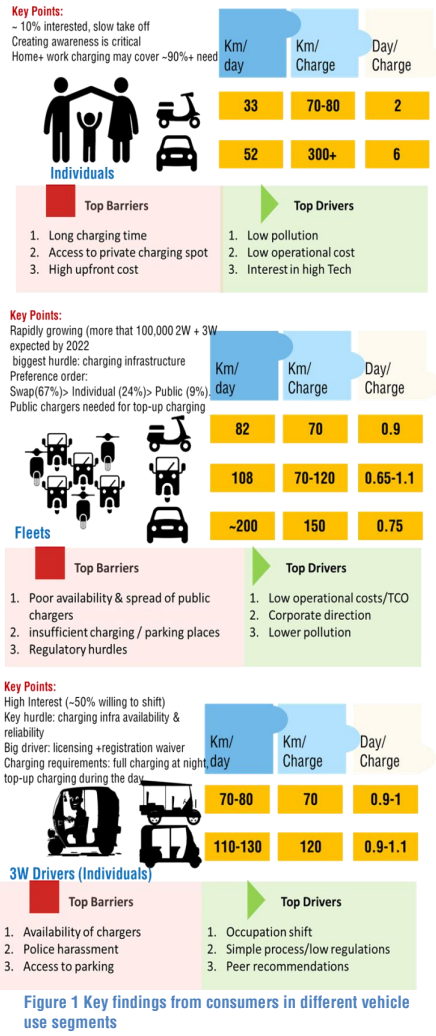


Figure 1 Key findings from consumers in different vehicle use segments

Electric Vehicles (EVs) are likely to take off in India driven by reducing EV prices, attractive Total Cost of Ownership (TCO) vis-à-vis Internal Combustion Engine Vehicles (ICEVs), more environment friendly attributes and lower pollution impact, and the big support offered to EVs through government policies.

EVs open up big challenges and opportunities for Distribution Companies (DISCOMs). In order to become future-ready, DISCOMs need to understand how consumers think about EV adoption and use, what they need, and how DISCOMs can engage with them for meeting these new requirements.

Charging Infrastructure is a key point of intervention for utilities. Globally, utilities such as Pacific Gas and Electric (California), San Diego Gas and Electric (California), Duke Energy, ENOVA (Norway), China State Grid, China Southern Grid etc. have played important roles in scaling up charging infrastructure for EVs. This has been a major contributing factor in the evolution of global demand for EVs.

BSES Rajdhani Power Limited (BRPL), the Delhi DISCOM, recognizes the impending challenges that can be posed by uncontrolled EV deployment, and wanted to pre-emptively understand consumer perceptions around EVs within its jurisdiction. Some of the specific consumer insights they wanted were:

1. Drivers and barriers for adoption
2. Current vehicle use practices
3. Likely charging behaviors
4. Openness to engaging DISCOMs
5. Perception around time of use (TOU) tariffs,
6. Perception around Demand Side Management (DSM) strategies
7. Peak Load Controls, etc.

Therefore, this study attempts to gain a meaningful insight into consumer perceptions around EVs in Delhi. While this study was geographically restricted to Delhi, we believe these results will be representative of other major urban centers across the country (barring places vastly different weather and other constraints). Using the results of this study, we have further developed some models of charging solutions that can be deployed to meet these consumer requirements.

This study presents results of a pilot consumer assessment designed to gauge consumer sentiment towards EVs. The study is a dip-stick assessment, with a small sample size, designed to qualitatively understand consumer perceptions.

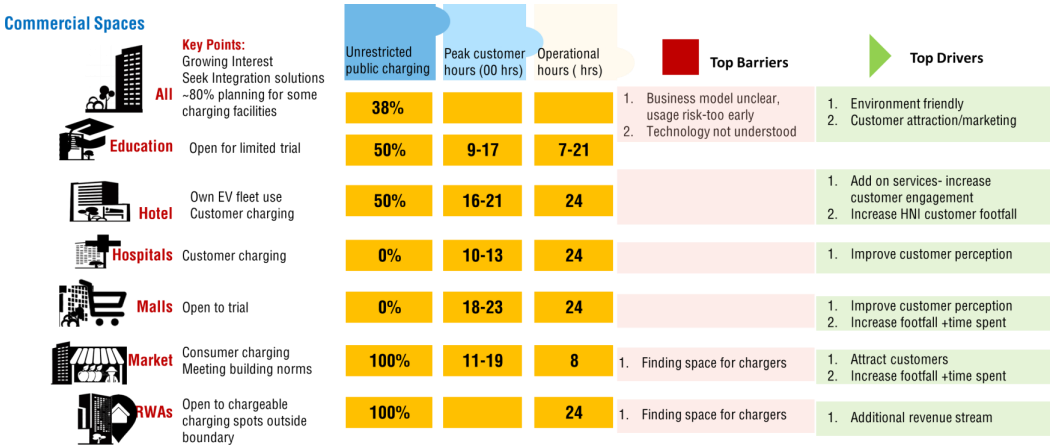


Figure 2 Highlights of findings from commercial spaces survey

The segments surveyed in this study include

1. Personal use vehicles or Individual Users and Residential Welfare Association (RWAs)
2. Commercial Spaces
3. Fleet Operators, & Original Equipment Manufacturers (OEMs), and
4. Three Wheeler Drivers

Through this survey we also reached out to some emerging charging network providers to understand their working models and projections. In this report, we also bring light to some of their concerns and challenges.

Individual EV users are beginning to evaluate EVs (~10% showed an interest in adoption), decisions are driven primarily by environment friendly attributes of EVs.

The personal use vehicle segment is primarily motivated by the low pollution profile of these vehicles, along with the cost advantage.

The main hurdles for adoption in this segment include uncertainties around charging availability and charging time, as well as the high upfront cost

Some key vehicle use patterns for this segment are particularly insightful:

- **Regular travel needs:** more than 1.5 hours and 50 km daily, on an average they reported spending ~ 4000 Rs/month on fuel
- **Home Loads:** Typically, sanctioned home loads is ~3kW, will need to increase it for charging e-cars
- **Customer acceptability:** For e-4WHs a price level of INR 17.5 lacs with 300km range and for e-2WHs price of around INR 75 thousand with 70km range

Resident Welfare Associations (RWAs) had a complex response

Less than 1% residents in RWAs had discussed EV or personal charging needs with their RWAs. RWAs were primarily excited to explore charging as an additional revenue stream for the complex.

Parking spaces in RWAs are overloaded and resident cars already outnumber available parking slots by ~40%. As far as available electrical infrastructure is concerned, they reported average sanctioned load per home as 4.2 kW. Some reported having additional spare capacity on common meters, which could be used for charging infrastructure, but space was scarce and it would be hard to dedicate it for charging use.

Commercial use segment will transition rapidly, Charging Infrastructure availability is a major hurdle

The survey confirms that fleet aggregators, local delivery operators and 3 wheelers (autos & rickshaws) will quickly transition to EVs. They are already well aware and are keenly designing long term EV strategies. More than 50% of the 3Wheeler drivers surveyed were positively inclined towards EVs. Key challenge for individuals is access to charging Infrastructure.

Commercial space owners are interested in offering additional green services to their customers, but are not sure of the business model and think these to be risky investments.

Commercial space owners see charging facilities as a means to provide "upgraded" services to their customers, to brand themselves "green", and improve their public perception with the ultimate aim to drive footfall in their establishments. However they perceive these investments as risky, and are not sure how to evaluate or select the technology. They are keen for an independent and credible third party to guide them through selection and installation of these chargers (Figure 2).

Our survey also found some other key consumer insights for DISCOM engagement (Figure 3).

- Consumers are open to DISCOM facilitation or DISCOM anchored EV programs to allow easy and fair access to charging technology and ease and speed of implementation.
- Users are open to TOU tariffs as a means of modifying their charging behaviors to adopt more sustainable charging practices. Peak time control or curtailment is not acceptable to most users. This could be due to lack of understanding on reduction in upfront costs (for sanctioned load increase) and in the additional recurring demand charges which they would be required to incur for installing high capacity chargers.

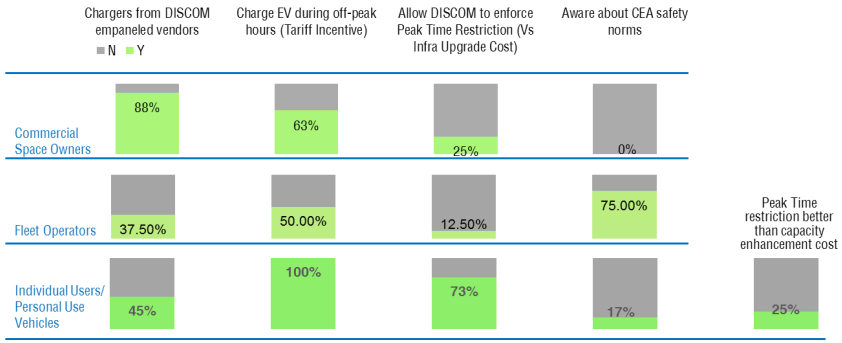


Figure 3 User reported DISCOM engagement needs

In conclusion, we assess that a critical role can be played by the DISCOM in promoting EVs and setting up EV charging infrastructure. The DISCOM will need to devise customer segment specific strategy to support EV scale up and will most likely need to design multiple programs for customer outreach and implementation.

DISCOMs will need to partner and work with parking space owners, regulators and service providers and develop specific business models for accelerating access to charging infrastructure.

2. Introduction

Electric Vehicles (EVs) have developed at a rapid pace over the last 5 years globally and are fast gaining traction across India. Globally, supportive government policies and technological innovations have made EVs attractive. Increasingly Total Cost of Ownership (TCO) advantage and significant environmental benefits are driving rapid adoption. In all cases availability of charging infrastructure has been a key driver or hurdle for rapid adoption.

There are many barriers to EV adoption too. In early consumer studies globally, the top three reasons for non-adoption of EVs were high upfront cost, concern over driving range, and low availability of charging infrastructure[1]. Since then, with declining battery costs and higher regulatory restrictions on ICE vehicles, leading automobile manufacturers along with venture funded start-ups have brought new electric models to market. This has increased awareness among consumers. However, adoption remains low (at less than 10% of sales, in most geographies).

More recent consumer behavior studies from developed markets show that top three drivers for EV adoption include improvements in driving experience, monetary subsidies and benefits, and TCO advantage[2]. Thus, it is evident that market response and consumer requirements are rapidly changing with changing technology trends and government regulations.

While past data gives us some insights into the likely trajectory of EV development in India, it is unlikely to be representative of the changing electric mobility future in the country. Past data shows that EV adoption has been slower in India than global adoption rates. While global sales penetration rates are closer to 3-4%, in India, EV penetration has been much lower (Figure 4). This can be attributed to many factors including the hyper cost-sensitivity of Indian consumers, low model availability, lack of charging infrastructure etc. Things are however rapidly changing in India, as many more EV models are being launched every year for 2WH, 3WH and 4WH. There is significant government push for EVs, with subsidies being available under central schemes such as Faster Adoption and Manufacturing of Electric Vehicles (FAMEI and FAME II) and state policies, lower registration and licensing requirements for EVs

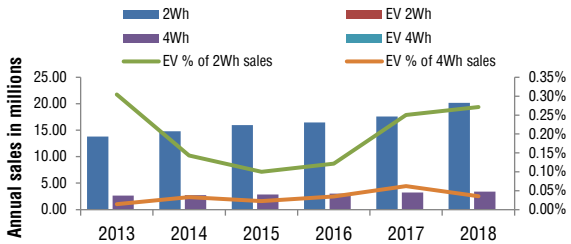


Figure 4 Sales penetration of EVs in 2Wh and 4Wh segment (India)

Delhi government has recently approved its EV policy for promoting adoption of EVs in Delhi. As more models become available, awareness among consumers is expected to rise as it has done for consumers globally, and will likely lead to higher EV conversions.

As EV adoption increases, associated infrastructure must also improve to facilitate its adoption. Grid infrastructure is a critical component for increasing availability and reliability of vehicle charging. Utilities across the globe are taking measures to improve their services for EV adoption.

[1] Electrifying Insights: How automakers can drive electric vehicle sales and profitability, McKinsey & Company, 2017.

[2] Road ahead for e-mobility, Mckinsey & Company, 2020.

Closer to home, BSES Rajdhani, aims to develop a robust program for promoting electric vehicle charging in the city. One key requirement for good program design is to understand customer needs. For this BSES has commissioned this study for understanding the requirements of its consumers to guide its program design.

2.1. Objective of the research report

BSES Rajdhani (BRPL), Delhi's electricity utility is planning to launch its EV charging program to ease EV charging within its jurisdiction. The objective of this study is to

- Gain an insight into the perspective of BRPL's consumers for EVs and EV charging
- To gauge the demand and pace of transition

3. Process of this study

In order to better understand the requirements that could be placed on this program, we conducted a consumer survey to understand the level of interest, usage patterns, and drivers and barriers to transition. Different segments of consumers were surveyed over the course of 3 months. Currently very limited data on consumer perceptions is available on EVs on the national level. General consumer awareness is still relatively low. Not many have seriously considered transitioning to EVs due to perceived risks.

3.1. Identified segments

Review of some national consumer studies on EVs seem to indicate that

- Consumers are highly price sensitive and the price and range of the vehicles currently available does not meet consumer expectations[3]
- Daily commute patterns especially among urban youth are also changing. Youth seem to prefer public transport to other modes of travel for their daily commute[4]
- Desire to own private vehicles may be also be decreasing
- In large cities, those owning personal vehicles primarily use their own vehicles, a substantial number do also travel using public transport (almost a quarter).
- Yet almost 80% Indians still aspire to own a personal vehicle, and older individuals are more keen on buying a personal vehicle than those still in their twenties
- Almost 70% people in large cities spend over 1 hour in their daily commute

A number of technology startups have emerged to offer alternative transport solutions and have become quite successful across the country. Thus, considering the insights available on user profile, shifting preference for transport modes, and

[3] Consumers prefer ₹10 lakh price tag for electric vehicles, 300km driving range, Mint, 22nd Jan 2020.

[4] How Young India navigates the urban commute, Mint, 17th September 2018.

the existing segmentation within BRPL consumers, we identified 4 distinct segments for consultations within this study.

- Personal use vehicle owners-BRPL's residential consumers (living in condominiums or independent houses)
- BRPL's commercial consumers (hotels, hospitals, educational institutes, malls, community markets and offices)
- Fleet operators considering expanding their operations in Delhi
- Individual commercial drivers (3Wheeler drivers).

These groups were contacted for one-on-one guided surveys with about 30 questions on travel patterns, parking preferences and overall interest in EVs.

3.2. Survey design

One-on-one guided surveys were considered appropriate for this study, since it was expected that users would likely have many questions and may not be fully aware of recent developments in electric mobility. During these surveys, information regarding electric vehicle model choices available, their range, their price etc. was shared with respondents to gain more meaningful responses.

The survey was slightly modified for different segments, considering differing levels of awareness. For example for fleet operators the questions were centered more on how they had planned their transition, while for individuals the questions were focused on their current travel preferences. Nevertheless, all modifications of the survey contained the same common themes of current transportation needs, modes in play, parking preferences, perceived drivers and hurdles for EV adoption and for those having experience with electric vehicles the questions were designed to understand how their experience has been and how they are using the vehicles. Relevant questions on tariff incentives, peak time restrictions were also included. In all cases, one key enquiry was in respect of their interest in EVs and whether they were seeing any specific difficulty in transitioning.

To conduct the surveys, different approaches were adopted for contacting users within different segments. Individual residential users were contacted using information available with BRPL within its existing consumer data-base. Responses were also taken from those willing to offer their response at BSES market-kiosks. Those willing to offer a response were considered in the results of this study. "No responses" were excluded from analysis. For commercial drivers (3Wheelers), the survey was done with individual drivers in high concentration areas identified by BRPL by directly approaching them. For fleet operators, discussions were held on call to record their response. For commercial spaces, existing commercial consumers of BRPL were contacted from BRPL's database, their responses were noted in one-on-one interviews on their premises to gain more insights into space availability, level of occupancy etc. more respondent information provided in Annexure I.

The numbers of respondents in this study is small due to the highly interactive mode of interaction. The results are therefore not amenable to statistical analysis but provide an initial insight into how users within BRPL's jurisdiction in Delhi are currently considering EVs. The study also provides an insight into their travel behavior so as to inform predictions on what the patterns for EV use could emerge in the near future. Using this is as the basis, BRPL can design a more relevant and consumer centric program for EV charging within its jurisdiction.

4. Main results of the study

4.1. Personal use vehicles

4.1.1. SUMMARY

Only 10% of individual respondent showed an interest in owning EVs. The Top Reasons for adoption include

- Low Pollution Index
- Low Operational Cost (including Total Cost of Ownership-TCO).

While Hurdles to EV adoption include

- Long charging times
- Lack of access to private charging places
- High upfront cost of the vehicle.

Another reason, which was not included in our survey but commonly cited, was that users already owned vehicles and were not keen on buying another or replacing the current vehicle before its time.

In terms of parking and charging patterns, as anticipated most respondents are looking at home charging as the primary mode of charging, work place charging and mall charging are other modes, in the order of priority. Public charging and street charging is not frequently rated highly by individual respondents. While this could be taken as prediction of future behaviors, it could also be a reflection of the fact that home and work place charging may be easier concepts to understand in terms of reliability and efficiency since the equivalent parking solutions are already visible, when compared with public and street charging which may seem logistically more challenging in the absence of equivalent existing models.

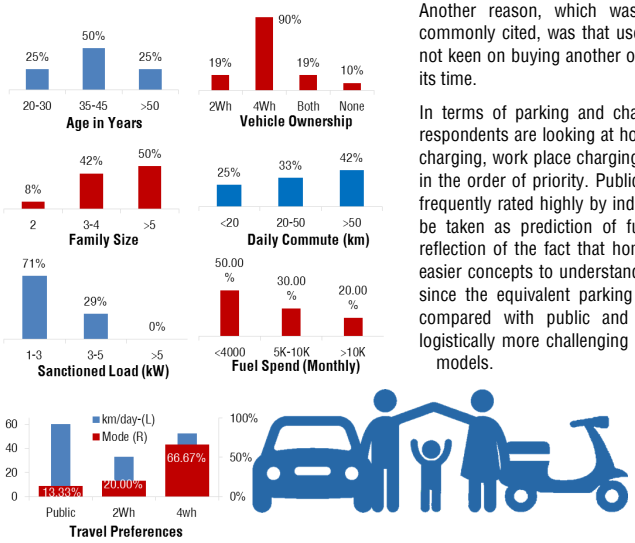


Figure 5 Respondent profile: personal use vehicles

4.1.2. INTRODUCTION

Personal Use Electrical Vehicle transformation is the most important segment for creating a large-scale interest in EVs. This is the largest automobile sale segment in India and globally, thus is the most relevant for driving manufacturer interests and creating a respectable share of EVs in the annual vehicle sale numbers.

While, EV adoption can be mandated within commercial fleets, regulators cannot create such mandates for personal use vehicles as it would most likely lead to public outcry. Therefore, understanding individual perceptions, drivers and hurdles to adoption, and likely plans, are critical for designing successful programs for meeting the requirements of this segment.

Personal use vehicle segment is the segment that global EV charging programs primarily cater to. The demand for chargers for personal use EVs is large but distributed. Thus, the challenges of meeting the requirements of this segment are more diverse and need closer examination.

In this segment of our study, we engaged with individuals to better understand how they use their vehicles and to gauge if they had any EV plans. Respondent Profile The average respondent profile is presented in Figure 5

Age

The typical respondents in our study were aged between 35-45 (yrs), this may be the result of the methodology followed for reaching out to respondents, since we used information on existing customers of BRPL, these connection holders would likely be home owners which makes it more likely for them to be older. Considering the demographics, this may also make them more likely to already own a vehicle.

Family Size

The average respondent in this study had 4 family members in their family and on average two were driving family members.

Vehicle Ownership

Most respondents in the study owned a vehicle, in some cases more than 1 vehicle, ~20% respondents owned both 2Wheelers and 4Wheelers. Nearly 90% of respondents owned cars. Only about 10% did not own any vehicles.

Daily Commute Distance

Nearly half of our respondents reported travelling more than 50km a day. They also reported that most of their travel was during peak office traffic times, thus on average, respondents of this study travelled for well over 1.5 hours in a day.

Monthly Fuel Spend

About 50% of our respondents reported spending less than 4000 Rs/month on fuel.

Sanctioned Load

Majority of our respondents have electricity connections with sanctioned loads of 3kW, none of the respondents reported having electricity connections at their homes over 5kW.

Travel Preferences

A majority (over 60%) reported using cars as their primary mode of travel, only 20% reported 2Wheeler use and less than 15% reported using public transport. Commercial vehicle use was not indicated by respondents, as it was reported to be used only in specific instances and not regularly.

EV plans

Only 10% respondents reported an interest in owning an EV (Figure 6). Among these, for cars the desirable range was indicated as 300km/charge and the price point of Rs. 17.5 lacs (Avg.) was reported as acceptable (after the existing available market choices were explained to respondents). For 2Wheelers, respondents indicated that 70km/charge vehicle at a price point of INR 75 thousand (Avg.) was acceptable. The results on price and range had high variance and very few respondents indicated their preference. Our overall study results indicate that interest and awareness for EVs is lower in India than the global trends.

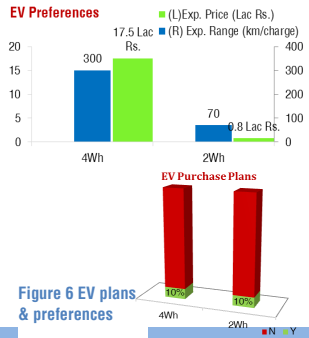


Figure 6 EV plans & preferences

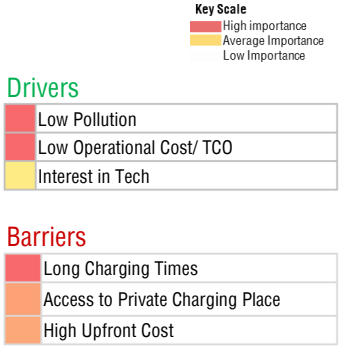


Figure 7 Drivers and hurdles for EV adoption for personal use segment

4.1.3. DRIVERS AND HURDLES FOR EV ADOPTION

Respondents were also asked to indicate the primary reasons driving their considerations for and against EVs. For each reason respondents were asked to attribute a rating from 1-5 (1 very low importance, 5 – very high importance). Weighted average responses were then considered for ordering the reasons in terms of importance for the entire group (Figure 7) the top three reasons have been highlighted in Figure 7.

Average survey response indicates that the top drivers for EV adoption in this segment are low pollution index, low operational costs, and a general interest in new technologies. While the top hurdles for EV adoption can be attributed to long charging times, lack of access to private charging space, and high upfront cost of vehicles. At some level the response seems to indicate the relatively lower levels of awareness about specific products, since the specifics of driving the vehicle did not feature among reasons for transition, even though on average these individuals spend a significant part of their day driving. It was also interesting to note that while range and model choice was cited as a barrier, these were not considered the top most hurdles to EVs.

4.1.4. PARKING & CHARGING OPTIONS

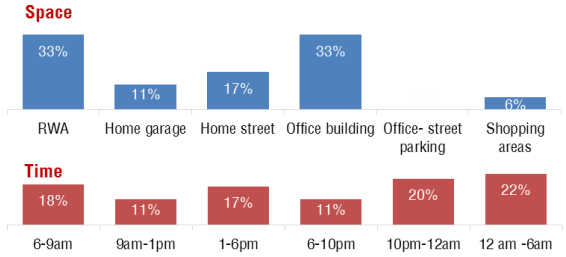


Figure 8 Daily parking practices

Current parking behaviors of users can be considered an accurate representation of how EVs may be used in the future.

Our survey indicates that vehicles are most commonly parked in RWA's, Home Garages, Office-Buildings, malls and shopping areas are also used, however the timing and regularity is variable (Figure 8). Respondents also reported that cars are parked at night and are in transit during office hours, consistent with the overall response that vehicles are primarily used for office commute.

4.1.5. EV CHARGING PLANS

When asked to predict what kind of charging infrastructure they would use, on average, respondents indicated that Private charging would meet most of their charging needs, and public charging would most likely form only ~14% of their charging mix.

While current parking patterns can be considered to be a good proxy for how users may charge their vehicle, we included a specific set of questions on how individuals were thinking about where and when they would charge. We enquired that if adequate charging was available in these spaces in which spaces would users use for charging. The responses indicate that home charging would be used by all, a few would also use office charging and fewer still would use shopping malls for meeting their charging needs, there seemed to be few takers for public charging options. On timing of charging, as expected most users indicated their preference to charge their vehicle at night through the early morning hours as needed (Figure 9).

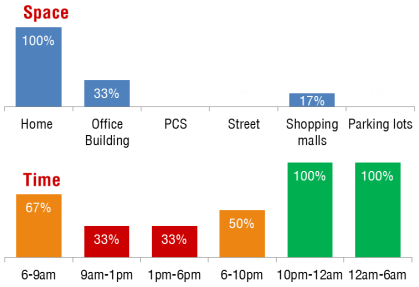


Figure 9 Indicative charging distribution- spaces + timing

4.1.6. DISCOM ENGAGEMENT

Our study also explored some parameters regarding tariff and interconnection charges which would become relevant for the DISCOM in designing a program, and how these would be considered by the respondents (Figure 10).

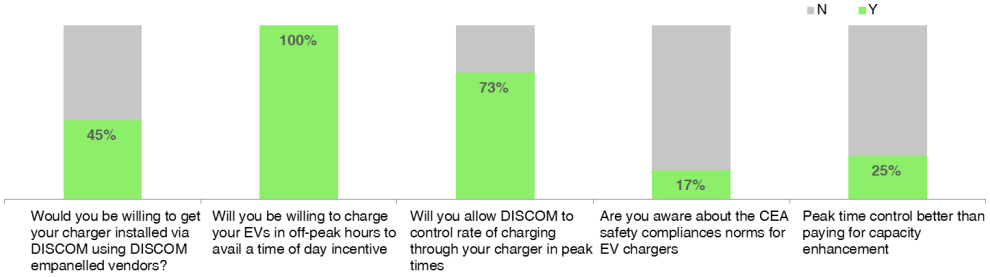


Figure 10 Enquiries into DISCOM engagement - personal use

55% respondents did not want to use DISCOM empaneled vendors for chargers since they were aware that chargers are supplied by the manufacturers when the car is bought, and were concerned about how vehicle warranties may alter in case other chargers were used. All respondents would be happy to charge in off-peak hours to avail the time of day incentive as long as it coincided with their night time charging requirement. 73% were okay with DISCOMs controlling rate of charging in peak times. 75% respondents thought that peak time restriction was more prohibitive than paying for additional load costs. Most respondents were not aware about CEA safety norms for EV chargers.

4.1.7. RESIDENT WELFARE ASSOCIATIONS (RWA) RESPONSE

A large proportion of homes in Delhi are governed by RWAs. RWAs take decisions regarding common/ public spaces and facilities use for a community of multiple homes. Delhi comprises a fairly large number of multi-story, RWA governed homes. RWAs are likely to become an important stakeholder in facilitating home charging for EVs in Delhi. We conducted discussions with some RWA secretaries to understand how they would look at the EV charging.

Our findings are based on discussions RWA secretaries who expressed an interest in BRPL's EV charging program via an online request form. These RWAs have already successfully implemented solar rooftop installations within BRPL's solar rooftop scheme and are keen on other similar programs.

On average these RWAs report having ~ 100 homes with about 3-4 people in each home. About 25% occupants are on lease (average rent ~INR 26,500) and the remaining homes have home-owners. Average sanctioned load in these properties is close to 440kW, or ~ 4.2kW/home. Different properties have different types of electricity connections. Some have a common meter from BRPL, which is then divided into sub-meters. BRPL bills the RWA, the RWA divides the bill based on consumption recorded on the individual home sub-meters and collects dues from individual homes to finally pay to BRPL. In other cases each home is directly metered by BRPL, there is also a common facilities meter for the common facilities in the complex, the common facilities electricity cost is included in the maintenance bill, while each individual home meter directly pays to BRPL. All complexes have car parking spaces, however dedicated scooter parking spots are not available. On average, the responses indicate that resident cars outnumber available parking spots by 40% in the complexes. Visiting cars were reported as being typically parked outside the gated communities. Scooters are typically parked within the car parking slots. Based on the details shared by the RWA secretaries we estimate that only 15% of these homes had scooters or 2Wheel drives, while nearly all homes had one or more cars.

EV plans

In our discussions, RWAs expressed an interest in EV charging more as a means of additional income for the RWAs than for covering any real inquiries from residents. Based on the response received, we estimate that less than 1% resident homes covered under these RWAs had made enquiries for EV charging with the RWAs for personal charging options. None of these RWAs reported having any EVs at present. RWAs were open to experimenting with 1-2 parking spots initially to see the mechanics. They would not allow outside vehicles inside their premises. However, they were open to releasing charging slots for charging on the outside of their boundary walls if permissions, investment and operations were taken over by a managing agency offering them some additional income. They were open to use based payments.

Expectations from DISCOM

Having had a successful experience with the solar rooftop implementation program, they were happy to engage in a DISCOM led program for EV charging if additional income or saving could be given to RWAs for the same.

4.2. Fleet operator segment

4.2.1. SUMMARY

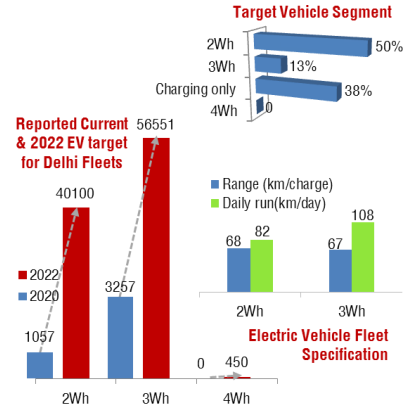
Fleet operators are an important category of EV users, they are expected to form the bulk of early adopters for EVs. Therefore, when planning for short term charging requirements their usage patterns are important for planning purposes. Unlike personal use vehicles, fleet charging requirements are more concentrated and are indicated as primed for rapid expansion. Our discussions with fleet operators indicate that most of the early adoption and planning is geared for 2WH and 3WH vehicle fleets. In India travel and intra-city logistics businesses, including e-com deliveries, are seeking ways to integrate EVs in their fleets to benefit fit from the TCO advantage and the potential branding advantages that come by going electric.

Our survey respondents included operators with mixed business models including rentals, taxis, and deliveries businesses, all of whom had already made electric transformation plans for Delhi. The main hurdles to adoption was reported as being availability of adequate charging options, difficulties faced in setting up charging points, and the high upfront cost of these vehicles and associated infrastructure. Technology risks are not the top hurdles stopping EV adoption among fleets. This may be because of better awareness and information availability with businesses.

In our discussions, respondents indicated that they would appreciate DISCOM support in site identification and for securing required permissions from various departments and municipal bodies for setting up charging facilities. Further, if the DISCOM can take measures that increase the availability of public charging spots in high usage areas, this would help these businesses in expanding their operations and improving their services.

4.2.2. INTRODUCTION

The TCO benefits of electrical vehicles are much more prominent for commercial fleets than for private vehicles due to the higher asset utilization (distance travelled/day) in commercial vehicles. Therefore from a pure cost advantage point of view commercial fleets would benefit more from transforming from Internal Combustion Engine Vehicles (ICEV) to Electric Vehicles (EVs). Each commercial fleet has a large number of vehicles with concentrated ownership, thus these are more amenable to planning exercises. In our discussions, we approached a number of fleet operators in Delhi to understand how they are looking at the electric transformation. In most cases, fleet managers were already seriously engaged in making their EV plans. Awareness about EVs in the fleet segments is high.



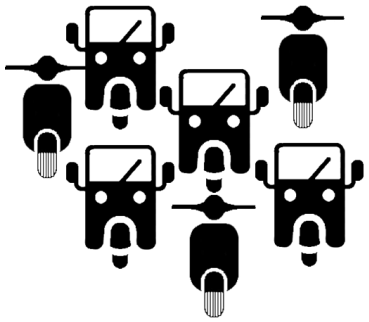


Figure 11 Fleet specifications

Most of our responding fleet operators had electric fleets running, our respondents also included a number of operators creating charging infrastructure (currently for commercial fleets, later to also serve private vehicles). Among the respondents were corporate leasing fleets, delivery fleets, last mile connectivity fleets, driver leasing fleets, charging operators, swapping operators etc.

4.2.3. RESPONDENT PROFILE

Vehicle category

Respondents in this survey target 2WH and 3WH fleets along with charging infrastructure fleets. None of our respondents had active e-car fleets. 50% of respondents targeted or included 2WH fleets, about 38% were charging fleet operators offering charging services to commercial and private vehicles, about 13% were 3WH fleet operators.

Daily commute distance

Respondents reported that on average e-rickshaw/autos cover a distance of 110 km/day, while scooters/bikes (2WH) cover about 80 km/day.

EV plans

Nearly all operators who responded had either already included EVs in their fleets or were fully electric at start. Some businesses have been operating EVs since 2014, while others were more recent entrants in EVs (about 50% in 2019), and some were just starting off. Operators are planning an increase of 3-4 times their current EV fleet size by 2022.

Respondent profile is depicted in Figure 11

4.2.4. DRIVERS AND BARRIERS FOR EV ADOPTION

In trying to understand the drivers and barriers for EV adoption among Fleet operators, we asked respondents to rate each reason from 1-5 (Very high importance (5), and very low importance (1)). The weighted average response of respondents was then used to rank order the reasons by order of importance (Figure 12).

Respondents report that the most important driver for shifting to EVs for fleet operations is the lower Total Cost of Ownership (TCO) and the Lower operational costs, followed by a corporate direction defined by its management, and lower pollution. None of the respondents reported that they were seeing any customer demand for making their fleets electric. We were also surprised by the response that operators are less affected by regulatory easements for EVs which matter more to drivers and those seeking individual permits, therefore this was among the lower rated reasons for adoption for fleet operators.

Among reported barriers for EV adoption, operators rate non availability of

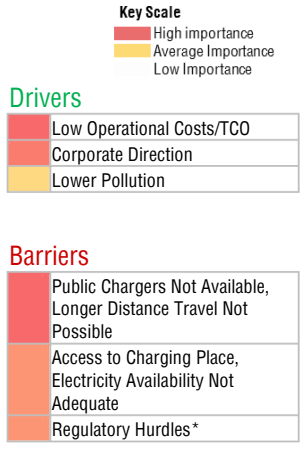


Figure 12 Drivers and barriers for EV adoption ordered by fleet operator responses

public chargers and charging sites with required permissions as their top barriers for EV adoption, followed closely by regulatory hurdles and delays, and high upfront cost of EVs. Unlike for personal use vehicles, operators also report non availability of good financing solutions as important in their responses. Since the market is dominated by 2WHand 3WH currently, the perception that charging time is not a barrier to EV adoption may be due to the fact that charging these smaller battery capacities (2-4 hours) is not as time consuming as the larger car batteries (which can take up to 8 hours for full charge). The response also indicates that operators are more concerned about battery performance rather than vehicle performance.

4.2.5. PARKING & CHARGING OPTIONS

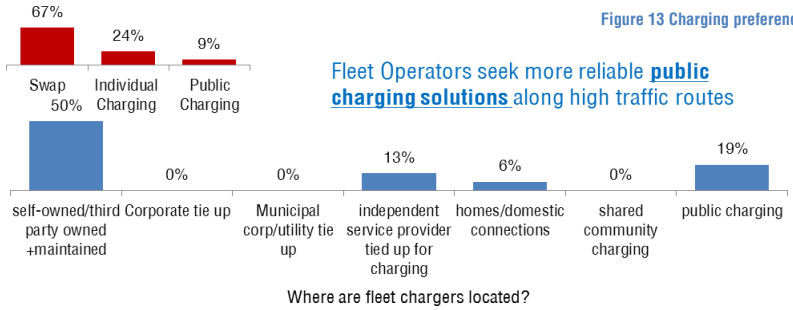


Figure 13 Charging preferences of fleet operators

In most fleet operations parking and charging currently happens in a central location so that asset health can be maintained and tracked more easily. Fleet operators are keen to make the swap model successful since it increases vehicle availability for productive work. Public charging options are still not considered appropriate for the charging needs of fleet operators.

Nearly 67% operators would prefer a workable swap model to other charging modes (Figure 13). On average operators reported a per day charge or swap requirement of 2.2 per vehicle/day. Therefore at least 2 daily charging rounds are required for fleet vehicles, which are presently managed at a central location by most fleet operators. Some of the respondents reported that the batteries are charged at a central location and swapped at the vehicle location (bike rentals).

4.2.6. EV PERFORMANCE

60% of our survey respondents were satisfied with the performance of the EVs in their fleets; 3WH operators reported concerns on battery performance and range. On average, respondents reported a 45% reduction in monthly fuel bills for EVs.

Problems faced by fleet operators in charging

When asked to rank the main challenges faced by operators in charging their fleets, operators reported that access to a suitable charging place was the biggest hurdle faced by them, followed by the lack of on-road charging options for these vehicles. Further, operators were asked to rank-order any regulatory hurdles faced by them in installing chargers, responses indicate that the biggest challenge faced while installing chargers is finding an appropriate site, followed by securing the required load sanction from

DISCOMs, and the long lead times faced in obtaining the required permissions. The cost of getting these permissions, cost of load sanction, or network up-gradation costs were not reported as being a significant hurdle.

4.2.7. DISCOM ENGAGEMENT

Respondents were also asked questions regarding tariff, peak timing and vendor empanelment with DISCOM. About 37.5% respondents did not have any concerns regarding using DISCOM empaneled charging vendors. Among those who reported this to be a problem, the primary concern was that vehicle warranties may not be honored by manufacturers if other chargers were used.

Fleet operators have 24 hour charging requirement, and only 50% reported that they would be willing to charge their vehicles in off-peak times if an incentive was available. Along the same lines, only 12.5% respondents were agreeable to peak time restrictions on charging. Unlike personal use users, most fleet operators reported being aware about CEA safety norms for EV chargers (Figure 14).

4.2.8. MANUFACTURERS' RESPONSE

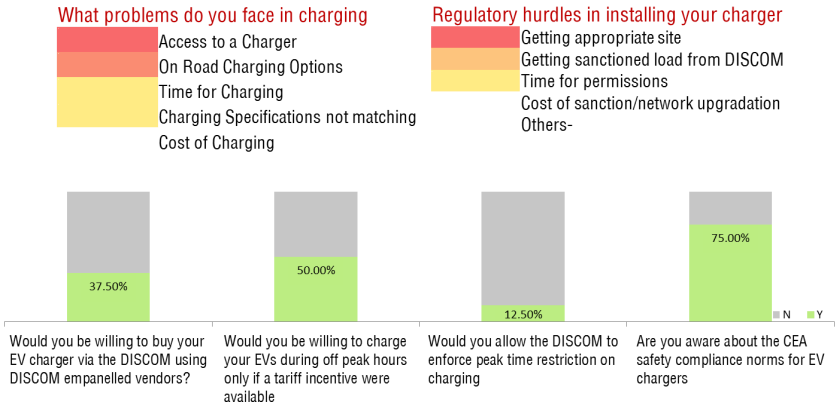


Figure 14 Fleet operator's expectations on DISCOM engagement

We had discussions with 4WH and 2WH manufacturers who are supplying vehicles in Delhi. In all production planning till 2021 for 4WH was reported as <1000 and for 2WH was reported as ~1.5 lac vehicles. About 4 e-car models and 32 e-scooter models are now supplied throughout India. For cars range varies from 100km/charge to 400km/charge, while for 2WH range varies from 70km/charge to 130km/charge. Cars have a price differential of 30-45% over equivalent ICE vehicles, while 2WH have a price differential of 10-20% over the equivalent ICE vehicle. Manufacturers supply EV chargers along with vehicles, cost included in the price of the vehicle. Some manufacturers also offer install at home service for chargers for the initial vehicles being bought. MG, for example is advertising that it plans to augment charger availability by also installing chargers along key city routes. Some manufacturers have established partnerships with charging services

providers to enhance availability of chargers. Manufacturers report that the order of priority for charging solutions would be as follows: Home charging, Public charging, Curb-side charging, Group Charging, Commercial space charging.

Manufacturers report that the main drivers for EV adoption would likely be Low TCO and ease of driving, while the top hurdles would be the high upfront cost, restriction on long distance travel, and access to charging places (Figure 15). Manufacturers do not believe that the positive environmental attributes of EV would become a major reason for adoption. They also attribute a lot of impact of government incentives of EV adoption. Manufacturers do not believe that technology risk perceptions would be a major hurdle for EV adoption.

When questioned about DISCOM empanelment of vendors 66% were agreeable to using DISCOM empanelled vendors for chargers. They think that off peak incentive will drive users to charge in off peak times. They are not agreeable with peak time curtailment. Most manufacturers are aware of CEA safety norms. When questioned if their chargers could be made tamper proof, one responded that they were not sure, one responded that it could be done, one responded that tampering is possible with their chargers. Manufacturers are in general willing to work with DISCOM to cover any points of concerns.

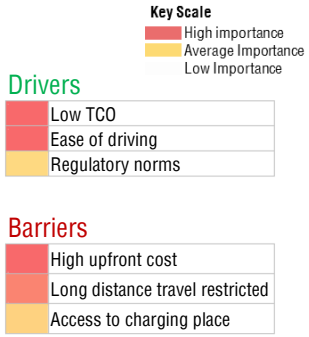


Figure 15 Driver and barriers for EV adoption as reported by manufacturers

4.1. Commercial spaces segment

4.1.1. SUMMARY

Commercial spaces around Delhi have a positive outlook for EV charging and are keen to upgrade their services to include EV charging facilities for their customers/users. EV charging can also become another revenue stream for the asset and investment heavy commercial space segment.

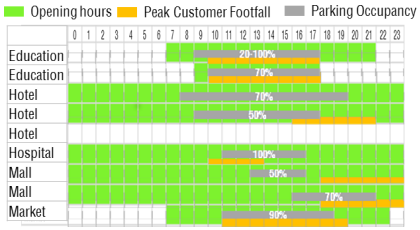
A number of spaces already have plans for installing EV chargers and are looking for appropriate service providers who can run these services within their premises. The main driver for adoption in commercial spaces is the environmental friendliness of EVs, and the potential for marketing advantage (better services for their customers) that commercial spaces gain by installing these chargers and becoming EV ready, while the main hurdle for adoption is the lack of well-defined and tested business models for charging and the perceived technology risk. Commercial spaces would benefit greatly by DISCOM led external validation of charging specifications and vendors since awareness regarding specification of this technology is low among managers of these spaces.

4.1.2. INTRODUCTION

Commercial spaces are uniquely placed as space-for-hire providers. Space for charging is an important parameter for identifying successful charging options. While even residences in some cases may not have sufficient space for reliable charging, commercial spaces may easily offer their parking spaces for EV charging. Commercial spaces also have high concentration of commuters. Vehicle services such as taxis and local delivery drivers frequent these spots. Therefore, commercial spaces can become critical stakeholders that enable reliable charging options for EV users across segments.

For commercial spaces we conducted on-one-one interviews with facilities managers of different commercial spaces around Delhi.

Figure 16 Respondent profile - commercial spaces



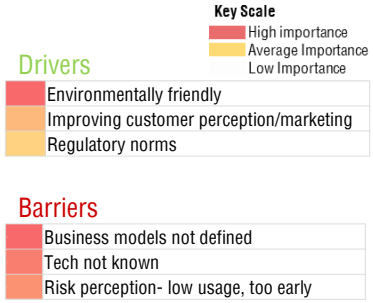


Figure 17 Barriers & drivers for EV adoption- commercial spaces

4.1.3. RESPONDENT PROFILE

Respondents in this study have an average size of 1100 sqm, with about eighteen 2WH parking spots/100sqm, and 14 car parking spots /100sqm. Malls have the highest number of parking spots per sqm, followed by hotels and hospitals, education institutions (Figure 16).

Different Institutions reported different levels of parking occupancy, and different peak parking occupancy times. Hotels and malls reported peak consumer footfall in the evening hours, while education institutions reported day time parking occupation of ~ 70%. Open market spaces indicated high customer footfall from 11am to 7pm, with peak parking occupancy of 90% from 10am and 6pm. One mall reported existing chargers (slow chargers) within their premises, however they were rarely used, and fast deteriorating. All managers reported having plans to install EV chargers. Delhi EV policy mandates all new public buildings should have EV charging facilities. Therefore existing building may be upgrading their facilities to meet future requirements. All managers considered EVs as being beneficial by virtue having zero tail pipe emissions.

A number of hotels and hospitals reported having plans to include some EVs in their captive fleets and were in the process of identifying suitable options.

4.1.4. DRIVERS AND BARRIERS FOR EV ADOPTION

While awareness among respondents in the commercial spaces segment appears to be high, most respondents did not appear to have sufficient information that would allow them to commit to installing EV chargers in their premises.

In this segment the top drivers for EV adoption are the relative environmental friendliness of EVs, and the improved branding and customer footfall that having these services could create for their customers. Regulatory norms are another consideration driving their decision towards EVs. The main barriers to adoption of EVs is that business models for charging are not well defined, technology is new and usage is uncertain. They are less concerned with the cost of chargers and associated infrastructure requirements.

4.1.5. PARKING & CHARGING OPTIONS

Nearly all the respondents reported having plans to install 3-4 EV chargers within their premises. Only 2 out of the 10 respondents were not interested in EV charging at all. Most respondents were not certain of the specification they should install. Several were looking at fast charging options which

were more future ready. While others were not aware of the charging options available or even what parameters should be considered while selecting chargers.

Most respondents were not willing to allow free public access of their chargers and internal spaces, and were keen on restricting access, selectively offering charging services to customers, patients, students, patrons and guests etc. 45% respondents were even willing to pay high tariff for charging to retain rights of selection and restricting access to EV chargers (Figure 18).

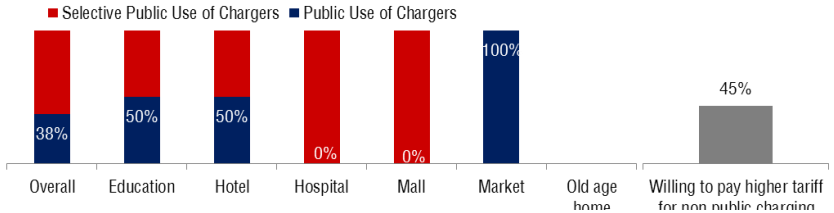


Figure 18 Openness to allowing full public access to avail special EV tariff

4.1.6. DISCOM ENGAGEMENT

Commercial space users have spare load capacity especially in the off peak night time hours, thus they do not anticipate significant additional infrastructure requirement for EV charging. Even in the case additional infrastructure is required respondents were keen to minimize DISCOM interference (Figure 19).

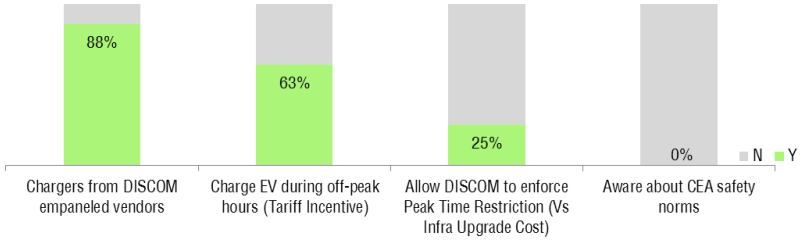


Figure 19 Commercial spaces' on DISCOM engagement

About 88% respondents were willing to use chargers from DISCOM empanelled vendors. In fact, respondents indicated that DISCOM engagement in vendor identification would help commercial spaces in making appropriate selections. Others suggested that they would like to minimize DISCOM interference and would be able to select based on existing procurement procedures. About 63% respondents were willing to utilize the off peak tariff incentive to guide their charging behavior. Only about 25% respondents were willing to accept peak time restriction from DISCOM. None of the respondents were aware about CEA safety norms.

4.1.7. CONCLUSION

While commercial spaces are interested in installing chargers they are not fully aware about the specifications and consider these investments risky. If a simplified process and external validation were available as a reference point for commercial spaces it may help them overcome their fears about the technology risks and adopt charging options within their premises. The increased visibility may drive further adoption among EV users. This group can act as a critical stakeholder that provides high visibility and appropriate solutions for charging needs of other segments of EV users.

4.2. 3-Wheeler (3WH) segment

4.2.1. SUMMARY

Our study indicates that the ICE 3Wheeler drivers are willing to shift to EVs however the timing of the change is less certain. The main hurdles for the transition seem to be concerns over battery performance and availability of charging infrastructure. Among those who have transitioned to EVs, availability of charging infrastructure is major challenge. From this study it appears that 3WH EVs can rapidly scale up if charging infrastructure can be reliably scaled-up.

The best locations for charging as identified from the respondents appear to be near homes of drivers for longer night charging, and within the route plans of riders for shorter day charges. Having 'shorter duration' top-up charging may be a good option for both the DISCOM and drivers as long as they can optimize the wait times and charging times.

Swapping seems to be the preferred mode among actual EV users due to time saved, while ICE users (planning for EVs) are ambivalent towards home/public charging vis-a-vis swapping.

Swapping would be good option for the DISCOM as well, since charging can be better controlled and distributed throughout the day more easily. Geographically concentrated charging infrastructure would allow DISCOMs to use the surplus capacity in distribution infrastructure more effectively. At present swapping is usually coupled with battery financing as offered by Sun Mobility and Ola Electric (pilot), although this mode has an inbuilt risk if the swap battery is not made available in time.

4.2.2. INTRODUCTION

Out of all the electric vehicles transformation stories, 3WH have shown the most promise for the shift. Partly as manual rickshaws have become electric, this has reduced the effort required, and improved earnings. Electric 3WH deployment in India beats all other electric vehicle types. There is now room for autos to also make the shift. However we anticipate that associated services would have to be strengthened to allow 3WH operators to choose electric options. In this segment of the survey we interviewed auto drivers (electric and CNG) to gauge their interest, requirements and expectations.

4.2.3. RESPONDENT PROFILE

The typical respondent profile is depicted in Figure 20

Age

Typically 3 WH drivers are males in the age group of 30-50. The profiles marginally differed between e-rickshaw drivers and CNG auto drivers. E-rickshaw drivers appear to be younger, with lesser overall driving experience, and lower education profile.

Past experience

Most e-rickshaw drivers had other professions (manual work – construction, rickshaw pulling etc.) before they shifted to e-rickshaw driving. One of the major drivers for adoption were the easy financing and simplified access options provided by companies like Saarthi, Sagun, SmartE etc.

Average drive distance

There is some indication that e-rickshaw drivers may have to put in longer days for similar pay. It also appears that most 3 WH drivers drive about 110-130 km a day

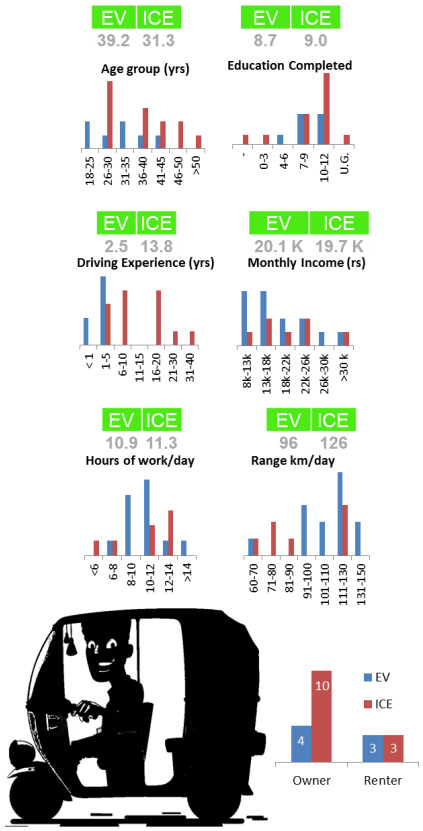


Figure 20 Respondent profile -3WH survey

Ownership

EV drivers rent and own in nearly equal percentage while higher percentage of ICE drivers own their vehicle. This could be due to the age or availability financing for ICE vehicles.

Financing

The upfront cost of the electric vehicle seems to be lower (INR 1-1.3 lacs/vehicle) than the cost of the typical ICE vehicle (INR 1.5-2.2 lacs/vehicle), this may be due to more prevalent use of the cheaper lead acid models of e-rickshaws. A large portion of ICE vehicles (nearly 25%) were bought on the black market due to permit restriction. The cost of these vehicles was significantly higher (almost 200%) than regular vehicles. This premium is not financed. The permit cost is exempted for EVs, which is a great advantage.

The responses indicate that daily rentals being paid by EV drivers appear to be marginally lower than for ICE driver.

4.2.4. DRIVERS AND BARRIERS FOR EV ADOPTION

While ICE drivers were less certain of the timeline for EV adoption, nearly 54% of them expressed a willingness to shift to EVs. This is a great indicator that EVs are already in their radar and the decision is leaning towards EVs if certain improvements are made and demonstrated.

It was clear that ICE vehicle drivers and EV vehicle drivers had differing opinions based on their experiences, therefore separating their responses offered valuable insights (Figure 21).

A key driver for adoption among ICE drivers was regulatory easements and subsidies offered by the government. We think that the positive government support coupled with high visibility and recognition received by E-rickshaws has been driving local discussions, and increasing awareness. This in turn has made EV's occupy a high mindshare in this segment. These insights are a great indicator of what is needed for other segments to increase awareness and drive adoption.

The main hurdles cited by ICE drivers to EV adoption were primarily reservations around availability- both battery performance, as well as availability of chargers, since this directly impacts their earning ability. We think that since most e-rickshaws use lead acid batteries which have shown a high failure rate and variability in performance across seasons, the opinion on EVs is being driven by these experiences. We expect with better li-ion powered models being launched and used, this should improve. Availability of chargers is a main concern for both EV users and non EV users. This indicates how important this is for this segment. The more unexpected result from the survey was the perception technology demonstration avenues were insufficient and this was a hurdle for adoption. Considering the high penetration of e-rickshaws in the vehicle pool, we had expected that most drivers would have had the opportunity to experience these vehicles, however this was not the case, and possibly represents an area of improvement for OEMs. The other common reason cited for non-adoption was their satisfaction with the existing vehicles, comfort with the technology and its management and unwillingness to change.

For EV drivers the main drivers for adoption were the potential for a better occupation, simple process for adoption, and peer recommendations. A number of our respondents were individuals who had shifted to driving E-rickshaws from manual labor. A number of EV drivers indicated that they received a lot of support from OEMs to own and operate these vehicles, be it for financing, for permissions, for subsidies etc. One key driver for adoption seems to be peer recommendations. A number of those who had adopted EVs said that the final motivation for adoption was the positive feedback and encouragement they received from their peers. Peer recommendations also played an important role for first timers. A number of the EV drivers were younger, and indicated that peer recommendations drove their decisions to adopt this job and vehicle type.

Positive peer recommendation and demonstration is likely to increase adoption in other segments as well. This is now happening for 2WH, where OEMs are making an effort to share more stories from users. This has great potential for increasing adoption in last mile delivery fleets (food, courier, e-commerce) operating on 2WHs as well.

The main barrier or hurdle faced by EV drivers is availability of chargers and battery range, and police harassment faced by them as they wait for passengers or to charge their vehicles. E-rickshaw batteries are sized to meet 40-60km per charge. Whereas travel requirements exceed this range, most respondents reported traveling nearly 100 km/day. This creates a charging requirement for 2 charges per day. This is difficult to manage without reliable charging services. This is also a likely reason why EV drivers don't do idle trips and seem to have longer work hours. CNG drivers can easily do idle trips to scout for passengers since they don't have range restrictions, this could also be a potential cause for their conflict with the police, as these vehicles wait in areas with high crowds and traffic. If vehicle range could be improved to service their daily range, then this would be a great reason for adoption, however the price differential probably does not allow for this.

Next push to EVs:' low costs' (TCO) and higher earning capability- charging infra would be critical.

So far the biggest shift to E-rickshaws has come as individuals shifted from manual labor. Discussions with drivers reveal that the next wave of shift to EVs would come as the cost economics becomes clearer and better e-auto models enter the market, more charging infrastructure is available, as this would drive the ICE auto drivers to also consider shifting to EVs. Our cost (Total Cost of Ownership or TCO) analysis indicates that in couple of years the fuel cost of ICEVs would be higher than the operational cost for EVs, and this would be a great motivator for drivers to discard ICEs and shift to EVs.

CNG auto drivers still spend a lot of time refueling, if battery swapping is successful, lower swap times and reliable swap availability system are introduced, this could increase daily earnings for drivers and be an additional motivation to shift to EVs.

Key Scale

High importance
Average Importance
Low Importance

For ICE Vehicle Drivers

Drivers

Subsidies
Permit limits
Regulatory costs

Barriers

Battery performance
Availability of chargers
Technology Demonstration

For EV Drivers

Drivers

Occupation Shift
Simple process
Peer recommendation

Barriers

Availability of Chargers
Police Harassment- Parking
Battery Range

Figure 21 Drivers and barriers for ICE and EV 3WH drivers

4.2.5. PARKING & CHARGING OPTIONS

In our bid to identify the best spots for installing charging infrastructure we attempted to understand the parking preferences of auto drivers (ICE) along with the current charging practices of EV drivers.

Home charging at night

Nearly all drivers park their vehicles at their home at night from 10PM to 8 AM (Depending on their work hours). EV drivers describe that chargers are installed near or at their home and over-night charging is common, typically done using 230V home plugs at rented rooms with a sub-meter. Those working in e-fleets like Smart-E park their vehicles in the Smart-E station where the vehicle is fully charged in 2 hours.

Renters need swap or strong Public Charging Station (PCS) network

The story differs for rented vehicles. Many CNG autos day-drivers return the vehicle to the owner at night, and the owner lets a second driver run the vehicle for the night. Such usage will require strong access to PCS or Swapping Options.

Day-parking/charging

Day parking and charging times are more variable. It depends on occupancy of the vehicles. Vehicle drivers reported parking in auto parking spots or pre-paid parking spots for 5min to 2 hours in the day time in the noon to 5PM lull. Some of the reported parking spots included – Ambience Mall, DLF promenade malls (Vasant Kunj), auto stands at metro exit (Nehru Place, Dwarka).

Lead acid battery operated e-rickshaws reported that they do not charge their vehicles in the day and only charge at night.

Drivers attached to fleet operators like Smart-E report charging their vehicles at least once in the day as well, usually at lunch time. Charging is free at Smart-E stations creating a great incentive for drivers to return to the charging station for their breaks.

Day parking for e-rickshaws as they await customers was reported to be mostly at metro stations

Preference for swapping

In our discussions, nearly 70% of e-3WH drivers expressed a preference for swapping due to the time saved. Whereas the response was more ambivalent from ICE vehicle drivers, who seemed equally inclined towards both swapping and home/PCS charging. Their main concern on swapping was quality of batteries, their state of charge, availability and range.

Charging costs

CNG auto drivers on an average spend ~150 INR/day on fuel (reported mileage of 30-50 km/kg) and are satisfied with the operational costs and efficiency of their vehicles. E- rickshaw drivers reported spending 100 INR/day. Smart-E does not charge for parking or charging at their station, the daily rental of the vehicle ~ 350 INR/day covers operational and capital costs of the vehicle.

If more authorized charging options were available at parking spots near driver residences or at waiting spots on their daily routes (e.g. metro stations, malls, curb-side charging at auto stands etc.) then reservations around charging availability as a hurdle for EV adoption can be overcome entirely.

Swapping stations along daily routes of the drivers is another great way to overcome range anxiety and push EV adoption. Swapping or battery leasing facilities would lower upfront vehicle cost, which may make the upfront cost of EVs cheaper than their CNG counterpart. This will lead to faster EV adoption. However swapping model creates concerns in the minds of some drivers around timely swap availability, dependence only on the swap provider to be able to charge e and run (no independent charging permitted), ability to get bank finance because the vehicle doesn't have motive power of its own, and availability of subsidy which at present is linked to battery capacity. Even for drivers operating under fleets, at present they have to drive some distance to their fleet operators charging station.

If easier alternative access options were available, this would increase overall efficiency and improve daily earnings for these drivers.

Local charging hubs

A number of makeshift charging hubs have emerged in and around the homes of E-rickshaw drivers to provide charging facilities. The drivers leave their vehicles for charging at these locations through the night. Some also come back for some day time charging during the weaker afternoon hours- 2-3PM.

These spaces accommodate as many as 60 vehicles at a time and typically have tied up with the vehicle owners. The charging hub provides a stabilizer and a converter, may have a separate common meter from the utility, but typically charges the vehicles a fixed rate for charging. A number of these operate on subscription models (Rs 2500/- to Rs. 3000/- per month), or on pay as you use models (INR100 to 200 per charging) depending on demand and ownership. Now with the utility announcing special EV tariffs several have applied for these connections to avail the lower tariff.

Figure 22 Images from Delhi's e-rickshaw charging hubs, metering arrangement, charging practices

We had the opportunity to visit some local charging hubs close to the homes of some EV drivers in Delhi (Figure 22). It was clear that not all charging stations were equal. A number of different business models are being explored for charging these vehicles. Some are facilitated by manufacturers, others are managed through local committees, and others still, are owned and managed by individuals looking for alternate sources of incomes. Access to information is also variable, while some charging operators were aware of the EV tariff and had already availed it; others were unaware and remained on commercial rates which was very expensive. While most of the spaces we visited had metered connections, a number of them had modified the downstream connections unsafely with exposed wiring which is a safety concern.

Some of the observed safety concerns include:

- All charging stations use either MCD or fuse instead of ELCBs recommended by BSES.
- The in-house electricians/workers are not qualified or trained for accidents or emergencies
- Lead acid batteries were over-used and corroded (Figure 23)
- Continuing battery problems, despite some corrections in controlling over-charge, limiting depth of discharge, replacement is not through standardized dealers, no quality maintained
- The charging stations did not appear to have any systems for controlling grid-overloading.
- Irregular terrains of these stations could be challenging during monsoons, high potential for water logging in these locations. This is also a safety concern.
- Dealer wiring and charging station wiring were of inferior quality which is a safety concern.

Figure 23 Bad operating practices of e-rickshaw owners & chargers- corroding e-rickshaw batteries

4.2.6. EV PERFORMANCE

In our discussions with EV drivers we also wanted to understand their experience with EVs, perceived improvements in efficiency, seasonal variations, range anxiety, after sales service, regulatory or utility hurdles faced etc.

Need for improved range and battery Life

Drivers wanted better efficiency, longer range and better battery life. *Most indicated that 100 km range was low since approximately 30km/day* may be idle travel and leaves very little productive travel per charge.

Most of these vehicles were powered with lead acid batteries, which are known to have poor efficiency and life, however these are still preferred due to their low upfront cost. Frequency of battery replacement was a cause for concern, several reported needing a replacement every six months (new battery price ~ 25000 INR, return old battery discount- 10000 INR, landed cost of new battery- 15000 INR).

Seasonal performance variations

Several drivers reported electrical malfunctioning – meter sparking, dimming lights, etc., in rainy season, and range reduction in winter season (almost 30%).

Most EV drivers indicated comfort with the digital reporting on charging states in their vehicles. They did not report having any range anxiety.

Satisfactory after-sales support

Overall drivers were happy with the after sale servicing, several small informal repair centers are available for small repairs, at most they spend 300 INR/month on servicing of the vehicle.

Police harassment is a dampener- dedicated parking and charging space for EVs will be very useful

On the regulatory side, drivers expressed concern over the high incidence of police harassment they face as formal parking spaces were not available for e-rickshaws. They feel the service is used for common people. Therefore the city should make options available for parking these vehicles in high mobility zones to ease the commute for people. Several drivers indicated that having a charging or swapping station along with options for formal parking spots at their waiting grounds near metro stations would save them a lot of police harassment and make it easier for them to run their services.

5. Conclusions

This survey has brought to light some interesting insights on consumer perceptions and expectations for EVs for different vehicle segments. It is clear that

- Each consumer segment will evaluate EV economics differently, look for products that meet their needs and then decide to transition or adopt EVs.
- It is also clear that viable charging option availability is a concern for all potential users.

Different segments reflected a different level of awareness and interest towards EVs.

- In the personal use vehicle segment awareness and interest was low.
- In the fleet segment awareness and interest was high. EVs are considered as the next big thing in mobility by commercial users.
- Among 3WH drivers awareness and interest was highest, this is also the segment with highest levels of adoption.
- Manufacturers are gearing up for scaling EVs. A number of manufacturers have already launched models or at least made announcements, recognizing that EVs could bring in a disruption and must be addressed. However capacity plans are low, considering the low vehicle demand in general, and low awareness levels in the largest market segment which is personal use.
- Commercial spaces expressed an interest in EV charging for its branding value and are exploring what kind of business models can be built around it.

Different drivers and hurdles govern the decision in different segments.

- Individuals with personal use vehicle are primarily driven to EVs for their “Clean and Green” attributes. Low operational cost and technological advancements are the other positive arguments in their EV decision matrix, while long charging times, uncertainties around access to private charging and high upfront cost are hurdles.
- A number of fleet operators have already decided to make the full transition to EVs for their better cost economics. They are also driven by a corporate direction towards EVs and the clean attributes associated with EVs. Lack of public charging, poor access to good charging locations and regulatory hurdles are the major barriers faced by them.
- Commercial spaces are looking at adopting EVs for their own fleets and also setting up charging facilities for their customers or users of their other facilities. They are primarily driven by the environmentally friendly attributes and branding value that would come from enabling EVs. They are also mindful of the regulatory norms for new buildings that require EV facilities and are keen to upgrade their infrastructure. The main barriers faced by commercial spaces is identifying business models, selecting technology and vendors, low penetration of EVs creates a high risk perception. 3WH drivers had the highest level of awareness.

As expected, different segments presented different parking and charging needs in terms of location, type of chargers, and timing of charging.

- The personal use vehicle segment would most likely largely be met by home chargers for its charging needs.
- The form of the home chargers is still malleable. A lot of people especially in Indian cities do not have access to private dedicated parking spaces, therefore the role of RWAs or municipalities in allowing private charging would be critical for their adoption.
- For fleets it is clear that night charging would be an important source which is being developed in central hubs, however well placed public charging facilities along driver routes is a major requirement for fleet adoption. Fleets would charge at night to full charge and recharge through their wait times in the day when feasible. This could be a great way to spread out demand loads.
- Commercial spaces indicated that while parking spaces are in use in the day, these are mostly available through the night, if EV charging can become a feasible method to monetize this space at night this could become a great option for the space and users.
- 3WH driver have already had some experience with EVs. Since availability of the vehicle directly impacts their livelihood, good charging options are a critical need for this segment. Currently charging happens at night at charging hubs close to their home. Most drivers also needed a day charging option, since two charging cycles are needed for these vehicles per day. Swap options show a lot of promise for meeting their needs.

When it comes to level of DISCOM interventions, customer responses differed widely

- Individuals and RWAs are happy for the DISCOM to manage all the technical and quality parameters facilitate the connection if the manufacturer guarantees remain unaffected. They are also keen to utilize the off peak tariffs for charging. They are less aware about technical specifications and safety requirements of these chargers. They are also hesitant to allow curtailment of electricity for charging in peak times.
- Fleet operators are less willing to use DISCOM empanelled vendors since a number of them already have experience buying and using chargers, they feel the additional interventions from DISCOM will make things more difficult. They are also willing to use off peak tariffs for charging, but are less open to DISCOM curtailments in peak times. Unlike individual users, fleets are more aware about technical specifications and safety requirements and standards.
- Commercial spaces reflected an interest in using DISCOM empanelled vendors to select vendors for installation. They are also interested in using off peak tariffs to further lower their electricity costs for charging, but are less open to curtailments. They are not aware about the safety and specification standards prescribed for chargers by CEA.

It is clear from this study that different vehicle and consumer segments have differing levels of awareness and interest, differing expectations around charging needs, and different needs of engagement with the DISCOM for selecting and installing chargers.

Therefore, segment and consumer specific programs will have to be designed by the DISCOM to meet the differing requirements.

- DISCOMs must design the program to drive more sustainable behaviors around charging times and locations so as to lower the burden on the existing infrastructure.
- DISCOMs are in a position to solve some consumer pain points by engaging stakeholders like municipality and charging services providers to design supportive charging programs that are easy to implement across segments.

DISCOMs are going to play a critical role is solving the charging piece of the EV puzzle and should be supported in doing the same.

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Survey information

Respondent details: