UNEP DTU PARTNERSHIP

Study on Electric Mobility in India

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List of abbreviations

2W	Two Wheeler
4W	Four Wheeler
ACMA	Automotive Component Manufacturers Association of India
AMP	Automotive Mission Plan
ASDC	Automotive Skills Development Council
BAU	Business as Usual
CKD	Completely Knocked Down
DHI	Department of Heavy Industries
DTU	Denmark Technical University
EESL	Energy Efficiency Services Limited
EV	Electric Vehicles
FAME	Faster Adoption of Hybrid and Electric Vehicles in India
GHMC	Greater Hyderabad Municipal Corporation
GOI	Government of India
HMRL	Hyderabad Metro Rail Limited
ICEV	Internal Combustion Engine Vehicle
ITI	Industrial Training Institute
JV	Joint Venture
MORTH	Ministry of Road Transport and Highways
NBEM	National Board for Electric Mobility
NCEM	National Council for Electric Mobility
NEMMP	National Electric Mobility Mission Plan
NMEM	National Mission on Electric Mobility
PHEV	Plug in Hybrid Electric Vehicles
PPP	Public Private Partnership
PV	Photo Voltaic
SIAM	Society of Indian Automobile Manufactures
TCO	Total Cost of Ownership
TSREDCO	Telangana State Renewable Energy Development Corporation Ltd.
TSRTC	Telangana State Road Transport Corporation
UNEP	United Nations Environment Program
WP	Work Package

1 Introduction

Increasing level of air pollution in Indian cities has been a cause of concern for policy makers. More than 25 Indian cities are within the 100 most polluted cities in the World [1]. The cause of growing air pollution in cities is related to a variety of sources however transport sector makes significant contribution [2]. It is important the emissions from transport sector are minimized. The adverse effects of air pollution on human health and to the economy are well known and therefore to minimize the impact on the environment, policy makers are considering several options. Electric vehicles have been seen as a promising technology option and several national governments have successfully implemented policies to promote the technology. Indian government is keen to promote electric vehicles as a green mobility options and is also considering it as a viable solution to reduce air pollution in cities.

Globally there are several success stories and best practices. For example, China has taken to electric vehicles in a big way for two wheelers and buses. In the UK, cities like London are giving incentives such as grants to purchase new electric vehicles, exemptions from congestion charges and free or reduced parking charges for electric vehicles in many boroughs.

In India, electric 3 wheelers have been partly successful, however not much diffusion of electric vehicles has happened within 2 wheelers, 4 wheelers and city bus fleets. Techno-economic assessments however show that electric two wheelers can become commercially viable by 2020 itself and electric four wheelers can be a major technology option by 2030 [3], if government provides incentives and infrastructures for charging are available. A strong climate policy also advances the cause of electric vehicles. The government is keen on promoting electric vehicles and the Minister of Power [4] has even put an ambitious goal of becoming 100% electric by 2030. The other ministries, particularly Minister of Road Transport and Highways, made a strong statement at Society of Indian Automobile Manufactures (SIAM) annual convention, that has unnerved the automotive industry.

> *"We should move towards alternative fuel. I am going to do this, whether you like it or not. I will bulldoze it. The government has a crystal clear policy to reduce imports and curb pollution."*
>
> *Nitin Gadkari, Minister of Road Transport & Highways @ SIAM's annual convention*

However formulation of policies would need inputs in terms of level of support required, implications for budgets of government, policy instruments needed and leveraging the private sector. This study attempts to address some of these questions.

In order to further understand the customer perceptions about EV in India, and to understand the market readiness, UNEP-DTU is conducting a study in the city of Hyderabad. The main objectives (O) of the proposed exercise are:

O1) Assess the consumer awareness and capture their perceptions about EV

O2) Evaluate consumer sensitivities on tangible and intangible parameters involved in purchase decisions related to EV

O3) Develop understanding about the current state of infrastructure and barriers to wider adoption of EV and propose improvements

O4) Study policy and regulatory aspects and come up with recommendations to the authorities

1.1 Methodology

The above-mentioned objectives can be realised by following the approach indicated in the below mentioned work packages (WP)

WP1) Design and conduct a comprehensive survey in order to understand consumer perceptions about electric vehicles

WP1 will be conducted in two stages.

- The first stage will include designing an exhaustive questionnaire in consultation with DTU and IIMA and conducting a preliminary sample survey with about 20 participants. We will then evaluate the responses and feedback from the trial participants in order to observe if there are any issues with the clarity, flow or content of the questionnaire. Using these inputs, we will prepare a final questionnaire
- For the second stage, we will then conduct a detailed consumer survey at showrooms, service centres, Petrol pumps to gather approximately 1000 data points to throw light on following
    - Consumer Awareness & interest in EV
    - Consumer behaviour, requirements and options for commute
    - Consumer stimulation towards different options or situations (Present the consumer with flashcards about multiple scenarios, and record user reactions to those scenarios)

The survey will be structured for a face to face interview format, but we will also employ other means such as web, e-mail, phone or postal surveys as deemed appropriate on a case by case basis. We would make every effort to keep the survey questionnaire up to the point and under 10 minutes per interview.

The questionnaire shall be designed in such a way that it capture the change in consumer perception and thus the prospective sale under different scenarios of

a. Business as usual approach
b. Under an ecosystem where improved supporting infrastructure exists
c. In addition to the supporting infrastructure, government incentives are introduced

WP2) Study the current state of infrastructure and barriers to wider adoption of EV and propose improvements

Conduct literature review and interview urban development officials, power distribution companies to understand the current situation of infrastructure and provisions under

government schemes for promoting use of EV. Also survey the availability of physical infrastructure and talk to at least 10 EV owners to capture their opinion about the infrastructure.

WP3) Use insights to explore government policies and environmental parameters needed to create a favourable and enabling environment for electric vehicles in India

In the end, we will undertake a detailed study of government policies related to EV applicable in the surveyed city and also take a look at environmental parameters like Electric Prices, Oil Prices, Battery development etc. and their expected impact on EV market in future. This would also include study of supply chain such as supplier, distributor and service network including vehicle technologies available for choice

> *"Obviously the horse can still do things that the gas car can never do, and the gas car will always be able to do things the electric car can't do. But they have really different uses and advantages."*
>
> *Chris Paine, American Filmmaker*

2 Questionnaire

A detailed questionnaire has been designed keeping in mind the objectives of the study. A mix of multiple choice and open ended questions has been used depending on the nature of information sought from the consumer. The questionnaire has been designed to start with a few warm up questions in the first two sections and then advance into more pointed questions that will help understand the consumer preferences and decision making. The intent is to keep the interaction under 10 minutes and will constitute between 15-20 questions in all. The questionnaire is organized into five sections:

- Travel patterns and Vehicle ownership: This section captures details pertaining to the vehicle ownership of the person being interviewed. This will help us in understanding the type of vehicles the consumer owns and their daily travel log.
- Awareness about Electric Vehicles: In this section we try to understand the general awareness of consumer when it comes to electric vehicles. This will give us an indication of the marketing communication and information dissemination requirements, and the effectiveness of current approaches.
- Consumer preferences about Electric vehicle: In order to truly succeed in any market, it is very important to understand the consumer perspective, and offer a solution that meets the consumer's requirements. To this end, we plan to understand the current barriers and prioritise the requirements accordingly.
- Scenario exercises: Through the scenario exercises, we plan to capture the change in consumer perception and thus the prospective sale under different scenarios that are detailed in WP1 above. Flash cards, will be employed in order to communicate scenarios to the consumer, and record his/her response to the scenarios presented.
- Consumer profile: Demographic and general consumer information is captured in the final section.

A detailed script containing standard responses to anticipated questions from the consumers for each question was prepared. This script was provided to the interviewers along with the questionnaire, so as to ensure that there is consistency in our presentation and in handling consumer questions during the interview.

The final questionnaires along with flash cards are available online at goo.gl/nRavFs

Some snapshots of the questionnaire are shared here for reference (Figure 2-1 & Figure 2-2)

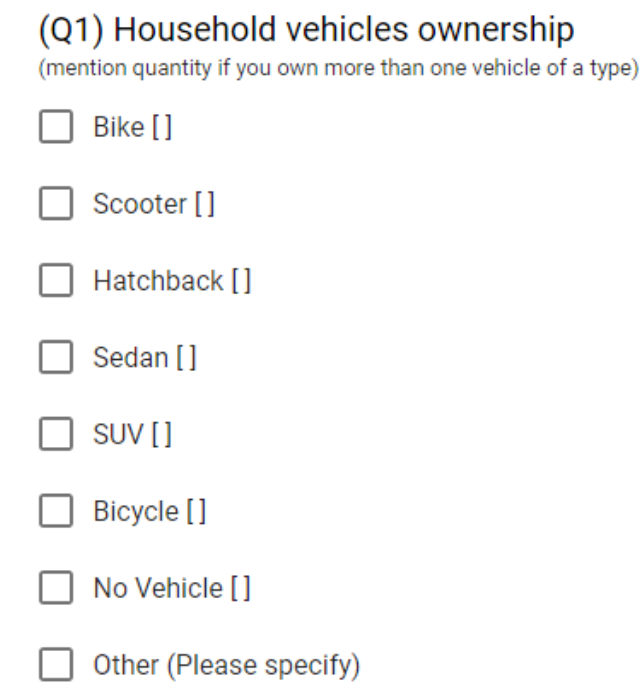


Figure 2-1 Snapshot 1 of the questionnaire

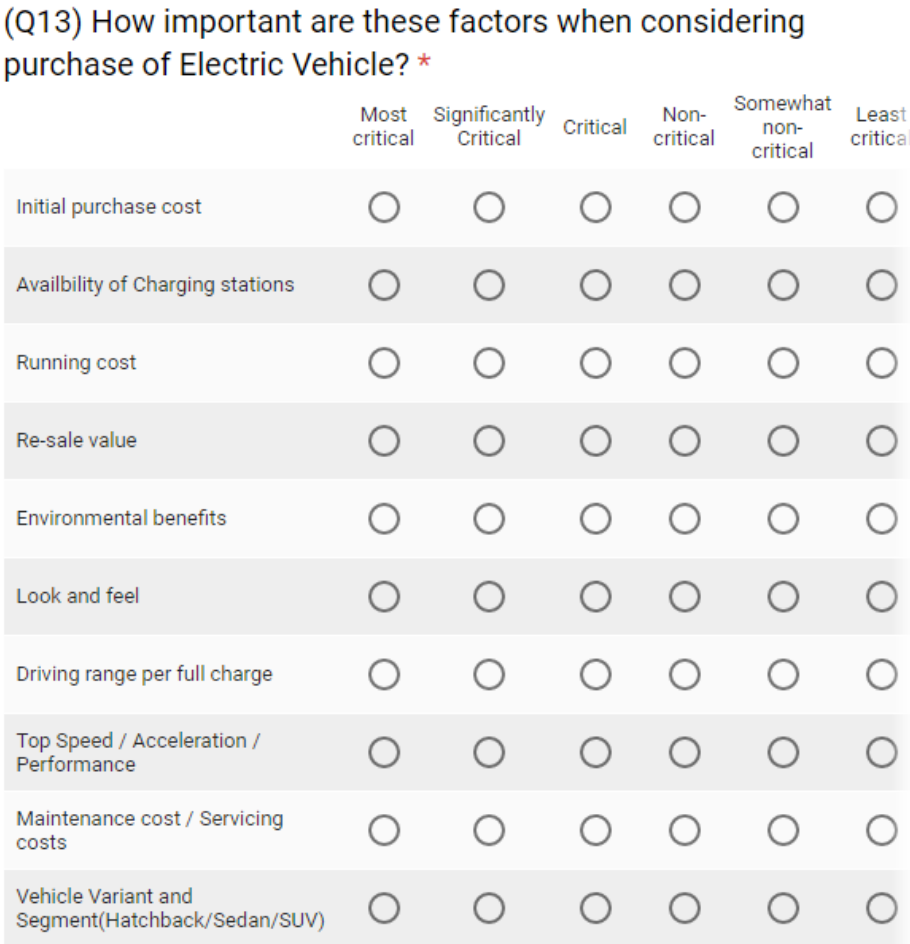


Figure 2-2 Snapshot 2 of the questionnaire

In addition to the questionnaire, interviews of municipality, urban local bodies, government officials, and automotive dealers were conducted in order to capture their perspectives and to understand their alignment with the goals set out by the central government. These interview questions were put together using a market mapping approach [5], which focuses on covering all the interlinked components in the value chain right from the conception till delivery to the end consumer. Using this framework, all the stake holders were identified and their role in the market outlined i.e. Enabling environment, Core market actors and Input service provision. The Figure 2-3 details a preliminary market map for electric cars as developed in a UNEP funded project "Technology Needs Assessments" [5].

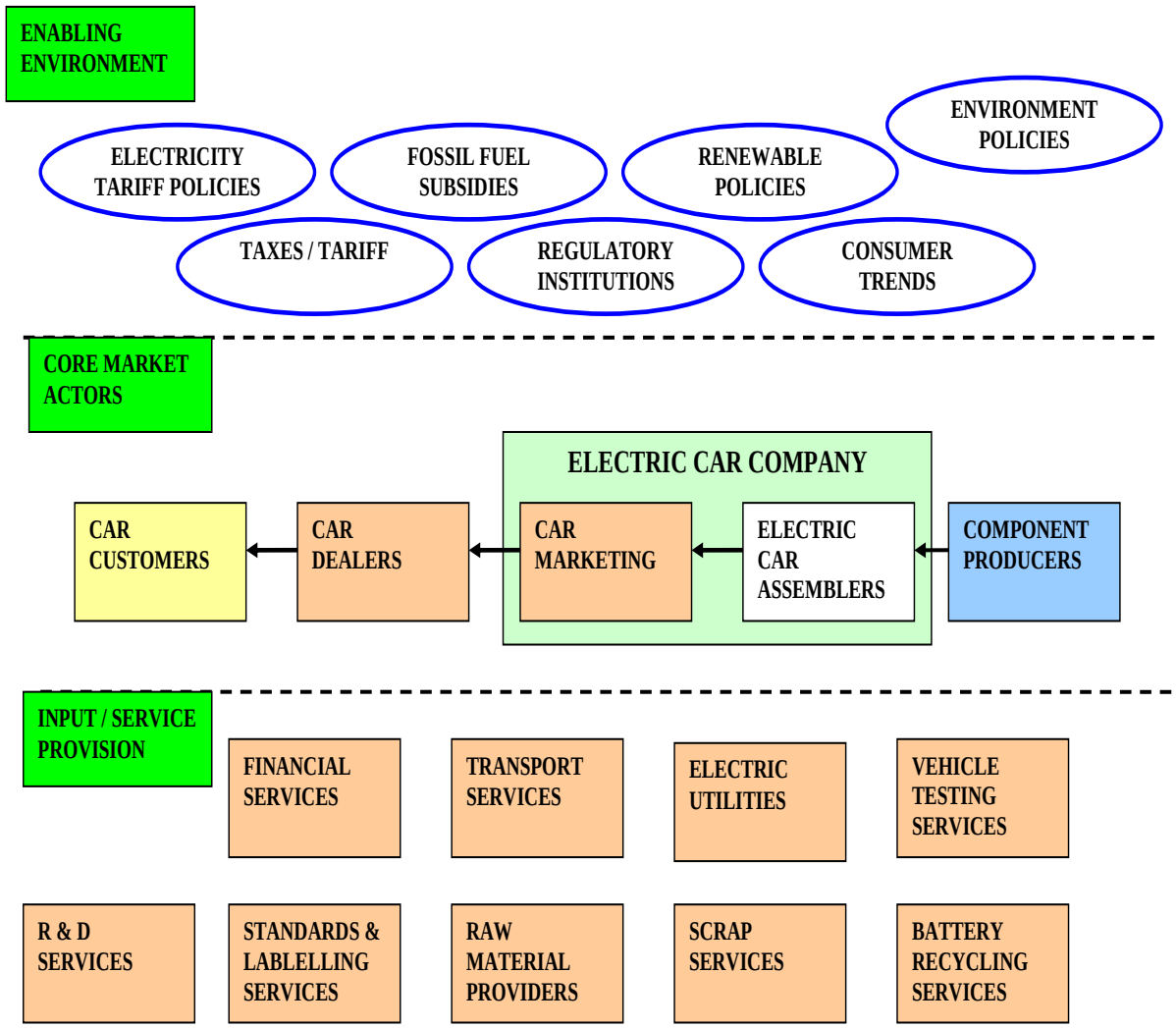


Figure 2-3 Market map for electric cars

3 Survey Sampling

There are multiple players in the EV market and it is very crucial to pick the right sample so as to get a representation of the various stake holders in the EV ecosystem. We plan to use a questionnaire format to record responses of potential and existing EV owners. Questions will be adjusted between the questionnaires used for potential and existing consumers in order to keep them relevant for both the groups. In order to capture views of the administration, we plan to interview various governments and urban local body officials. We will also interview automotive dealers in order to understand the views of auto industry and other core players when it comes to electric mobility. All put together, we plan to conduct 1000 consumer interviews and around 20-30 interviews of all the other stake holders in the EV segment. The table below gives a tentative breakup of the sample space.

Table 3-1 Details of Planned vs Actual data samples

S. No	Type of Player	Samples (Planned)	Samples (Actual)	Format
1	Prospective consumers	950	1000	Questionnaire
2	Existing consumer	50	8	Questionnaire
3	Govt. officials & stake holders	10	5	Interview
4	Automotive dealer	10	14	Interview

"Already we are leapfrogging from BS-IV to BS-VI within three years, which is the shortest time anywhere in the world. However, what we are asking is consistency in the policy, which once formed must not be changes as the auto industry has long gestation period to introduce new technology"

Vinod Dasari, SIAM President

4 Survey Execution

The project execution was split down in to multiple stages and activities were defined for each stage.

I. Preparatory Phase:
   a. Preparation of initial questionnaire
   b. Conducting sample survey
   c. Finalizing questionnaire
   d. Identify locations and seek permissions from government departments for conducting survey

II. Field work Phase
   a. Primary survey of prospective and existing consumers
   b. Interview of Auto Dealerships
   c. Interview of Municipal, Urban local body officials, Supporting organizations and other Stakeholders

4.1 Preparatory Phase

a) A preliminary questionnaire was prepared based on the objectives and scope of the project. Organization of the questionnaire and details of its subsections have been covered in the "Questionnaire" section above.

b) After taking consent from DTU on the preliminary questionnaire, a sample survey was conducted by the summer interns with over 20 participants at the university campus. Based on consumer responses to the sample survey, wording of a few questions was modified to make them clearer, format and rating scales of a couple of questions were changed, and a few other questions were broken down into multiple parts. The revised and fine-tuned questionnaire was then sent to DTU for final approval.

c) The following factors were considered in choosing the location for survey. The location should be able to provide us with unrestricted access to a good number of candidates with

- Spare time on hand so that the participant can give a quality interview
- Exposure or experience of participant with purchasing a vehicle
- Higher probability of the participant owning a vehicle
- Participants of both genders and from all age groups
- Minimum basic awareness about automobiles and electric vehicles

Based on the above criteria we found that passenger waiting halls at Railway stations and Bus stations, consumer lounges at auto service centres, food courts and resting / seating areas in malls to be ideally suited for our survey. In addition to that, we also got permission from a few private organizations and PSU companies to interview their employees during break time.

4.2 Field work Phase

Field work was completed with the help of summer interns from Institute of Public Enterprise at Osmania University. They were assigned the task of primary data collection by conducting face to face interviews at designated locations. We had a daily roundup call at 20:30 in order to facilitate knowledge sharing about consumer behaviour patterns that the team members were observing at different locations, interviewing tips and to respond to any concerns that

the team members brought up. We adjusted the survey locations, timings etc. based on the experience in the first 3-4 days of conducting the surveys. For instance, at the Railway stations and Bus stands, we had initially targeted passengers in Higher class waiting halls and lounges as we expected that these passengers would have spare time on hand and would be more inclined to participate in our study. Contrary to our initial expectation, we realized that most of these passengers did not qualify for the survey because they were non-locals, waiting for a connecting train. The few that qualified would usually be travellers from a large group (wedding party, pilgrims etc.) and did not show interest in participating as they were preoccupied with their group. We also found it very difficult to secure permissions to conduct interviews inside Technology and Business parks and premises of large MNC's and IT companies that we had initially planned for the survey. At the same time, we found that malls / shopping centers, large public sector undertakings like Electronics Corporation of India Ltd. (ECIL), Indian Railways etc. and public sector banks generally responded warmly to our request seeking permissions to conduct survey in their premises and colonies.

Survey timings were also adjusted for various locations in order to get a better mix of consumers and also to ensure a higher footfall and hit rate. For instance at railway stations it was observed that most of the travellers during day time (9:00 - 15:00) were visitors or non-locals who were coming to Hyderabad on business or personal reasons, or were returning back to their home towns. On the other hand there was a higher distribution of local travellers early in the morning (6:00 - 9:00) or late afternoon and evening (after 15:00). This was because many long distance trains have a transit halt at Hyderabad during the day time, whereas there are lot more local trains that originate from or terminate at Hyderabad early in the morning or late in the afternoon and in the evening respectively. Similarly for auto service centers, it was observed that lot of 4W drop offs were scheduled, and vehicle owners did not visit the service center for dropping off their vehicles. Whereas most of the 4W vehicle owners turned up for picking up their vehicles in the evening between 16:00 – 19:00. The case was different for 2W service centers, in that customers were present both during drop off and pick up times. Even in this case, the hit rates were lower during the drop off time as most of the consumers would be rushing to work in the morning, whereas it was easier to get responses in the evening time when the consumers would come for picking up their vehicles.

In addition to the consumer interviews, sales managers or heads of selected auto dealerships of major domestic and global two and four wheeler auto makers like Suzuki, Toyota, Mahindra, Tata, Honda, Hero Motors, TVS, Bajaj, Volkswagen, Skoda, Renault / Nissan, BSA etc. were interviewed for the study. A total of 14 dealerships were interviewed.

For the stake holder interviews, we approached auto component makers, electric vehicle manufacturers, Indian Railways, Telangana State Road Transport Corporation, Hyderabad Metro Rail Corporation, Hyderabad municipal and state government departments. A total of 5 stake holders have been interviewed for our study. We have official clearances from the respective authorities to publish their interviews conducted as a part of this study.

5 Analysis

We start our analysis by summarizing the views of various stake holders who play a role in the electric vehicle ecosystem.

5.1 Electric Vehicle Component Manufacturers

Few EV component manufacturers who are involved in the manufacture of chargers and controllers for electric vehicles were interviewed. They are also working on developing specialized battery packs and storage solutions based on the end usage of the vehicle. For instance they have separate battery recommendations for passenger rickshaws and small load autos, cabs vs private cars etc.

They mentioned that today almost all the electrical modules, motors, controllers and batteries are imported from China, while the structural components connected to the chassis such as steering, brakes, suspension, air conditioning are generally sourced locally by the auto makers. The primary reason for this is because there is an indigenous supply chain of conventional auto component makers who can supply structural components for EV at competitive prices. On the other hand technical competency is lacking among Indian manufacturers for production of Lithium ion batteries and other electronic and electrical components in India. Chinese suppliers are at least 5 years ahead in technology, and offer products at a predatory price. Further they are incentivised by the Chinese government with tax breaks and subsidies on exports. Unless there is a huge demand, new entrants cannot achieve the economies of scale that would be required to compete against the more established Chinese players. Further, there are no major entry barriers on import and trading of these components, so it is cheaper to import from China than to manufacture them in India. All these factors make it unattractive for the Indian auto component manufacturers to invest in domestic manufacturing, when they can actually import goods at a reasonable cost to meet the current market demand.

Take for instance the specific case of energy storage batteries used in EVs. The transition to EVs would require a battery capacity of about 400 GWh (gigawatt hours) each year, which, as per research conducted by Council on Energy, Environment and Water (CEEW), is equivalent to increasing the current global EV battery production by a factor of four, just to cater to the Indian EV market [6] [7]. Currently China is in the lead position followed by the US with installed capacities of 125 GWh and 35 GWh respectively. Germany is leading the EU nations and plans to have 34 GWh capacity by 2019. [8] Currently 100% of Li-ion batteries are imported. It was for the first time in 2016 that Central Electrochemical Research Institute (CECRI), Karaikudi in Tamil Nadu, set up the first indigenous Li-ion fabrication facility that has applications in defence, solar powered devices, railways and other high end usages. EVs will create a huge demand for Li-ion batteries, and this is an ideal opportunity for the domestic auto component manufacturing industry to transition into.

Figure 5-1 Global battery manufacturing capacity [9]

Manufacture of lithium-ion batteries, which are the primary source of energy used to propel electric vehicles require critical minerals such as lithium, cobalt, graphite and phosphate. The resource endowment of the most critical component i.e. Lithium, is limited to only nine countries and 95% of global lithium production comes from Argentina, Australia, Chile and China. The recent demand surge in the electric mobility market has already resulted in a twofold increase in lithium prices from $4,390 per tonne (in 2013) to $9,100 per tonne currently. It is estimated that India would require about 40,000 tonnes of lithium to manufacture EV batteries in 2030, considerably higher than the current annual global lithium production of 32,000 tonnes [7]. To meet India's demands amid a global surge in electric vehicle demand, the entire mineral supply chain needs to be overhauled and expanded.

However, India has missed many such opportunities to be integrated in the global value chain in the past. During the early waxing phase of solar PV and electronics industries, there was a lack of suitable policy support by the government for solar cells and wafers and electronics manufacturing. This led to an ever-increasing import bill for electronics products, currently the highest after oil and gold. The annual EV battery market is expected to be around $30-55 billion [7] and India cannot afford to fulfil the demand solely through imports. Hence there is a need to formulate policies incentivising domestic manufacturing companies to create a vibrant battery manufacturing, research and development ecosystem, and mining companies to simultaneously invest in overseas lithium mining assets.

The same view was also reflected in a recent article published in Auto News magazine [10], by the president of Automotive Component Manufacturers Association of India (ACMA), Mr. Rattan Kapur. He expressed cautious optimism over the government's plans to switch over from ICE vehicles to EV by 2030. Unless government policies and regulations create a conducive environment, it would be difficult for the component manufacturers to face the dual challenges of graduating from B-IV to B-VI and gear up for supporting the electric mobility wave in India. Component manufacturers also highlighted that lack of industrial standards was also compromising public safety and leading to poorly built and unstable / unfit vehicles plying the

road. Last year, the GOI exempted E-rickshaws and E-carts from the regulatory process governing other motor vehicles, thereby allowing them to ply on roads anywhere in the nation [11]. Lack of standards leads to poor construction quality and substandard vehicles which are cheap, but at the same time is a safety hazard. According to a recent news article there were 380 deaths due to e-rickshaws, with maximum 71 deaths reported from Telangana, followed by 66 in UP, 56 in Haryana, 47 in Maharashtra and 20 in Delhi. [12]

5.2 Analysis of Dealers and Stakeholder Interviews

A total of 14 dealerships were interviewed. Major domestic and global two and four wheeler auto makers like Suzuki, Mahindra, Tata, Nissan, Honda, Fiat, Mitsubishi, Bajaj, Volkswagen, Skoda, Volvo, Renault and BSA were interviewed for our study.

EV awareness and market potential – Auto Dealership perspective

Most of the dealerships mentioned that there is very little awareness of EVs among consumers. Not just consumers, there is also very little awareness among auto dealerships about the plans of their respective auto makers about EVs. This overall poor market awareness results in very few inquiries for EVs. Less than 5% of the total inquiries in a month are for EVs, and fewer still (~20% of the EV inquiries) actually convert into orders. Despite the higher prices, margins on BEVs are lower than conventional ICEVs or mild hybrids. This is partly because of the auto makers not being able to reach economies of scale with low volumes, but also partly due to the complicated government subsidy disbursement process. The subsidy is not directly passed on to the consumer by the government, but the dealer needs to sell the vehicle at reduced price to the consumer at the time of sale, and then needs to recover it from the government through an e-platform developed by the government. This makes it convenient for the consumer and the government, but the time taken for recovery makes it unpalatable for the dealership. All these put together demotivate the sales team and the dealerships to pursue sale of XEVs. One of them mentioned that a lot of 2W dealerships had stopped offering electric 2W after EV sales had dropped between 2013-2016.

After sale service and battery recycling

The dealerships were also not confident of providing the same level of after sale service to EV owners as they would to ICEV owners. Components for EVs are mostly imported by auto makers, and the lead times are very high. Also the EV technology is evolving rapidly and components change frequently. So most of the local auto component re-sellers do not stock EV components, and it is also not possible for auto service centers have to maintain local inventory of all the components. The service centers make every effort to maintain minimum inventory of critical spares and problematic components. Also there is a scarcity of trained staff to work on EVs and so not all service stations are capable of repairing EVs. All these resource bottlenecks, cause delays in service of EVs and there have been instances where customers had to wait for a couple of weeks to get their EVs repaired. Strangely, the dealerships / service centers did not express any concern about future availability of skilled servicemen or re-training of existing staff to work on EVs. They mentioned that by the time EVs become prevalent, most of the service personnel will re-skill themselves through unorganized means. They even drew parallels to service technicians at electrical and electronics gadget repair centers, and computer and mobile repair shops that spawned in every nook and corner. These technicians mostly do not have any formal training, but have learned troubleshooting of hi tech electronic gadgets on the job.

One more problem that service centers mentioned is that most of the times residences of consumers do not have proper earthing or adequate power supply at the parking lot to setup charging stations. So the dealerships offer technical support and can even arrange for an electrician to setup the charging point, but would charge additional for material and service. There was a mixed response from the dealerships on whether or not automakers provide any assistance on recycling of used EV batteries. Most of the dealerships mentioned that the automaker would provide assistance on replacing the battery upon end of its service life, but they were not certain on recycling facilities for EV batteries. They expect the strong battery recycling network that exists for conventional lead acid batteries would play an important role in recycling of EV batteries as well.

Other stakeholder perspectives

For the stakeholder interviews, we approached auto component makers, electric vehicle manufacturers, Indian Railways, Telangana State Road Transport Corporation, Hyderabad Metro Rail Corporation, Greater Hyderabad Municipal Corporation, and Industries & Commerce (I&C) and Information Technology (IT) Department of the Telangana government. A total of 6 stake holders have been interviewed for this study.

The awareness of common man about any product or technology is primarily driven by his consumption of the product. From that perspective, a common man is still not aware of EV's as much as he would be aware of the tradition IC engine vehicles or even latest mobile technologies. Even those who know something about EVs have a very low level of understanding and all they think is that electric vehicles are slow moving vehicles. But there is lot of curiosity among masses about the Electric vehicles and an increasing awareness due to adoption of EVs in public transport by various cities and states. Even within their respective organizations, only the persons / departments handling EV projects or activities are aware about initiatives of the state government or municipality on EVs. The primary reason for this is because this is a nascent area and there are very few projects or activities being pursued at present in this area. So only designated government department that is responsible for EVs is aware of it. Once state level policies for EVs are developed following the release of central government policies on EV, the roles and responsibilities will become clear to the government machinery.

Considering the current technical advancements in EV space, long term savings for the users, increasing environmental awareness among masses and GOI mandate to replace all traditional vehicles by 2030, most of the stakeholders agreed that there is a huge potential for EVs. Government usually prefers a bottom up approach for its programs to ensure outreach, scale up and create impact. Private vehicles need to be incentivised first in order to create awareness among consumers and create a market pull. If that is done, the government foresees 10-15% conversion in the first 3 years, which will reach 25-30% in the first 5 years. After that the growth will be very steep and will reach 75-80% in the following 3 years. Balance 20-25% will happen at slower pace over a period of time.

As to the main barriers to EV, most of the stakeholders agreed that cost, availability of charging infrastructure and maturity of technology were the top three parameters.

Incentives, Infrastructure and Projects

Telangana State: Government is actively promoting the generation and use of renewable energy and see it as an ideal starting point to improve air quality problem. It is also encouraging the vehicle aggregators in expanding their base in the state to propagate shared mobility concept along with EV fleet introduction to deal with vehicular pollution concerns. Various proposals for EV introduction in public transport are also at advance stages of planning. The government has proposal to set up 4-5 charging under PPP and will be operational by the end of 2017. More charging stations will be added on a periodic basis as the demand grows. In addition Telangana state has already exempted EV's from road tax and other incentives are under advanced stages of consideration. Details will be shared at an appropriate time.

HMRL: Hyderabad city is facing severe traffic congestion and increased pollution levels. High emissions of CO, CO2, SO2, NOX, TSPM, RSPM, etc. and deterioration of Air Quality Index is posing a major threat to the health of denizens. Keeping in view of all these factors, Hyderabad Metro Rail is being built not as a simple Metro, but an urban redesign & rejuvenation effort to transform Hyderabad into a people friendly green city with good air quality and living standards. In this direction, HMRL is critically considering usage of electrical vehicles as feeder services not only to provide seamless travel to the commuters, but also to reduce carbon footprint. These vehicles will be specifically designed to be eco friendly, aesthetic and safe. They will run on battery and will be zero air and sound pollution vehicles.

GHMC: Currently the municipality is not running any programs for EVs, but will be supporting other departments. We are identifying government lands in prime areas for setting up charging stations, and are discussing with urban planning and electricity board on the feasibility of high power charging stations. We are pushing for converting cabs to CNG and other pollution free technologies. We are aware of ongoing talks with Ola to convert conventional fleet vehicles to e-vehicles and launching them in Hyderabad, and the pilot run that TSRTC is conducting.

TSRTC: TSRTC is currently running a pilot for 2 months on EV buses supplied by BYD, China. The bus has a range of 250 km on full charge and consumes around 1kw/km. This translates to Rs 8/km running cost for electric, compared to Rs 30/km for diesel. However, the capital costs for this bus are almost 4-5 times that of a regular bus. We have submitted a proposal with Dept. of Heavy Industries (DHI) for allocating subsidy for 100 E-buses. They have agreed to fund the project but are yet to disburse the funds. TSRTC will not be able to foot the bill out of its budget. If the project gets underway, we are planning to operate these E-buses in a PPP mode. Since TSRTC owns and operates its own workshops, we are also concerned about lack of knowledge among our service staff. There is a urgent need to revise curriculum in ITI's etc. so that the students become more aware of electrical subjects in addition to the mechanical and automotive engineering.

Indian Railways: IR is a central government undertaking and does not engage in any state projects. IR was the first to pursue electrification in a big way and most of our locomotives are propelled by electricity. We offer two charging stations at Secunderabad railway station for free, but have not seen a single consumer use them so far. This is because there are no EV users and the few who use it, do not see a need to visit railway station for charging their EVs. Our primary business is transportation of passengers and freight and we prefer to focus our efforts on those. We will continue to evaluate meaningful ways to provide support to our consumers / passengers in the future and take necessary steps.

5.3 Existing Consumer Interviews

We interviewed a total of 9 EV owners in the city of Hyderabad. As early adopters, the existing consumers were aware of the occasional issues that come along with new products like poor support ecosystem, technical limitations and maturing technologies, no resale options or resale value etc. Despite some of those limitations, they went ahead because the benefits like automatic transmission, low running cost and environmental friendliness and outweighed the limitations like low range, uncertainty and high cost. In order to have a better support mechanism to help overcome some of these limitations, the users developed social media communities on WhatsApp and Facebook and shared concerns and DIY approaches to resolving everything from refilling of customized lead acid batteries to improving the effect of air conditioning in summers to nearest charging points and other emergency failures. One of the common concerns mentioned by all the customers was that the service stations do not give priority to EV owners and take a lot of time to resolve issues. At times customers ended up posting their issues publicly on Facebook etc. before the consumer support decided to act on their issues at a higher level. When questioned about what are the most important criteria for a purchase decision, most of them put Environment and Driving range on the top; initial purchase cost, maintenance and running costs, and availability of charging stations came next; and performance, styling, availability of variants and resale value were considered the least important criteria in making a purchase decision.

5.4 Analysis of Prospective Consumer Interviews

5.4.1 Demographic Analysis

Given below is a graphical representation of the differences in vehicle ownership pattern for different age groups. One can clearly see that among the younger participants (<30 yrs) there is a clear preference for 2 wheelers (2W), whereas the middle age (30+ yrs) and older participants do not have any such preference. Also the ownership patterns are similar for the middle and older age groups.

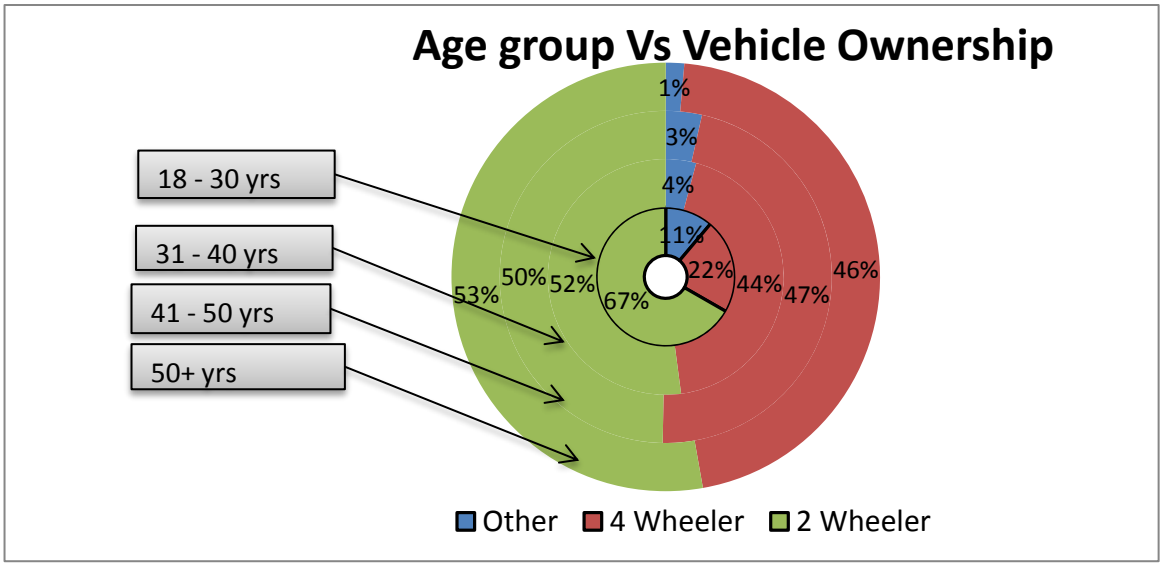


Figure 5-2 Changes in vehicle ownership with age

A gender wise split reveals that both gender groups have a similar preference for 2W, but females have a greater preference for public modes of transport when compared to males. This could possibly be because there are a higher percentage of a women in the workforce till they get married (~25-30 yrs), and these women have a preference to use office cabs or other public modes of transport.

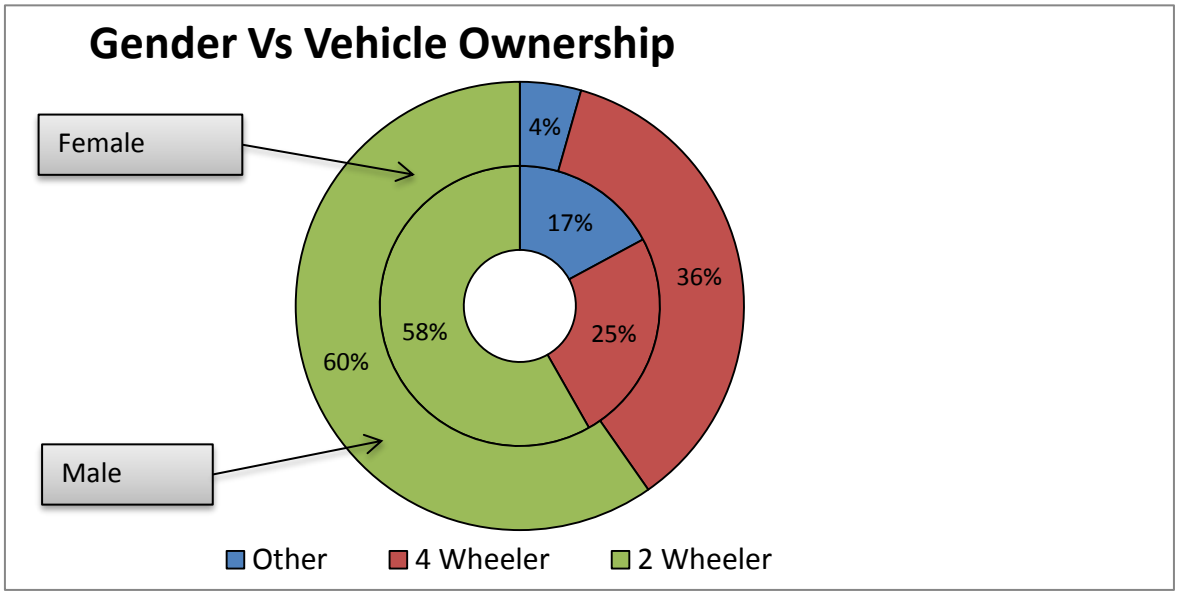


Figure 5-3 Gender wise preferences in vehicle ownership

The next section captures consumer preferences on vehicle ownership, and mode of travel preferred for daily commute, segregated based on age and gender. This is done by asking the consumers what mode of transport they use for day to day travel, while their vehicle ownership details have already been recorded earlier. It can be seen in Figure 5-4 that a 71% of 2W owners (motor bike, scooter) prefer to use 2W for daily commute, whereas this percentage drops to 53% for 4W owners (hatchback, sedan, SUV), who also show a preference for 2W. This is

possibly because of longer time it takes for commute in 4W and the higher running costs for a 4W when compared to a 2W.

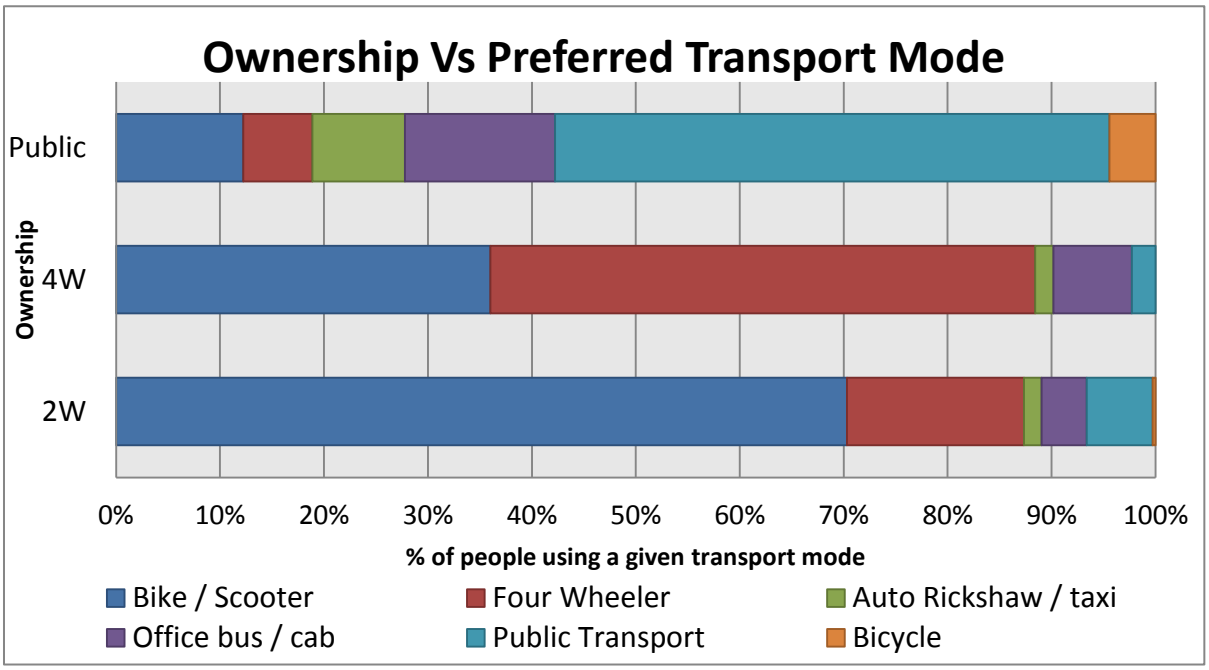
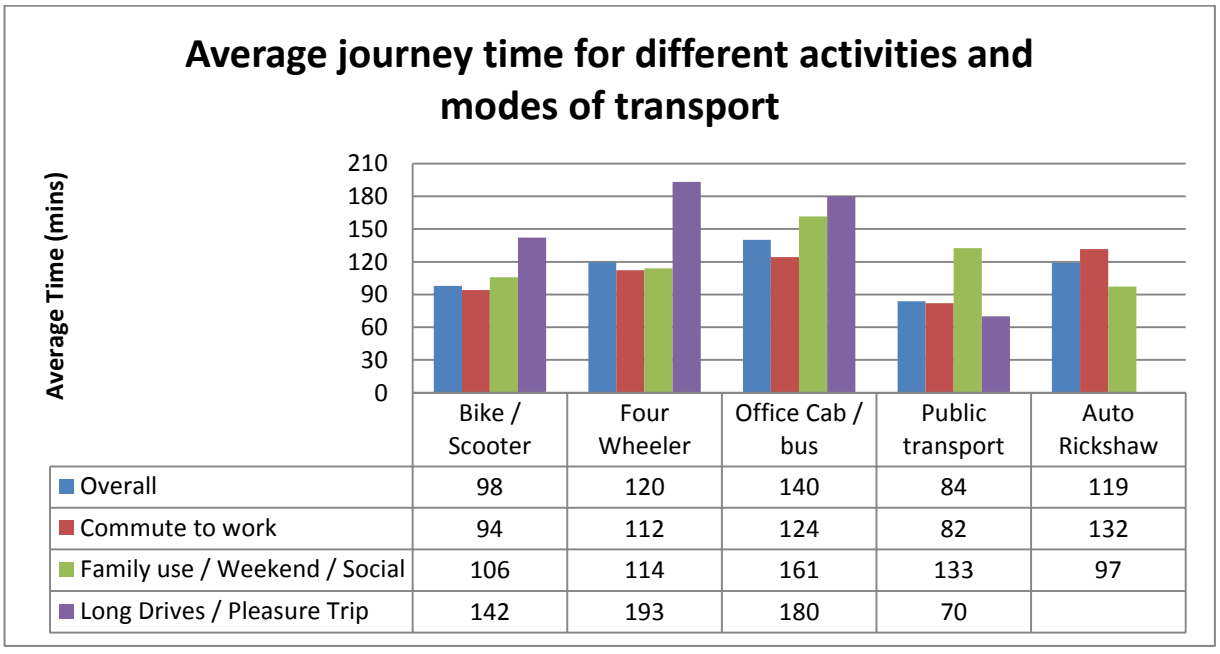


Figure 5-4 Comparison between vehicle ownership and preferred mode of transport

Analysis of average travel time for different activities and modes of transport is presented in more detail in Figure 5-5 below. It confirms that the overall travel time to commute on a 2W is around 20 mins less than overall travel time on a 4W, which is also in line with general experience. The number of data points for "Family use / Weekend / Social" and "Long Drives / Pleasure Trips" is low and so it is not advisable to infer anything substantial from the data for these applications / activities.



	Bike / Scooter	Four Wheeler	Office Cab / bus	Public transport	Auto Rickshaw
Overall	98	120	140	84	119
Commute to work	94	112	124	82	132
Family use / Weekend / Social	106	114	161	133	97
Long Drives / Pleasure Trip	142	193	180	70	

Figure 5-5 Average journey time for various activities and modes of transport

Among men, it appears that two wheelers and public transport are preferred by the youngsters while four wheelers and office cabs are preferred by the middle age and older people. Auto rickshaw has similar acceptance across all age groups (Figure 5-6). Among women, it appears that the preference for all the modes of travel goes down with age (Figure 5-7). But I would refrain from drawing any conclusion because there are only 20 sample points for women in the age group of 40-50 and 50+

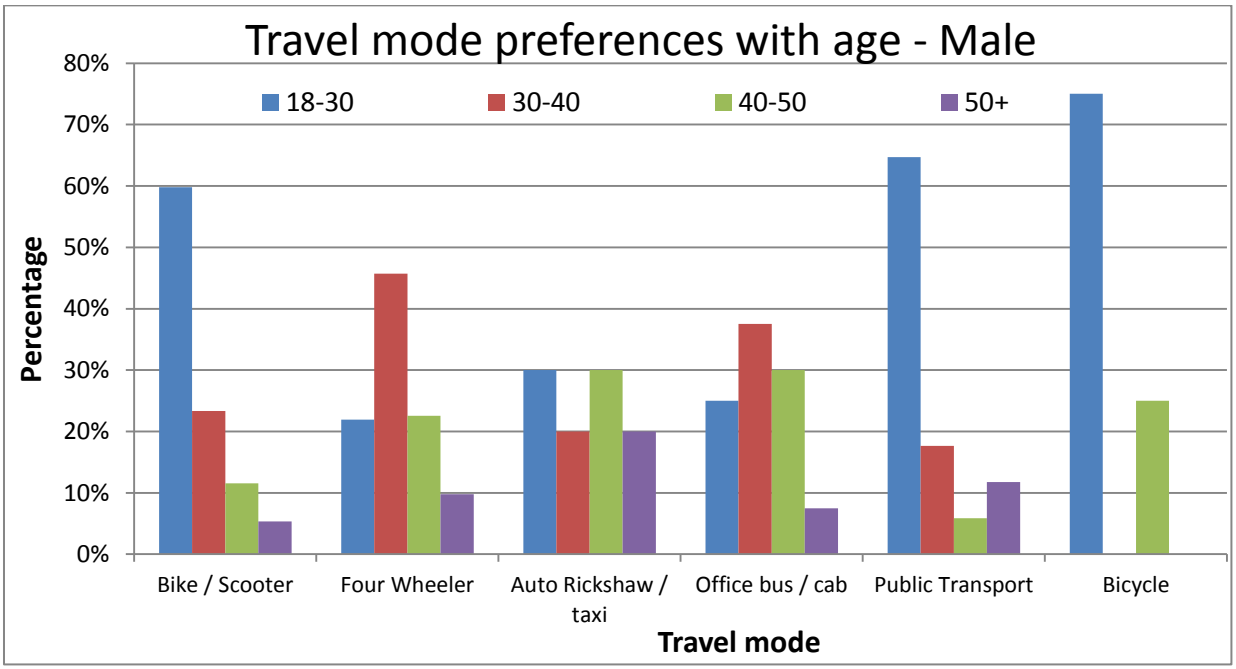


Figure 5-6 Mode of travel preferred for regular travel - Men

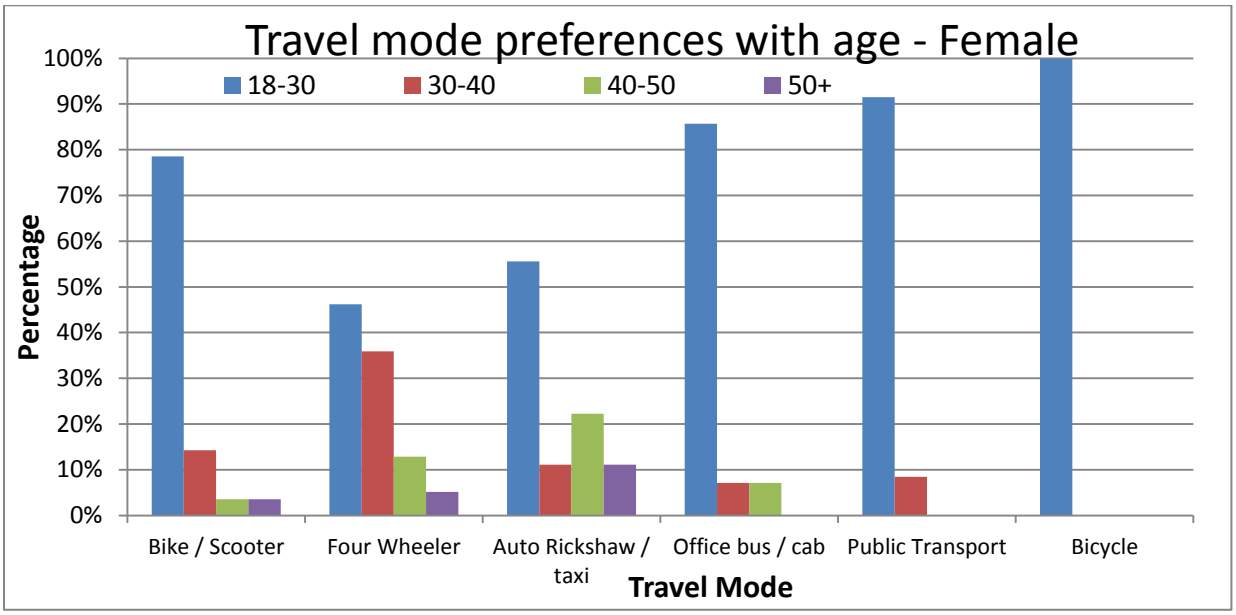


Figure 5-7 Mode of travel preferred for regular travel – Women

5.4.2 Travel Pattern

A study of travel pattern reveals that commute to work is the main reason for using ones vehicle. This is closely followed by family use and long drives.

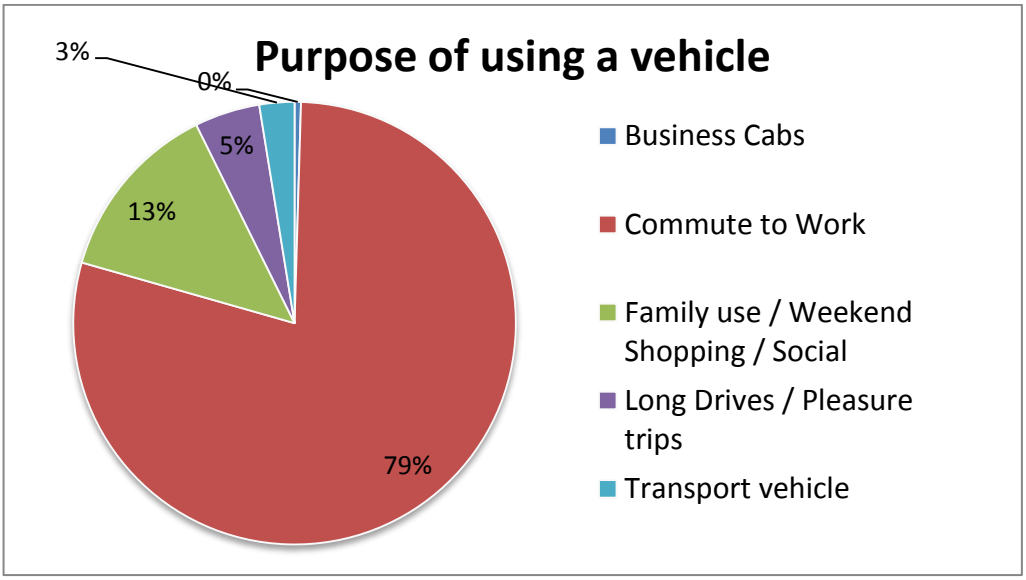


Figure 5-8 Purpose for using a vehicle as stated by users

Further evaluation of the mode of travel and the reason for travel reveals that two wheelers are preferred across the board, regardless of the purpose of travel, with the exception being Business cabs, where fur wheelers are preferred over other modes of transport. Figure 5-9 shows that shared modes of transportation like cabs and public transport are not preferred for commute to work and long drives.

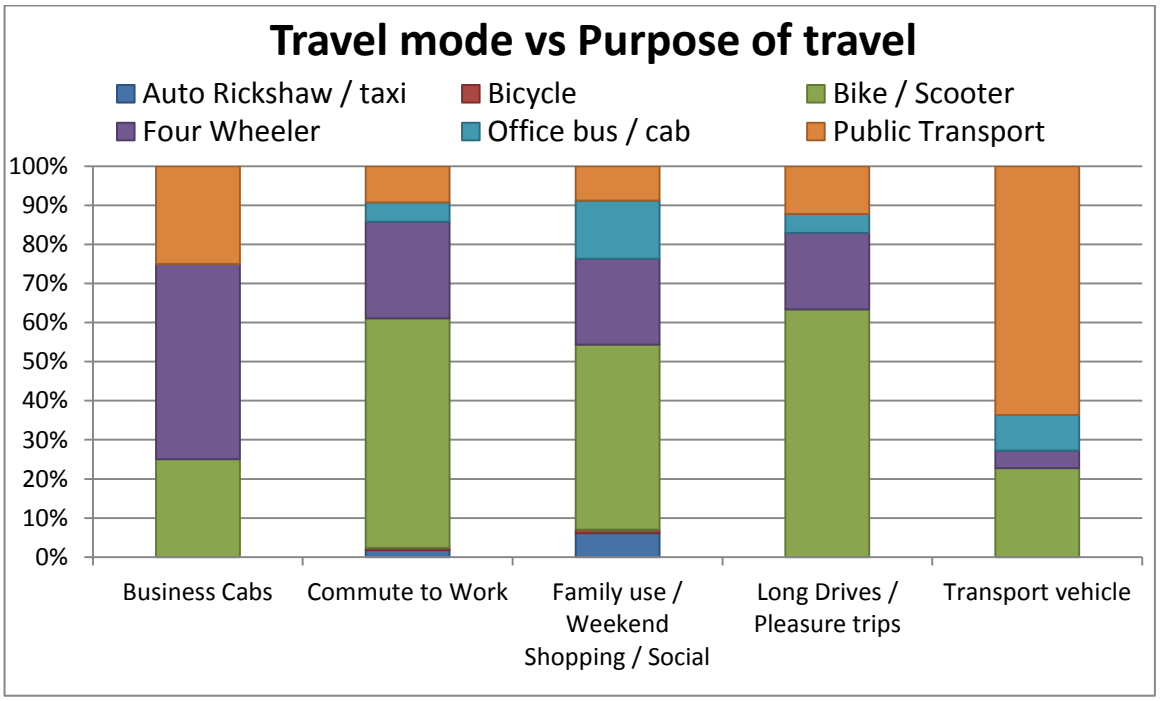


Figure 5-9 User preferences on mode of travel for various situations

Further examination of data shows that 90% of the commuters are able to fulfil their everyday personal and professional obligations under km of travel every day (indicated by the yellow dot in Figure 5-10). Also, only 10% of the city commuters spend more than 3 hrs on road on an average day (Figure 5-11)

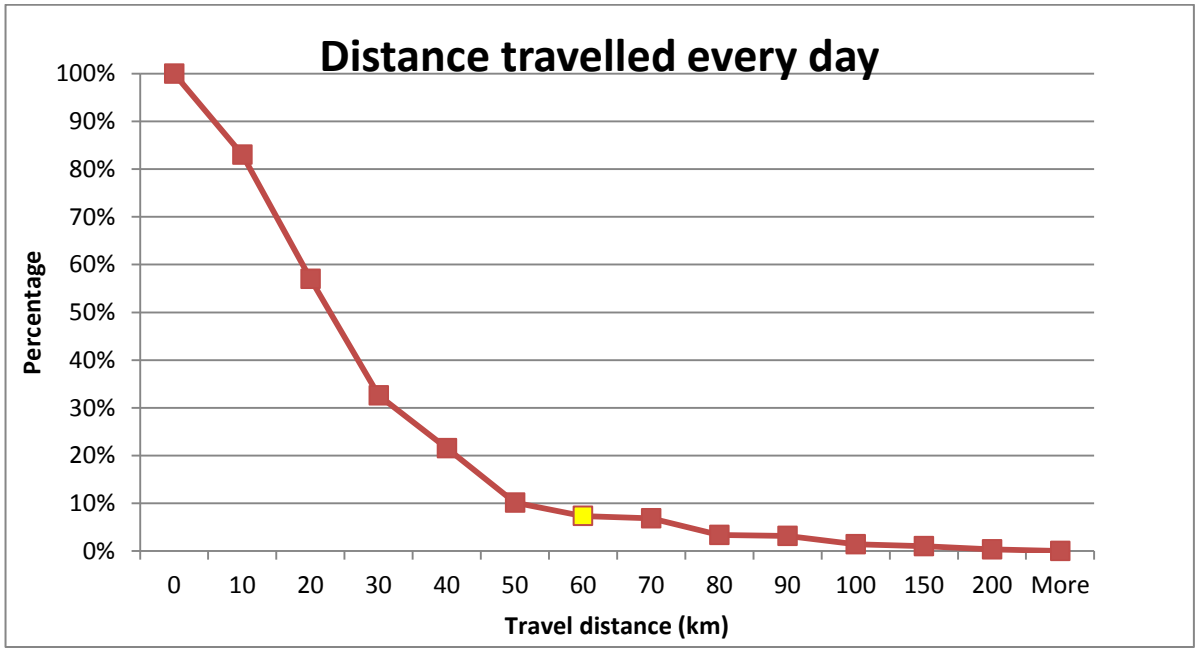


Figure 5-10 Distance travelled to fulfil everyday obligations Vs proportion of population

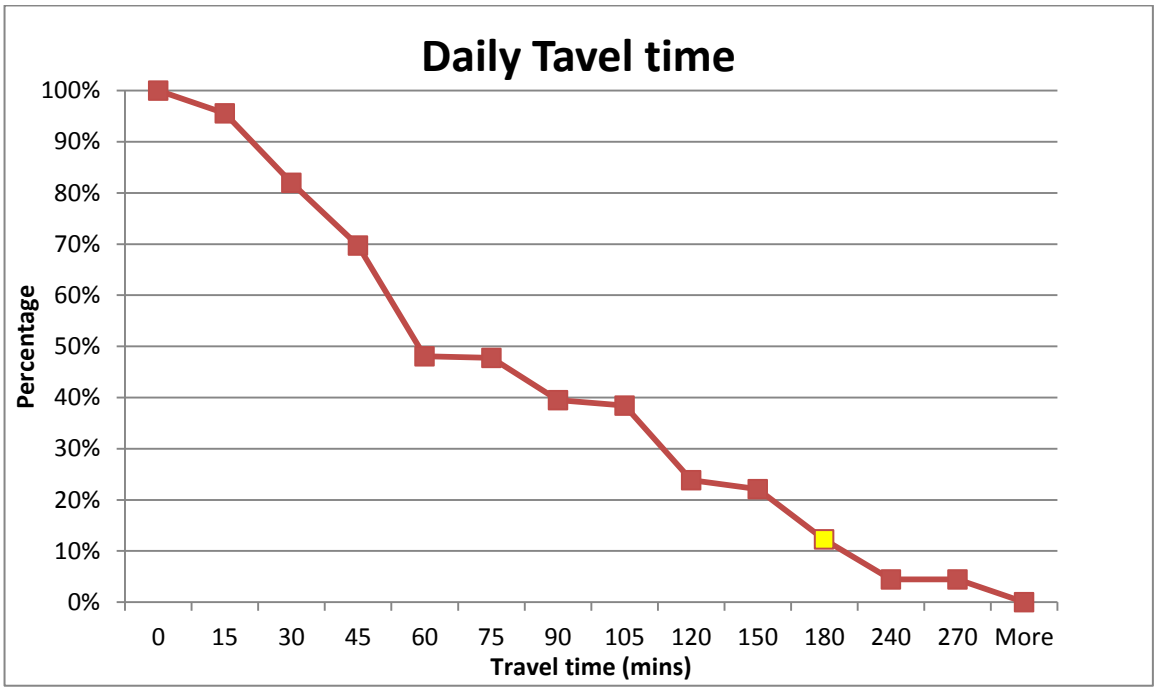
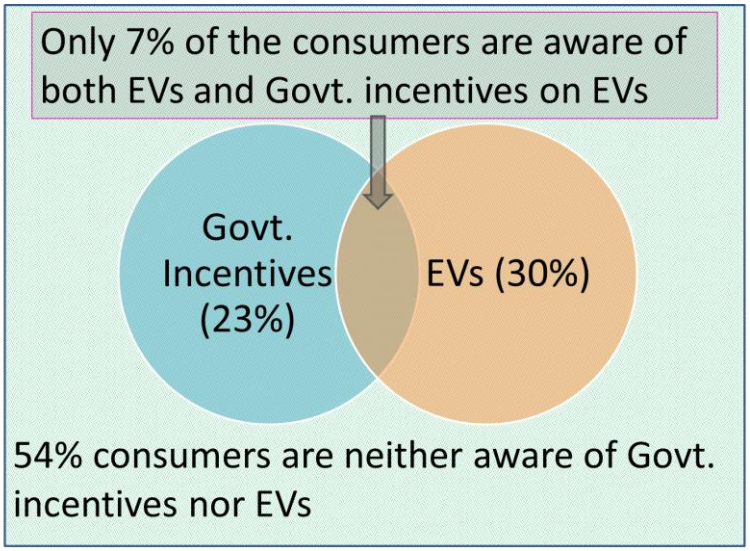


Figure 5-11 Time taken to reach the destination every day

5.4.3 EV Awareness

Consumer awareness about EVs is evaluated by asking the consumers to name a few brands of ICEV and EV available in the market, and further inquiring if government provides any incentives to the consumer for purchasing EVs. Analysis of the survey results reveals that only 30% of the respondents were aware of EVs whether it be 2W or 4W. Among those who are aware, people are 3 times more likely to be aware of a EV 4W than they would be about EV 2W. This is mainly due to the admiration for Mahindra Reva and Tesla.



Among those consumers who have some basic level of awareness about EVs, only 25% (i.e 7% of the total population) are aware of the fact that Government provides incentives for purchase of EVs. 54% of survey participants are neither aware of EV nor government subsidy.

Figure 5-12 Consumer Awareness on EVs & Govt. Inventives

5.4.4 Preferences for Electric Vehicles

In this section a study of user preferences on vehicle range, charging time and purchase preference priority for electric vehicles is evaluated. As the Figure 5-13 suggests, 90% of the peoples range expectations for electric 2W will be met if a range of 200 km is offered. For electric 4W, this range envelope to meet the 90% consumers expectations doubles to 400 km Figure 5-14. Comparing the range expectations against the daily travel patterns of the users, we see that 90% of the users travelled under 60 km on a daily basis. So if the electric vehicles 2W offer a range of the, say 120 km, it would address the requirements of a vast majority of the consumers. But this would fall short of the expectations, which are around two and four times of the requirements.

Majority of the consumers prefer charging their electric vehicles at home. Among those who prefer other locations, there is an equal propensity for public charging stations and charging stations at work. One of the main reasons stated by consumers is because currently public charging stations are not available in Hyderabad, so the thought of charging at a public location does not arise. Couple of consumers also stated that they did not see public charging stations serving any purpose other than giving the EV owners some psychological comfort that they won't be left stranded in the middle of the road should their electric vehicle require a re-charge. This re-assurance may go a long way in improving consumer confidence which would sway them in favour of electric vehicles.

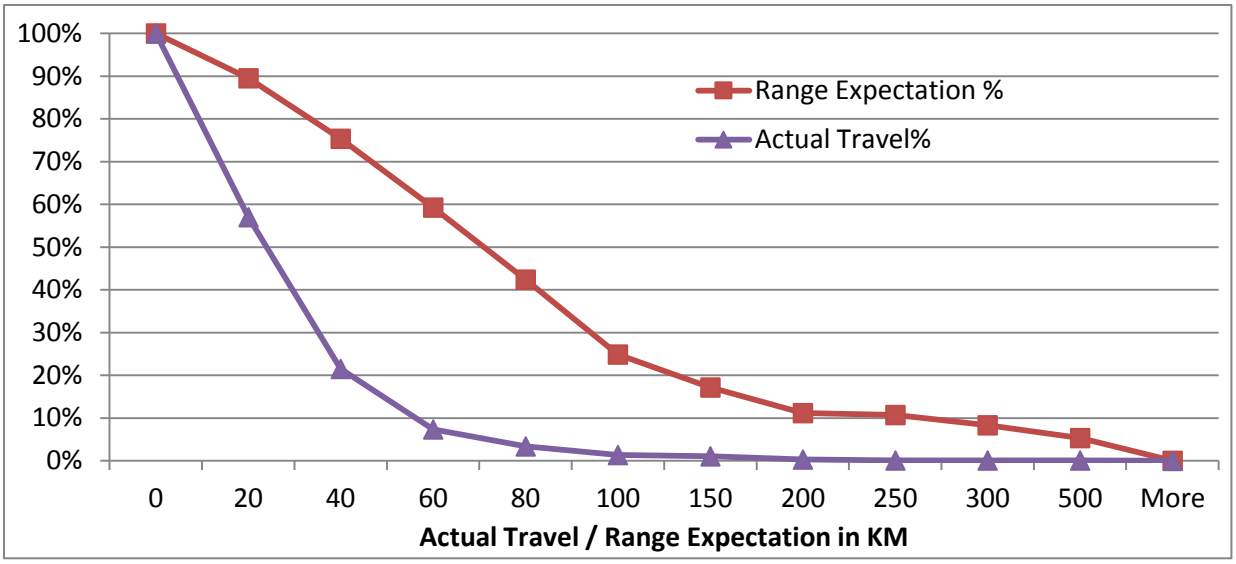


Figure 5-13 Comparison of Actual Travel Vs Range expectation for electric two wheeler

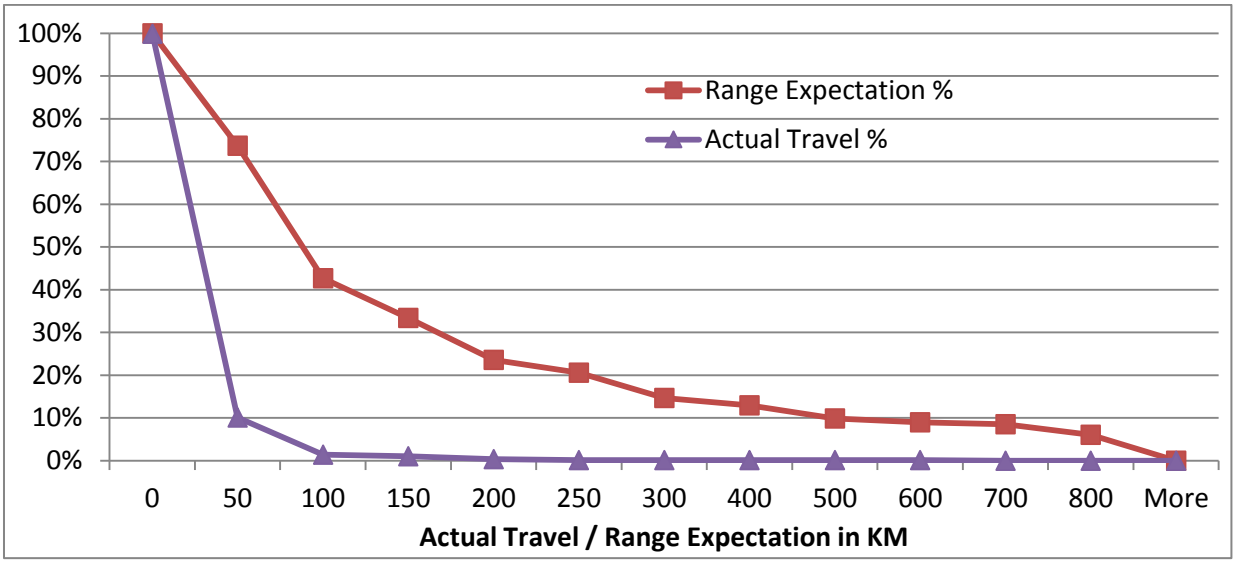


Figure 5-14 Range expectation for electric four wheeler

Another perspective was also brought up by consumers, who pointed out that it would be impractical to consider public charging stations as it takes way too long for recharging a vehicle with currently available technologies. Most of the curb side parking is owned by government and parking lots are both public and privately owned. Rentals for these prime real estate spots are very high in most of the metro cities. Currently the rent burden per consumer at a gas station is very low as filling up the tank at a gas station hardly takes any time and the rental cost is recovered from multiple consumers who drive in to the gas station. Whereas the situation with electric charging stations would be quite different as charging vehicles takes time, which means the burden is spread on fewer consumers. Unless government offers curb side parking slots and open lands at no rent for charging stations, the per hour parking fees / rentals would itself exceed the price for recharging / energy consumption, making public charging stations unviable, and thereby defeating the purpose of providing public charging stations. Possibility of theft of power from charging stations, or vandalizing charging stations all together on

highways and other remote locations that are not secured was also raised by some of the consumers.

The survey results suggest that up to 70% of the consumers are willing to wait between 5 and 15 minutes at a public charging station for a booster charge that can give a range extension of 40 km.

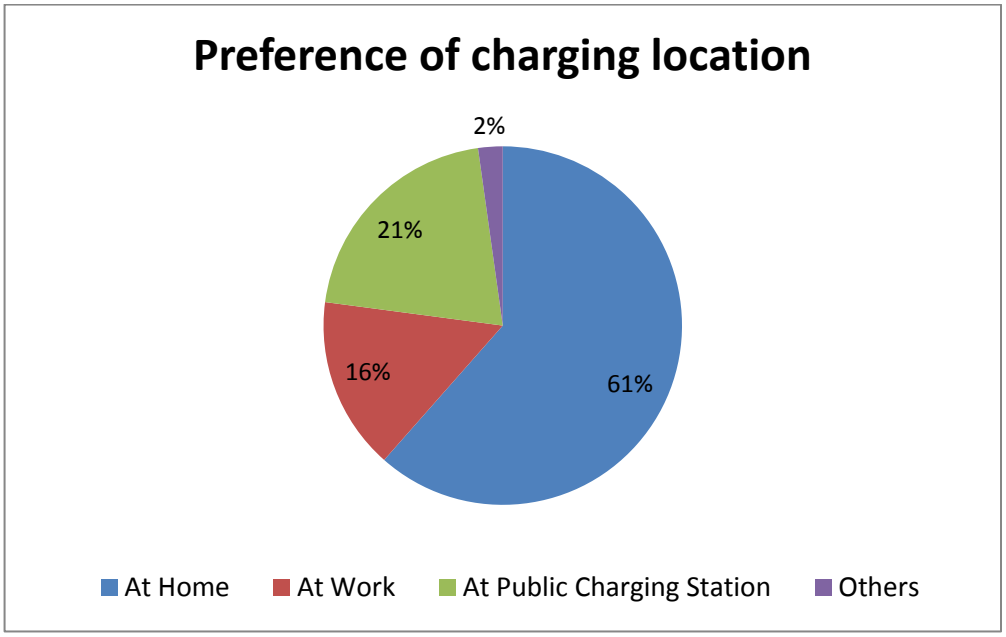


Figure 5-15 Preference of location for charging EV

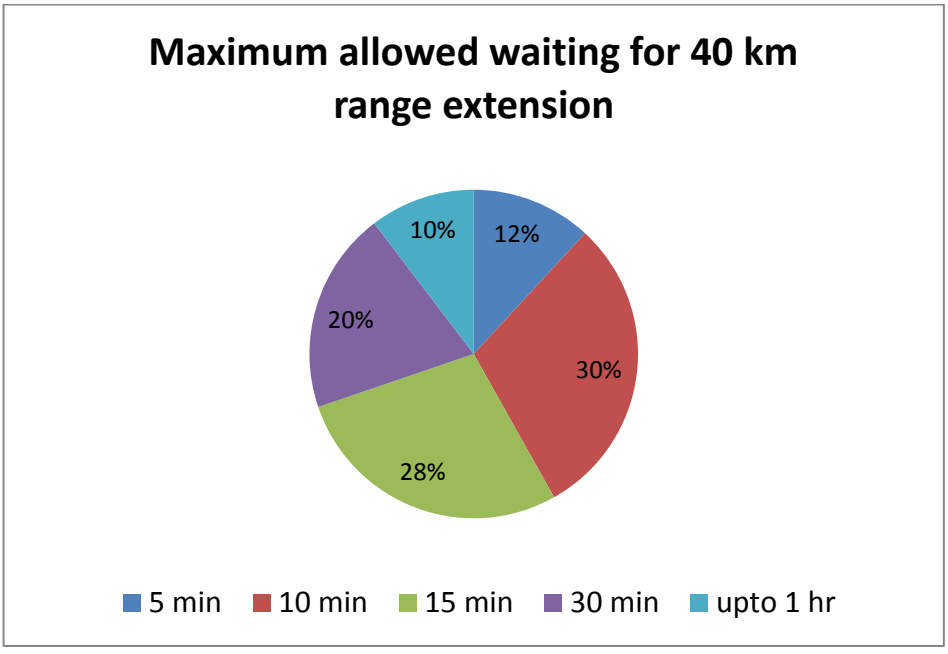


Figure 5-16 Time that consumers are willing to give for a booster charge that can offer 40 km range extension

While there were a few customers who compared charging stations to emergency services, in that having charging stations provided the re-assurance to users that they would not be left stranded in the middle of the road with dead batteries, we can see that consumers ranked that to be the most important parameter impacting their purchase decision. In response to a direct question about the importance given common factors considered while taking purchase decision, consumers responded that availability of support infrastructure such as charging stations, price and driving range are the most critical factors.

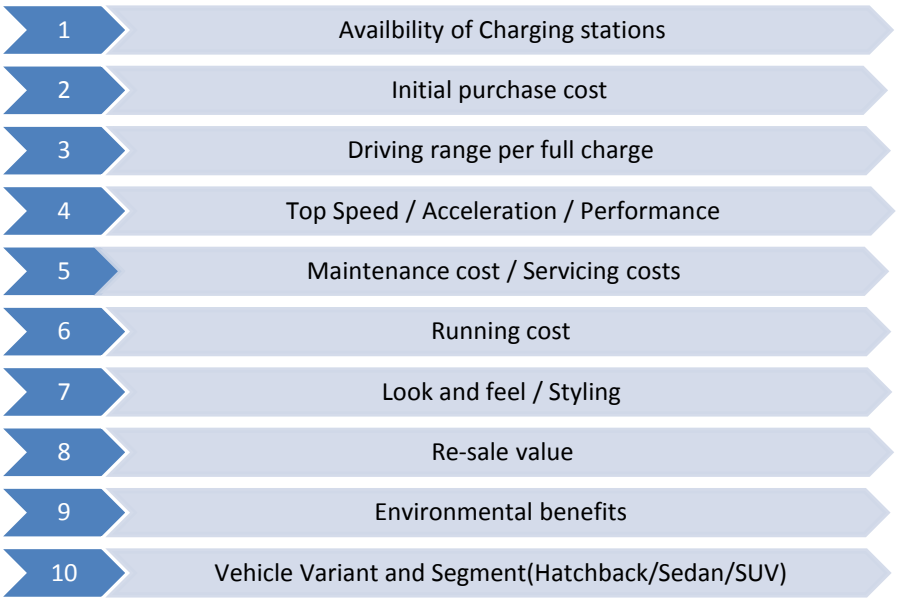


Figure 5-17 Ranking of purchase criteria

5.4.5 Scenario Exercises

A Scenario exercise is conducted by exposing the consumer to hypothetical situations which are created by defining various technical, regulatory, market and environmental factors that influence purchase decisions of potential consumers. Analysing the stated preferences of consumers to these hypothetical scenarios helps understand the sensitivity of consumers towards these factors how they manifest themselves in a purchase decision.

In the current study, the following three scenarios are presented to the consumer by using flash cards:

i. Business as usual scenario (BAU)
ii. Scenario 1 with improved supporting infrastructure for electric vehicles
iii. Scenario 2 with improved infrastructure and better price value proposition

Consumer responses with regards to purchase decision are noted for all the three scenarios, and the reasons for those decisions are also recorded.

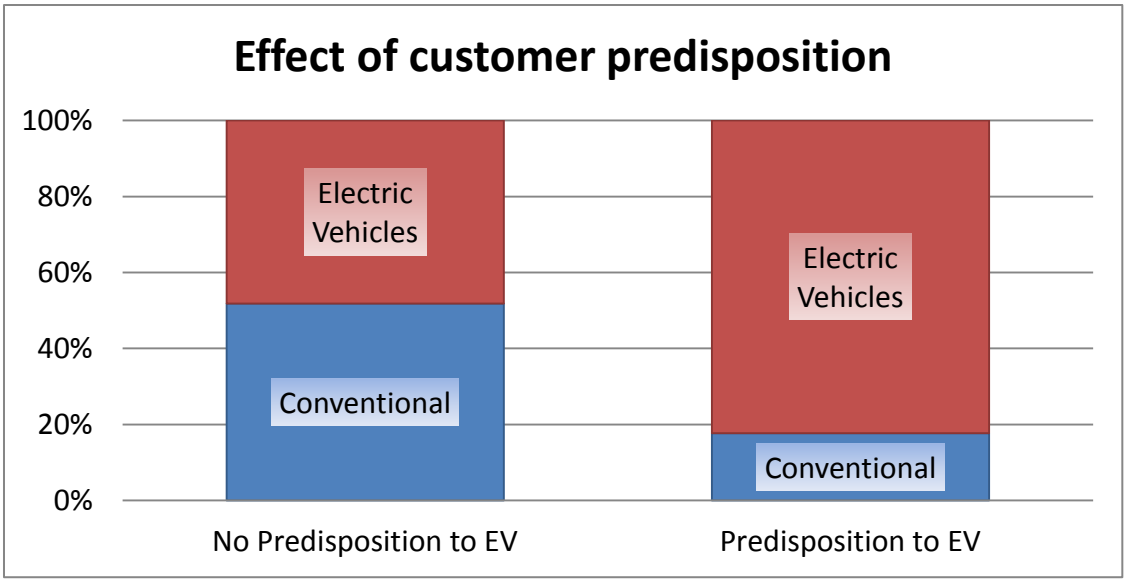


Figure 5-18 Effect of predisposition on vehicle choice in "Business as Usual" case

An evaluation of the impact of predisposition of the consumer towards EVs shows is done. Figure 5-18 shows that if the consumer was already predisposed towards, electric vehicles before seeing the flash cards, he/she would be 1.7 times more likely to choose an electric vehicle over a conventional vehicle, upon being asked to choose between the two after viewing the "Business as Usual" scenario shown in Figure 5-19. On the other hand among the consumers without any such predisposition towards electric vehicle, there is an equal chance that he/she would choose one or the other.

4 Wheeler - Hatchback

		Conventional	Electric
Product	*Fuel*		
	Mileage / Range	17.2 kmpl	170 km on full charge
	Power	1200 cc / 104 hp	1717 cc / 107 hp
	Max speed	140 kmph	149 kmph
	Charging time	0	Normal Charge - 6 hrs Quick Charge - 1 hr
Price	*Purchase Price*	13.4 L	22.08 L
	Govt. Subsidy	0	1.9 L
	All inclusive Ownership cost	20.64/km	26.42/km

Figure 5-19 Business as usual scenario

The flashcard for BAU scenario makes an effort to educating the customer and providing a very objective comparison between conventional and electric vehicles. It compares ICEVs and EVs on commonly used product attributes such as fuel economy, performance re-fuelling time etc., and price components such as subsidy, vehicle price etc. For the electric vehicle as well, power was specified both in cylinder volume "cc" and in horsepower. The engine power in HP and corresponding engine capacity in cc are estimated and included for a direct comparison between the two vehicle types. Upon raising the consumer awareness by presenting this information, around half of the consumers who have no predisposition towards EVs are likely to switch over to electric vehicles. This ratio is as high as 80% among those consumers with a predisposition towards EVs. This shows the importance of consumer awareness about electric vehicles, when considering a vehicle purchase.

One good way to raise consumer awareness would be to provide a very basic and simple statistic on the savings that can be achieved per day by switching over to electric vehicles. For instance providing information by putting things into perspective like "Pay less than bus fare when you travel in an electric car", or "A ride to airport will only cost you only ₹30/- when you ride in an electric car" etc. will be much more impactful and create awareness than trying to explain concepts like Total Cost of Ownership etc. to the consumers. Some examples of this being practiced in the real world are shown in Figure 5-20.

Figure 5-20 Raising awareness by putting things in perspective

Further the consumer is presented with two hypothetical scenarios. In Scenario 1, the consumer is presented with a scenario with better supporting infrastructure for electric vehicles. In Scenario 2, the consumer is presented with a better price value proposition for electric vehicles in addition to the better supporting infrastructure presented in Scenario 1. Representative flash cards for these two scenarios are shown in Figure 5-21 & Figure 5-22 respectively for reference.

Scenario #1

Fuel	**Conventional**	**Electric**
Infrastructure	None	No parking fees Priority Parking
Congestion	None	Priority driving lanes
Tolls	As usual	No Tolls
Public Transport	None	Free pass to use public transport
Charging infrastructure	N/A	Setup Quick Charging point at home

Figure 5-21 Better supporting infrasctructure for EVs (Scenario 1)

The better support infrastructure scenario offers a few perks to EV owners like charging points on arterial roads and public locations such as metro stations, malls and parking lots, free parking, priority driving lanes, exemption from tolls, free pass to use public transport etc. There are no direct monetary rewards but time and money savings as a result of preferential treatment offered to EVs. The second scenario offers direct monetary rewards to the owner by offering low cost financing, exemption on road tax and lower taxation rate compared to conventional vehicles. In addition to that, owners are also offered Income tax benefits. This reduces the Total Cost of Ownership (TCO) for EVs while the TCO for conventional vehicles remains the same as BAU scenario.

Scenario #2
4 Wheeler - Hatchback

Fuel	**Conventional**	**Electric**
Financing (10 yrs)	Regular rate @ 8%	Low rate @ 5%
GST	29%	12%
Road Tax	12%	No Road tax
Revised vehicle price	13.4 L	17.12 L
Revised Ownership cost	20.64/km	17.78/km
Income Tax benefits	None	Yes (up to 25000)

Figure 5-22 Better price-value proposition in addition to support infrastructure (Scenario 2)

Figure 5-23 & Figure 5-24 summarize the propensity of consumers to switch over to EVs when offered with just better infrastructure only (Scenario 1), and when offered both better infrastructure and price value proposition (Scenario 2). It can be seen from Figure 5-24 that consumers who had no intention of purchasing any vehicle regardless of whether it was ICE or EV, upon being furnished with more information about EVs offered

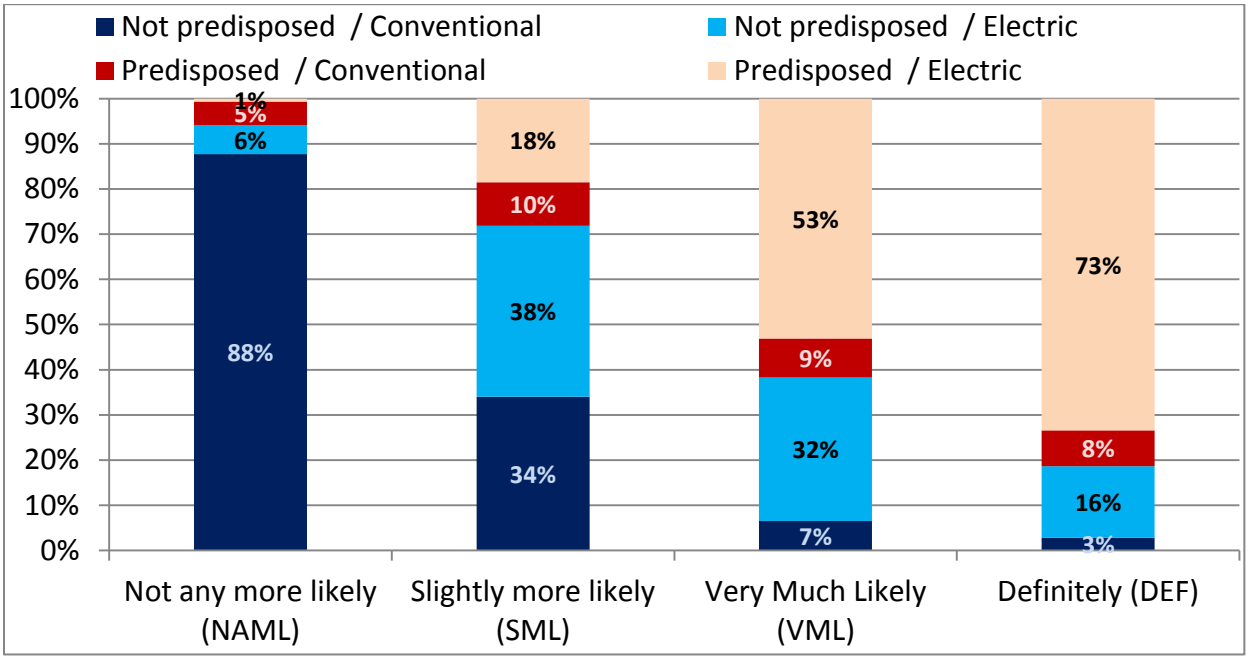


Figure 5-23 Consumer propensity to purchase EV when presented with Scenario 1

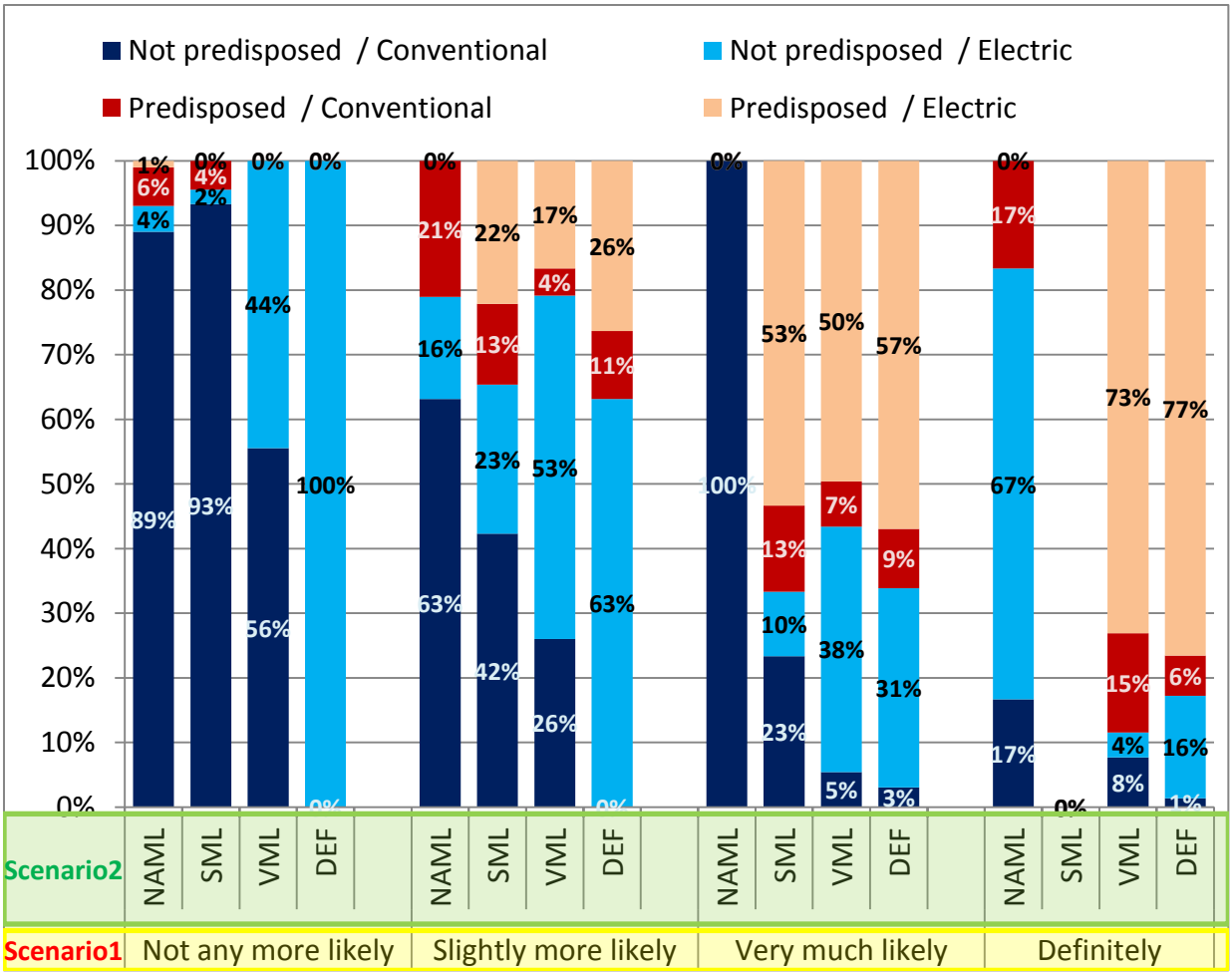


Figure 5-24 Consumer propensity to purchase EV when presented with Scenario 1 & 2

"We have the unique position of having years of experience of the Indian market as well as over 265 million kms (164 million miles) driven on our EVs."
Mahesh Babu, CEO, Mahindra Electric

6 Policy and Regulatory frameworks for EVs in India

The Union Government recently announced that the nation will completely switch over from internal combustion engine vehicles (ICEV) to electric vehicles (EV) from 2030. The current National Electric Mobility Mission Plan (NEMMP) has set a sales target of only 5-7 million EVs and hybrid electric vehicles annually by 2020. On the other hand, the Indian automobile market, which includes two-, three- and four-wheelers, is expected to clock an annual sales figure of around 23 million by 2030. Ramping up at such a scale can only be done when the government sets a good long term vision and backs it up with industry friendly policy and regulatory frameworks.

Considering the current adoption rates for EV, a switch over to EVs would not only require a significant push from the government both in terms of policy and regulatory environment, but also would need to localize the supply chain, and enhance domestic capacities for product and technology development for BEVs. Figure 6-1 shows the policymaking and technology commercialization interlink that needs to be created for a sustained advancement of the industry.

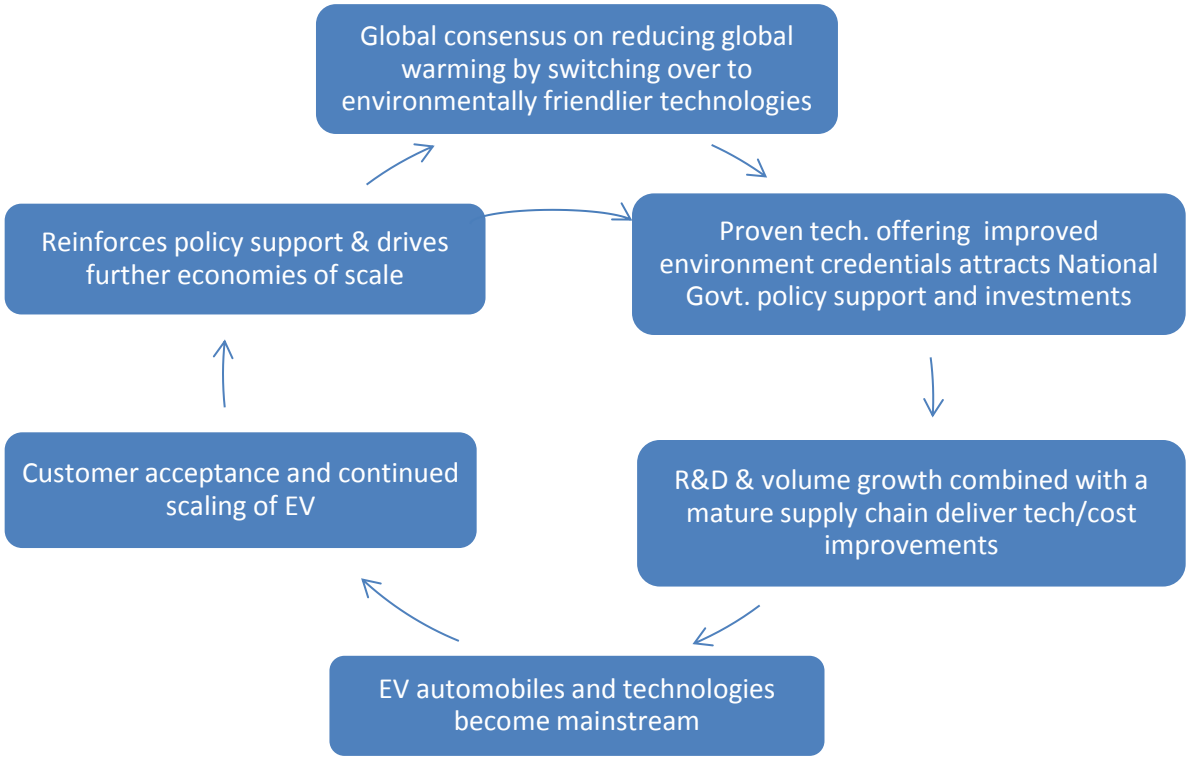


Figure 6-1 Policymaking and technology commercialization interlink

The Department of Heavy Industry (DHI) is the nodal department of GOI for the automotive sector and has taken a number of initiatives aimed at accelerating the growth and development of Indian automotive industry. It is also entrusted to develop a 10 year roadmap for automotive industry i.e Automotive Mission Plan (AMP). The AMP is the collective vision of Government of India (Government) and the Indian Automotive Industry on where the motor vehicles, auto components, and tractor industries should reach over the next ten years in terms of size, contribution to India's development, global footprint, technological maturity, competitiveness,

and institutional structure and capabilities. The first decadal AMP was published for 2006-2016 and was followed by the second AMP 2016-2026.

AMP 2026 seeks to define the trajectory of evolution of the automotive ecosystem in India including the glide path of specific regulations and policies that govern research, design, technology, testing, manufacturing, import/ export, sale, use, repair, and recycling of automotive vehicles, components and services [13]. But AMP2026 does not focus on EVs and does not have any provisions for the electric vehicle industry as AMP has a broader mandate for improving auto industry in general.

Though commendable initiatives have been taken by GOI since 2010, the policy framework for EVs is still evolving. Among the primary factors that influenced government into proactively developing policies are:

- Fast dwindling petroleum resources
- High current account deficit owing to huge oil import bill
- Environmental considerations, climate change
- Worldwide shift to more efficient drive technologies and fuel efficient systems

This require a paradigm shift from the current petroleum based mobility towards more efficient and cleaner alternates such as electric vehicles, hybrids, fuel cell vehicles etc., which have a lower per km energy consumption. However the high cost of technology, cost conscious consumer mind set and almost non-existent government support were major impediments towards such transformation. In order to catalyse such change and create a sustainable framework, the then Indian government in 2011 initiated National Mission on Electric Mobility (NMEM), and cleared the proposals setting up of a National Board for Electric Mobility (NBEM) and National Council for Electric Mobility (NCEM). [14]

6.1 NMEM and NEMMP

The objective of NMEM the program was to overcome above barriers through a collaborated approach between different stakeholders, providing necessary government support and effecting the entire transformation under a mission mode approach. Earlier in April 2017, a 6 member NBEM board was constituted. This board will examine, formulate and propose short and long-term plans and contours of the mission programme on electric mobility, and roles and responsibilities of the various stakeholders. The mandate of NBEM is to improve communication between government and industry and to resolve difference of opinion, if any, among various ministries. It will examine, recommend, monitor and review electric mobility related R&D projects and pilot projects and also evaluate and propose business models for popularising electric mobility.

Under the *National Mission on Electric Mobility,* a plan was set up to ensure saving on transportation fuel in coming years through initiation of *National Electric Mobility Mission Plan 2013 (NEMMP).* The plan calls for achieving 6-7 million electric/hybrid vehicles in India by the year 2020 along with milestones for indigenisation of technology, thereby ensuring India's global leadership in electric mobility segment. A total cumulative outlay of about Rs.14,000 Crore has been planned during the span of the scheme, including contribution from the Industry.

In addition the NEMMP 2013 also calls for

1. Demand side incentives to facilitate adoption of hybrid/electric vehicles which was later accelerated through Faster Adoption of Hybrid and Electric Vehicles in India (FAME) scheme
2. Promoting R&D in technologies such as battery technology, power electronics, motors, systems integration, battery management system, testing infrastructure through participation of industry, academia and all other stakeholders to promote indigenisation and achieving technology breakthrough for cost reduction
3. Promoting charging infrastructure to instil consumer confidence thereby creating necessary infrastructure
4. Supply side incentives
5. Encouraging retro-fitment of on-road vehicles with hybrid kit

6.2 FAME: Faster Adoption and Manufacturing of Hybrid and Electric Vehicle in India

In order to create a sustainable ecosystem for adoption of Hybrid/Electric cars and their Manufacturing, Indian government identified four areas where necessary financial push shall be provided by the government through initiation of FAME scheme. These four areas are technology development, charging infrastructure, pilot projects and demand creation. A total outlay of 795 crores has been planned with flexibility of distribution of these funds among the four identified areas for the period 2015-2017 with further allocation to be decided on the basis of learnings and outcomes in this period. Such funds are available to users/ stakeholders in smart cities notified by Indian Government under the smart city mission, North eastern states, state capitals and cities with a million+ Population, and Metros of NCR Delhi, Ahmedabad, Chennai, Bangalore, Kolkata, Greater Mumbai and Hyderabad. Department of Heavy Industries (DHI) under Ministry of Heavy Industries & Public Enterprises, Government of India (GOI) has been entrusted with the responsibility for successful implementation of this scheme and allocation of funds between different focus areas with National Board for Electric Mobility and Department council for Auto and Allied Industry overseeing the scheme. Several Pilot projects such as development of public charging infrastructure, development of new battery technologies, testing infrastructure for certification of electric vehicles, sponsoring electric buses for various cities etc. have been initiated under the scheme through an implementation and sanctioning committee. [15]

Under the demand creation, a demand side incentive scheme was introduced wherein Government of India shall reimburse the automakers the discount that the auto makers will pass on to the end customers. This would not only encourage and provide initial sale push but also help manufacturers achieve scale and develop interest in the segment. This Six year scheme was introduced in two phases - Phase I (Apr'15- Till Sep'17) and Phase II (Oct'17 till 2020 - based on learning and outcomes of Phase I) and provides different level of incentives for all vehicle of XEV family (Mild Hybrid, Strong Hybrid, Plug in Hybrid Vehicle and Pure Electric Vehicle). Such incentive levels are based on kind of vehicle, technology made and use.
Further the demand incentive has been proposed at two Levels , Level I and II with Level II qualifying targets at 50% higher than Level I in terms of fuel saving potential and Level II incentive being at 120% of Level I.

Regulatory Perspective: Ministry of Road Transport and Highways (MORTH) is the nodal body for regulatory framework of EVs plying on roads. Various regulations have been introduced and

suitably modified from time to time based on the learning and outcomes of such regulations. While the major focus area for regulations till date has been retro-fitment with electric /Hybrid Kit, E rickshaws and Ecarts, upcoming regulations are expected to deal with mobility as whole with a vision of shared, connected and electric mobility at its core. A snapshot of all the different regulations pertaining to EVs along with timelines has been detailed in Table 6-1.

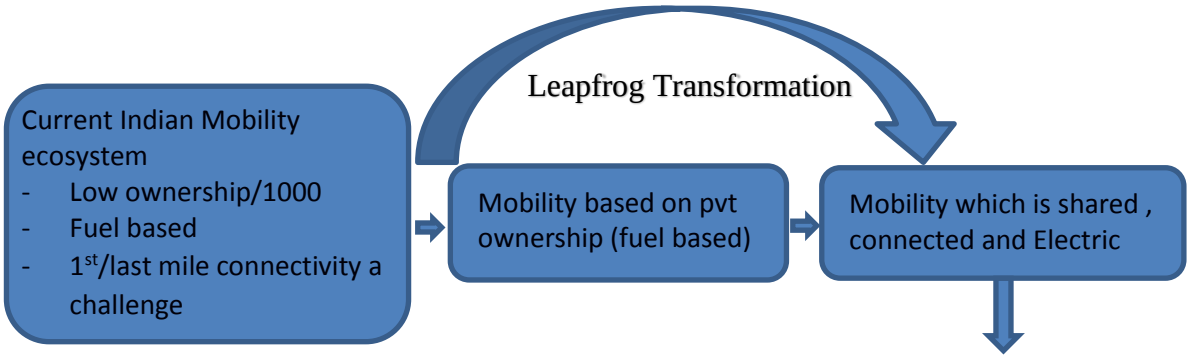
Year	Notification	Brief
Apr'14	Central Motor Vehicles (5th Amendment) Rules, 2014.	Two wheeled battery operated Vehicle meeting minimum conditions cease to be considered Motor Vehicle if (i) thirty minute power consumption less than 0.25 kW; (ii) maximum speed of the vehicle is less than 25 km/hr; (iii) Weight < 60 Kg
May'14	Central Motor Vehicles (8th Amendment) Rules, 2014	Retro fitment of hybrid electric system kit to in-use vehicles. the vehicle to be retrofitted must (i) conforms to Bharat Stage-II or subsequent emission norms (ii) belongs to category MI or category M2 or category N1 with Gross Vehicle Weight not exceeding 3500 kg (iii) fuelled by either gasoline or diesel fuel (iv) not retrofitted earlier (v) will not be fuelled by any other alternate fuel
Oct'14	Central Motor Vehicles (16th Amendment) Rules, 2014	(i) E rickshaw and Ecart defined and recognised under CMV rules (ii) E rickshaw and Ecart defined to provide first and last mile connectivity of passenger and luggage respectively. (iii) Load Limit : 4 passenger and One driver with 40 KG Luggage Limit for E rickshaw and One driver and 310 Kg limit for E cart (iv) Power consumption less than 2 KW with speed limit of 25 Km/Hr. (v) Driving License for E-rickshaws to be issued with validity of 3 years. The rules also call for permit of E-rickshaw/e cart on specific route /area only (vi) Size specification of E rickshaw Issued
Jan'15	Central Motor Vehicles (1st Amendment) Rules, 2015	*Regulation w.r.t to training of e rickshaw/ Cart driver :* Minimum 10 days of training mandatory with certification from e rickshaw/ Cart association or manufacturer
Mar'15	Department of heavy Industries	FAME scheme initiated (Phase –I)
Apr'15	Central Motor Vehicles (13th Amendment) Rules, 2015	Type approval for Hybrid EV : AIS 102-2009 AIS 102-2010 standards to be used
Jun'16	Central Motor Vehicles (7th Amendment) Rules, 2016	Further amendment to Retro fitment of Hybrid Electric system kit to include vehicles with GVW exceeding 3500 Kg subj to following conditions (i) conforms to Bharat Stage-II or subsequent emission norms; (ii) category M & N not retrofitted earlier;

		(iii) not provided with permits for carrying dangerous or hazardous good; AND conversion of vehicles for pure electric operation with fitment of electric kit if- (i) belongs to category L5 , M ,N1 or N2; (ii) manufactured on or after 1st Jan'90 (iii) not provided with permits for carrying dangerous or hazardous good,
Aug'16	Order dated 30th Aug'16	No permit needed for E-rickshaw and E cart and can ply freely. However the state governments may impose restrictions under appropriate traffic laws on plying of these vehicles in specific areas or specific routes.
Nov'16	FAME scheme	FAME scheme extended till Sep'17 with exception of Mild Hybrid EV
May'17	NITI Aayog	Vision Paper on Mobility transformation Issued

Table 6-1 Summary of regulations pertaining to EVs along with implementation timeline

6.3 NITI Aayog- Vision Paper on Mobility transformation

Indian think tank, Niti Aayog along with Rocky Mountain Institute, USA has come up with a mobility transformation concept in May 2017, wherein India intends to leapfrog from private ownership and fuel based mobility to a new mobility paradigm which is shared, connected and electric. The roadmap of such transformation from ownership based approach to usership based approach is proposed through a three phase activities of system integration achieved through mobility as a service and interoperable transport data, scaled manufacturing achieved through new products and technology and Electric Vehicle deployment and shared infrastructure development through Mobility oriented development an vehicle grid integration. The details are shown in Table 6-2. Further such transformation is expected to be achieved in three phases spread over a period of 15 years from 2017 to 2032. Various activities and agendas for these three phases is given in the Table 6-3



Governance	Infrastructure	Policy and Incentive	Business models	Data accessibility
To achieve Coordination	To achieve shared	To achieve accelerated adoption of	To achieve cost reduction for manufacturers	To achieve system integration

among stakeholders	Infrastructure development	new mobility paradigm		
Steps proposed				
a. Metropolitan Planning Authority b. Incubation centres	a. Integrated Transport Hub b. Vehicle Grid Integration c. Electric Vehicle charging stations	a. Freebates b. Zero emission vehicle credits c. Mobility as a service encouragement d. Fiscal and non-fiscal incentives	a. Manufacturing consortium for procurement b. Development of standards c. Bulk procurement of assembly /sub assembly level parts	a. Interoperable transport data b. Standards for sharing such data

Table 6-2 Roadmap proposed by Niti Aayog for transitioning from ownership based approach to usership based approach

Phase I 2017 -2019	Phase II (2020-2024)	Phase III (2025-2032)
• Implementing phase for Solutions which are already economic and scalable and cultivating solutions for phase II which are nearly economic. • Lighthouse (test) cases to be taken up	• Implementing solutions cultivated in Phase I • Ground work by private and public sector for future and complete mobility • Lighthouse (test) cases to be taken up	• All spectrum of mobility implemented based on learning from previous phases and lighthouse cases
Focus: on Projects and States	**Focus:** on States and region	**Focus:** on entire nation as whole
Major activities		
• Compile and share data • Refine existing policies and incentives and suggest new policies • Create Infra to support EV • Mobility oriented development and Modal Integration	• Develop more policies and create shift from Government led to market led development • Integrate Modes and region • Increase domestic supply and improve supply chain management	• Phase out subsidy

Table 6-3 Phase wise implementation details

The central government on its part is leaving no leaving anything to chance in underscoring its intention to move to EVs. As a number of government departments such as Ministry of Power, Ministry of New and Renewable Energy, Ministry of Road Transport and Highways, Ministry of Heavy Industries and Public Enterprises etc. are responsible for anchoring the transition from

conventional to electric mobility, GOI has shifted the electric vehicles programme from the Department of Heavy Industries (DHI) to government's premier think tank Niti Aayog. This move is expected to help synchronise efforts of the different departments of the government to move the nation towards electric mobility by 2030. [16]

On August 17th 2017, the Ministry of Power,GOI, through its Energy Efficiency Services Limited (EESL) has launched a global bid for 10,000 electric cars for use by Union ministers and senior bureaucrats, and for 4,000 public charging stations for the city of Delhi. The government hopes that this will give a fillip to the EV industry in India and will provide confidence to the corporates who can in turn bring in much required investments. This will also address the concerns raised by few organizations about the low demand for EVs in India.

The government recently also launched Technology Platform for Electric Mobility (TPEM) – a joint initiative of the departments of heavy industry (DHI) and science and technology (DST), which aims to make the hybrid and electric vehicle market in India self-sustaining by increasing domestic capacities for product and technology development. The government will bear up to 60% of the research and development (R&D) cost for developing indigenous low-cost electric technology with the remaining amount expected to be contributed by user-industry partners (vehicle and component manufacturers) in kind and by resources, providing labs and facilities for the research. [17]

At the Telangana state level, the department overseeing automobile industry is the Department of Industries and Commerce. The department works on developing policy frameworks, attracting new investments, identifying opportunities for setting up industries, utilizing IT in various government processes, and promoting digital empowerment of the citizens. They are working along with different public partners such as Telangana State Road Transport Corporation (TSRTC), Telangana State Renewable Energy Development Corporation Ltd., (TSREDCO), Hyderabad Metro Rail Limited (HMRL), Greater Hyderabad Municipal Corporation (GHMC), and private partners such as cab aggregation companies like Ola, Uber and other start-up companies to promote EVs and to provide infrastructure to support EVs. Though state level policies are being developed for Production and sale of EVs, promoting low carbon transport, recycling of batteries etc., the state is currently well aligned with DHI, Niti Aayog and GOI in putting together the same. Once the central government policies are framed (based on the Niti Aayog report on EVs that comes out in Nov-Dec'17), state level policies will be put in place.

In the meantime, the Telangana state government is keen on taking Public Private Partnership (PPP) route to fund infrastructure development projects and for other state initiated projects such as electric buses etc. introducing EVs. The following stake holders have been identified for promoting of EV technologies by the state government.

- Power Generation and distribution companies
- State run and Private Infrastructure players
- Vehicle manufacturers
- Component Manufacturers
- Vehicle Aggregators
- Town Planners
- State Run Transport corporations

7 Perspective on Taxes and Duties

In India, the basic customs duty is at 125% for Completely Builtup Unit (CBU) i.e if a completely built electric car is imported. It is 30% for Semi Knocked Down (SKD) units i.e if only assembled components are imported, and it is a mere 10% for most of the critical EV components that are imported in Completely Knocked Down (CKD) condition and most of the value addition is done in India. Customs duties on some of the critical components are given below. A closer look at Table 7-1 reveals that though the basic customs duty is the same, there are other components like IGST and Special Compensation cess, which can significantly alter the taxation on EVs and their components. If the EV is manufactured in India, then the GST levy will provide a colossal incentive for electric cars as they are taxed at 12%, when compared with 43% on hybrids.

		CBU		**Components**		
		Battery Electric Vehicle for transport of passengers	**Plug in Hybrid Electric Vehicle**	**Lithium Ion Accumulator**	**3F AC Induction Motor**	**DC Electric Motor**
	Customs Tariff Head (CTH)	*87038030*	*87037030*	*85076000*	*85015210*	*85013210*
		Rate of Duty (%)				
Customs Duty Head	Basic Customs	125	125	10	10	10
	Education Cess	2	2	2	2	2
	Secondary and Higher Edu. Cess	1	1	1	1	1
	Countervailing Duty	0	0	0	0	0
	Anti-dumping duty	0	0	0	0	0
	IGST Levy	28	28	28	18	18
	Compensation Cess	15	15	0	0	0
	TOTAL DUTY	**171**	**171**	**41**	**31**	**31**

Table 7-1 Customs duties on common EV components and EVs

Table 7-2 provides a snapshot of basic import duties on conventional vehicles. It is interesting to note that in general the basic customs duties on ICEV are lower than BEV. India is well positioned in terms of ICEV technology, supply chain is mature, and ICEV manufacturing costs in India are low, there is little need for a protection for this segment. On the other hand, considering that manufacturing technology for EVs is not available indigenously, especially for battery and electronic controllers, a lower duty would help drive down the cost in the short term which will immensely benefit the industry.

Criteria / Applicability	Basic import Duty in %
Used car import	125
Cars CBUs whose CIF value is more than $ 40,000 or Petrol Engine > 3000 CC or Diesel engine > 2500 CC	100
Cars CBUs whose CIF value is less than $ 40,000 and Petrol Engine < 3000 CC and Diesel engine < 2500 CC	60
Two-wheeler CBUs with engine capacity <800 cc	60
Two-wheeler CBUs with engine capacity >=800 cc	75
Commercial Vehicle CBUs (Trucks & Buses)	20
CKD containing engine or gearbox or transmission mechanism in pre-assembled form but **not mounted** on a chassis or a body assembly	30
CKD containing engine, gearbox and transmission mechanism not in a pre-assembled condition	10

Table 7-2 Import duties on conventional vehicles and components [18]

In addition to the import duties, there are other clauses such as minimum local sourcing restriction that in most cases does not apply to EV manufacturers, but has nevertheless been highlighted as a cause of concern by otherwise well informed MNC's like Tesla and Mercedes-Benz, and the US government as well. This begs the question as to whether or not the government policies are clear on their scope and latitude when it comes to FDI and Imports. [19]

> *"Maybe I'm misinformed, but I was told that 30% of parts must be locally sourced and the supply doesn't yet exist in India to support that"*
>
> *Elon Musk, CEO, Tesla*

8 Market updates and media roundup

The automotive industry has been going through a lot of churn globally as many of the leading automotive markets have announced their countdown to switch over to electric mobility, or as in the case of Norway, have already embarked in a significant way that direction. France and UK have announced that they will be banning all petrol and diesel cars by year 2040. Germany has announced that they will have 1 million electric cars by 2020, up from 100,000 electric cars as of August 2017. China has committed to a quota of 8% Alternate Energy Vehicles from 2018, 10% from 2019 and 12% from 2020, and at least 20% its projected annual vehicle sale of 35 mn vehicles would use alternate energy by 2025. India has been among the most aggressive and has set itself an ambitious target to completely switch over to electric vehicles by 2032 a full decade ahead of more industrialized nations [20]. This would still mean a very steep ramp up 2,000 electric cars in year 2016 to selling 10 million electric cars in year 2030.

Automakers have been quick to respond to the aspirations of the regions and some of them have made significant adjustments to their planned product mix and electric vehicle offering. Arguably the steepest course correction has been made by the Swedish car manufacturer Volvo, which announced that it will be dumping petrol-fuelled cars starting in 2019. Compare this to the announcement made in 2016 by Volvo about a 1mn cumulative EV sale by 2025. Ford, which was relying on its lone horse "Ford Focus EV" from 2011 till date, has announced in January 2017 that it would introduce 13 new EV models by 2020. [21] German auto maker BMW has announced launch of 4 new EV models between 2018 and 2020, and expects up to 25% of sales from EV by 2025, up from 4% in 2017. [22] Luxury car maker Porsche has promised that half of its new vehicles will be electric by 2023. But there are significant regional differences as well. The Big 3 have in general followed the wait and watch approach, the German automakers are warming up to EV's, the Japanese and Korean automakers are getting serious about BEV, and reluctantly slowing down development of Fuel cell technology, while the Chinese automakers are lapping up the enormous opportunity presented by their home market, which is also the biggest auto market in the world.

> *"Before I start pushing EVs, I have to make sure they give him the value that they should give to him, which is what a customer expects from Maruti . Unless the EV is good for the customer, I can't push him to buy it,"*
>
> *RC Bhargava, Chariman, Maruti Suzuki, Interview with ET*

Table 2 • List of OEMs announcements on electric car ambitions, as of April 2017

OEM	Announcement	Source
BMW	0.1 million electric car sales in 2017 and 15-25% of the BMW group's sales by 2025	Lambert (2017b)
Chevrolet (GM)	30 thousand annual electric car sales by 2017	Loveday (2016)
Chinese OEMs	4.52 million annual electric car sales by 2020	CNEV(2017)
Daimler	0.1 million annual electric car sales by 2020	Daimler (2016a)
Ford	13 new EV models by 2020	Ford (2017)
Honda	Two-thirds of the 2030 sales to be electrified vehicles (including hybrids, PHEVs, BEVs and FCEVs)	Honda (2016)
Renault-Nissan	1.5 million cumulative sales of electric cars by 2020	Cobb (2015b)
Tesla	0.5 million annual electric car sales by 2018 1 million annual electric car sales by 2020	Goliya and Sage (2016), Tesla (2017a)
Volkswagen	2-3 million annual electric car sales by 2025	Volkswagen (2016)
Volvo	1 million cumulative electric car sales by 2025	Volvo (2016)

Note: Chinese OEMs include BYD, BJEV-BAIC Changzhou factory, BJEV-BAIC Qingdao factory, JAC Motors, SAIC Motor, Great Wall Motor, GEELY Auto Yiwu factory, GEELY Auto Hangzhou factory, GEELY Auto Nanchong factory, Chery New Energy, Changan Automobile, GAC Group, Jiangling Motors, Lifan Auto, MIN AN Auto, Wanxiang Group, YUDO Auto, Chongqing Sokon Industrial Group, ZTE, National Electric Vehicle, LeSEE, NextEV, Chehejia, SINGULATO Motors, Ai Chi Yi Wei and WM Motor.

Sources are indicated in the table.

Key point: By April 2017, nine global OEMs had publicly announced their willingness to create or significantly widen their electric model offer over the next five to ten years. Several Chinese OEMs also announced very significant electric car production capacity scale-up plans.

Figure 8-1 Details of EV plan announcements by major global auto makers

There has been a flurry of action in India as well ever since the government announced its ambition to convert to 100% electric mobility by 2030. India's largest auto maker Maruti has been sceptical of the government's plan for 100% electric vehicles saying that technology for pure electric vehicles needs to mature and that hybrid electric vehicles are more practical [23]. Most of the European brands like Volvo, Mercedez-Benz, Audi, BMW have all announced their intention to launch more efficient power trains, alternative drives, plug in hybrids (PHEV) and full electric vehicles in the next 2-5 years. The strategy of most of the auto makers seems to be to launch PHEV's, in order to bridge the gap between their current offerings and full electric vehicles of the future. But with the duties going up very steeply for hybrid vehicles, most of the auto makers are reviewing and revising launch their plans. Table 6-1 shows the

OEM	Announcement	Concern	Source
Volvo	First BEV launch planned globally including India in 2019. Will continue to offer PHEV in the interim.	--	Business World [24]
Mercedez-Benz	Intends to bring EVs into India starting from 2020.	Govt. should encourage both PHEVs and EVs. It is also crucial to achieve a smooth transition to BS VI from BS IV	Economic Times [25]
Renault - Nissan	Pilot run for Nissan leaf to be conducted by end of	EVs require a strong charging infrastructure as, operating range	Economic Times [25]

	2017. No confirmation on commercial launch.	is still a developing parameter and battery costs are still high	
Maruti Suzuki	Already offers mild hybrids in the market. Has been working on PHEV technology and localizing the supply chain, but has not announced any timelines.	Govt. should not alter policies. Companies make investments based on policies and later realize that the policy has been changed without notice.	Business Standard [26]
Tata	Will launch Tata Tiago globally in 2017 and Tata Nano in India in 2018	--	Economic Times [27]
Mahindra	Established player. Offers 2 BEVs cars, 1 BEV mini truck, and 2 micro hybrids as well.	Requests Govt. to be consistent with the subsidies they are giving. Huge investments go into new technology development and need long term stability for recovery.	Economic Times [28]
Hyundai	Dropped plans of launching hybrids next year. Will focus on launching full electric vehicles for India in 2018.	--	Autocar [29]
Toyota	Already offers hybrids in the market.	--	--

Table 8-1 Launch plans of major EV auto manufacturers in India

In April 2017, Suzuki Motors announced a JV with Toshiba and Denso to invest 1200 cr in setting up a Lithium ion battery manufacturing facility in India [30]. Tesla had in February 2017 announced plans to launch its Model 3 in India as early as May-June 2017, and was also available for pre-order but in May, Tesla CEO Elon Musk was quoted saying that he was mis-informed about the duties and regulations in India and has indefinitely delayed the launch. Mercedes-Benz and Tesla had announced their intentions to enter the Indian market, but has also requested the government to offer temporary relief on electric-car imports until local manufacturing is setup and becomes viable. In the meantime, they expect the demand for EVs pickup and the local supply chain to be matured [31]

Unlike the electric 4W industry, the electric 2W industry in India is very fragmented and is dominated by many smaller brands such as Electrotherm, Lohia, Ampere etc. Also most of the electric scooters offered by them do not qualify as a motor vehicle as they have a top speed of 25kmph and are powered by a low power electric motor. It is only recently that the big brands have announced their plans for launching electric 2W. Hero motor is already offering electric vehicles and plans to launch hybrid electric vehicles as early as 2018. TVS motors announced launch of hybrid electric bikes by end of 2017 and pure electric bike by March 2018. Since rural India is a big market for 2W, but has very little supporting infrastructure for charging EV's, TVS believes that there will be a market for hybrids in rural India and pure electrics in cities. With the cost of batteries and other critical components coming down, TVS estimates that the market for EV's would pick up significantly and that 20% of all vehicles sold in India would be

EV's by year 2020 [32]. Table 6-2 offers some more details about the plans of some of the more popular EV 2W makers.

OEM	Announcement	Source
Hero Motors	Offers around 18 e-scooters for 8 years now	Economic Times [33]
Mahindra	Offers GenZe bikes in US. No plans for India.	--
Bajaj	Working on an e-scooter and may introduce by 2020. Will launch a e-auto in 2018	Financial Times [34],
TVS motors	Will launch hybrid bike by end of 2017, and BEV bike by March 2018	Business Standard [32]
Ampere	Already offers e-cycles, e-scooters	--
Ather Energy	Startup planning to launch in 2018	Moneycontrol [35]

Table 8-2 Launch plans of major 2W auto manufacturers in India

A report published in May 2017 by investment bank UBS predicts that cost parity between conventional and electric cars will be reached as early as 2018. Lower cost would increase the demand, which would help the auto makers reduce the manufacturing costs and benefit from economies of scale. The report also predicts that although the costs of EVs and current cars will be the same for consumers by 2018, manufacturers will not reach manufacturing cost parity until 2023, when they will make 5pc margins on EVs - about equal to the profit on current vehicles. [36]

Not just auto makers but even traditional core infrastructure and base metal conglomerate JSW has announced its intention to manufacture EVs, energy storage systems and charging infrastructure. JSW through its group company JSW Energy plans to roll out its first EV by 2020 [33]. Even cab aggregator OLA, which is a portfolio company of Japanese investment gaint Softbank, is being thrusted by its investors into EV manufacturing. Under a pilot project around 200 electric vehicles (including a mix of e-cars, e-buses, e-autos and e-rickshaws) will be purchased from OEM partners and run in the city of Nagpur [37].

> *"Businesses look for stability, they look for direction. You don't need that much more if you're just smelling opportunity. We're not looking for subsidies, we were just saying, 'Tell us that's the track you're going to follow.' If you're going to do that, there's money to be made, there's going to be a return."*
>
> *Anand Mahindra @ Bloomberg Global Business Forum, New York*

9 Conclusion

The automotive industry in India is at a cross roads between continuing on the usual course or taking bold steps and leapfrogging in to the new realm; from personal mobility to shared mobility and from a petroleum based mobility to electric mobility. The first wave of electric vehicles (EV) that were introduced around 2010-11 were two wheelers from little known start-ups, and they failed to create major inroads. There are exceptions like Reva and e-rickshaws, which succeeded in creating a market for electric four wheelers and three wheelers respectively. But lack of clear government policies, lack of vehicle standards and wait and watch attitude of large auto makers meant that Indian EV sales are a mere 0.02% of total auto sales in 2016 [38]. After release of the vision document by Niti Aayog and the ensuing incentives announced by the government, the policy and regulatory environment also seems to be conducive for implementation of electric mobility. The stance of GOI is very clearly in the favour of BEVs. Provided the government is able to generate enough investor confidence, auto majors and would foray into XEV manufacturing, and investments would come knocking on the door into India.

Auto Industry Perspective: The auto industry in India has been taken by surprise by the governments sudden thrust towards EVs. Barring Mahindra Electric Mobility Limited, which already has two BEVs in its stable, most of the other domestic and international auto majors were planning on launching micro hybrids, medium and heavy hybrids and PHEVs in phases starting from 2018 – 2020. With the withdrawal of FAME incentives and increase in tax rate post GST, most of the auto makers have called off fresh hybrid vehicle launches. Despite the presence of alternate mobility technologies, there is little doubt among auto makers that EV is the future of mobility. The auto makers have returned to the drawing board and are busy preparing a line-up of BEVs localized for the Indian market. Technology alliances have been announced between Indian and foreign companies, and India is on the radar for upcoming global launches by German, Japanese, US and Korean auto majors.

What the industry expects from the government is to stay consistent with policies that have already been announced (subsidies, taxation etc.) as huge investments go into new technology development and companies need long term stability to recover these investments. They also would like government to participate in putting charging stations and other infrastructure building required to prepare the nation for EV wave.

Consumer Perspective: Our study shows that consumer awareness about EVs and about government schemes/policies related to EVs is very poor. This points to poor marketing on part of the auto industry and lack of awareness campaigns etc. on part of government. Despite that, there is a lot of consumer interest in EVs, and if educated properly, clearly expressed preference towards EV. A study of travel patterns reveals that most of the consumers use their private transport to travel to work. Also 90% of the consumers travel under 60km every day and spend 3 hours on the road. The range expectations for 90% of the consumers for 2W and 4W are 200 km and 400km respectively. This expected range for EVs is beyond what most of the EVs in the market can presently deliver, but going by the technology trajectory, it will certainly be possible in the next 5 years. 75% of the consumers are willing to wait up to 15 mins at public charging station for a booster charge that will give a range extension by 40 km.

Most of the customers still see BEVs only as their second vehicle meant for limited range travel within the city, in other words for regular commute to work. According to them the primary barriers to large scale adoption of EVs are lack of charging infrastructure, high initial cost of the vehicle and low driving range. As long as initial costs are comparable, most of the consumers are willing to take technical and operational risks associated with EVs.

Policy: Ideally speaking it would be best to create a level playing field and let the market decide the winning product/technology. That is the best strategy, as it means producing a great car, not a compliant one. But that approach would take a long time and so policy makers are to choose from among the tools available to them like purchase subsidies, measures supporting Electric Vehicle and component manufacturers, fuel economy standards and Zero Emission Vehicle (ZEV) mandates. Heavy subsidies distort the market, create compliance cars and cost tax payers money. A better option would be to have a high carbon tax on gas guzzlers, and use that fund to accelerate the development of technologies. But such a policy would be difficult to implement and may have many leakages without adequate cross checks. The government must also focus on regulations for disposal and recycling of batteries and standardization of charging infrastructure and other key components EVs for the safety of owners. In the case of e-rickshaws

- The roads for plying slow moving vehicles like e-rickshaws needs to be defined
- E-rickshaw makers need to be certified
- Standards need to be framed to prevent fragile structure, which has been found to be a major cause of concern for road safety

Infrastructure: The consumer survey ranks need proper support infrastructure as the most important criteria impacting purchase decision, followed by initial cost. Consumers view setup of charging infrastructure to be responsibility of the government, while government prioritizes projects that are in larger interest of the masses. So there must be enough EV plying on streets for government to make setup of charging infrastructure priority.

Going by the charging preferences mentioned by the consumers, charging stations just provide reassurance to intra city travellers who prefer charging at home only and not in public charging stations. Charging stations are mainly required on highways so as to enable inter city travel using EVs. Location and security of these charging stations will be very critical on highways since at 4 - 8 lakhs a piece, quick charging stations are expensive capital equipment and could be easily vandalized unless properly secured.

Local urban bodies must also work on identifying prime locations and make them available for setting up charging stations as real estate is very limited and expensive in prime areas.

Training: The Government should make efforts to introduce electrical concepts related to EVs in traditional automotive courses at Industrial Training Institutes (ITI) such as Mechanical Engineering and Automotive Engineering. This will help prepare these students for their eventual careers in a new realm dominated by EVs. In parallel, automotive sector skill council i.e Automotive Skills Development Council (ASDC) should come up with courses to re-skill existing work force and recognize prior informal learning, thereby allowing transition of service technicians from non-formal to organised job market.

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