



Planning Strategies & policies for provision of Electric Vehicle Charging Infrastructure

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Abstract: Owing to the impacts of climate change and growing environmental, economic, and social restrictions, sustainable development has developed into a strategic priority for cities all over the world. Sustainability is now essential to combating climate and one of the major contributors to climate change is the transportation sector. To address this problem, the Indian government set up a target for electric vehicle fleets in the country by 2030. The goal is very ambitious but difficult to achieve due to the lack of resources, technology, and infrastructure required for EVs. Hence, different policies, charging infrastructure, consumer perception, incentive programs, and local manufacturing for affordability and availability will have to be provided to create an ecosystem for electric vehicles in India. The paper gives an overview of current e-mobility trends, practices, and challenges, policy Interventions required to encourage the growth of sustainable e-mobility in India.

Keywords - E-mobility, need, challenges, policy interventions.

I. INTRODUCTION

The transition towards electric mobility is closely related to the rising global population. As the population continues to grow, especially in urban areas, the demand for transportation is increasing making it a significant trend where normal fuel-based vehicles are being replaced by electric vehicles. This shift is driven majorly by environmental effects, sustainability, technological aspects, government policies, and consumer attitudes. Rapid urbanization, economic growth, rising household income, and segregated urban planning contributed to the need for mobility and increased the travel demand at a very high rate (Joshi, Joseph, & Chandran, 2016). The transport sector in India consumes nearly 16.9% of total energy from coal, diesel, petroleum (gasoline), and electricity as per the Bureau of Energy Emergency, which accounts for 80% of total emissions, including 60% of greenhouse gas emissions only from vehicles (TEDDY, 2006, Patankar, 1991). At present, with most of the fuel-based vehicles in India, the situation is getting worse. Hence, the government decided to adopt green mobility producing less or zero emissions in the country. This is a big step for the country as the government has targeted to shift towards electric vehicles by the end of 2030.

II. RESEARCH OBJECTIVE & METHODOLOGY

The research conducted is exploratory aiming to investigate the transition towards electric mobility in India. Using the comprehensive approach, the study will assess the current trends, practices, need, challenges and policy interventions.

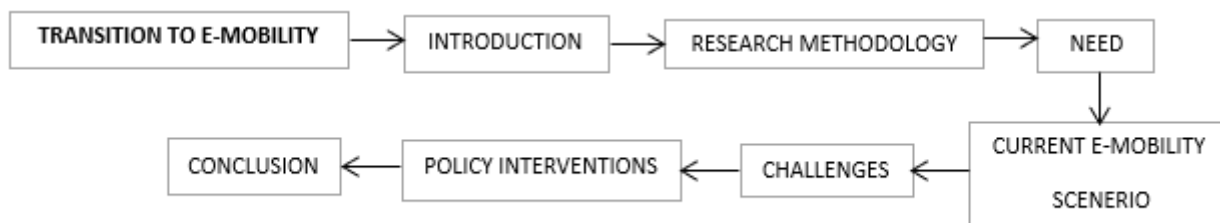


Fig 1. Flowchart for the research

III. NEED TO IMPLEMENT EV CHARGING INFRASTRUCTURE IN INDIA

3.1 Reduction in Greenhouse Gas Emissions

According to IQAir's "Global Air Quality" research, India is the eighth most polluted country in the world in 2022, down from fifth in 2017. It is dominating in PM2.5 emissions globally and provides a home to 22 out of 30 most polluted cities in the world (World Bank, 2022). Here cars and two-wheelers generate nearly 11.5% and 77.7% of the total transport-related air pollution.

| RANK | CITY | ANNUAL PM 2.5 |
|------|-------------|---------------|
| 1. | Delhi | 99.7 |
| 2. | Faridabad | 95.6 |
| 3. | Ghaziabad | 91.3 |
| 4. | Patna | 90.9 |
| 5. | Muzaffarpur | 86.9 |

Table 1. major polluted cities in india

The majority of GHG emissions in India are from the energy and transportation sectors, and can therefore be reduced by the shift towards electric mobility. In addition to having no tailpipe emissions, Over their lifetime, electric cars produce 52% less GHG emissions than gas cars, and electric trucks produce 57% less than gas trucks (Kelly shin, 2023)

3.2 Increased Use of Renewable Energy

In 2016, with only 0.3% of the oil reserves in the country, India consumed 4.8% of the crude oil and became the world's third largest oil consumer (Srikanth, 2018). This consumption is likely to grow to 8.7 million barrels per day by 2040 according to Energy Outlook 2021 by the International Energy Agency due to an increase in population and vehicle dependency (Agency, 2021). In order to reduce dependence on fossil fuels and oil imports, india is steadily adding renewable energy to its overall power consumption. Increased EV adoption will require more power, which could lead to more renewable energy generation.

3.3 Economic Growth

The shift to EVs and renewable energy sources will reduce India's dependence on oil imports, thereby freeing up money which can be put towards generating more jobs. The resulting increase in demand for EVs and battery manufacturing may also create more job opportunities in this sector.

IV. CURRENT E-MOBILITY SCENERIO IN INDIA

India's EV Market Is on a Rapid Growth Trajectory as India is one of the world's largest markets for two- and three-wheeled vehicles, ranking among the global top five for private cars and commercial vehicles. We Indians normally compare a vehicle based on the mileage and efficiency provided which results in the preference for fuel-based vehicles in the country (Sarode & Sarode, 2020).

The **EV-to-public-charging ratio** in India is 135:1 — the country has 1 charging station for every 135 vehicles. This is very low compared to the global average of 6:20. This gap in India is due to factors like an inadequate power grid, the vastness of the country, the high cost of investment, etc.

5,254 public charging stations are currently operational in India. To meet its 2030 goals, India needs a total of 46,397 stations. Until then, India can complement the existing fast charging infrastructure with slow chargers to meet EV drivers' needs.

In India, 3 agencies are responsible for creating and implementing charging standards involving EVs and their components: the Bureau of Indian Standards (BIS) creates interoperability standards; the Central Electricity Authority creates power grid safety

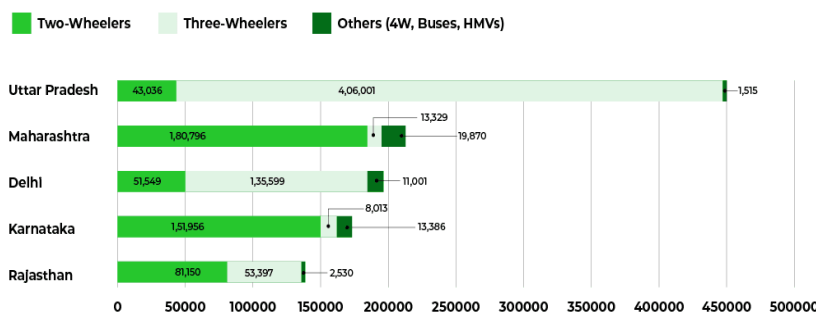


Fig. 2 states with the highest number of registered EVs

standards; and the Automotive Research Association of India (ARAI) creates manufacturing and safety standards, known as AIS-XXX standards.

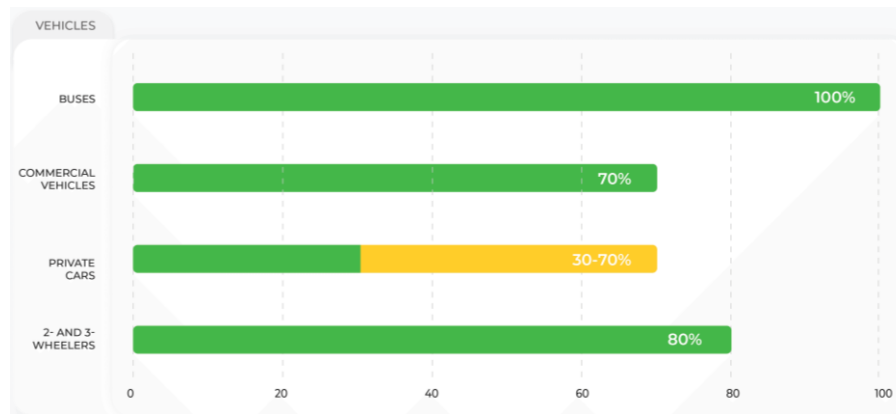


Fig. 3 target EV to standard car mix: india |2030

V. CHALLENGES IN THE IMPLEMENTATION OF E-MOBILITY

These challenges and issues are described briefly as follows-

5.1 Range anxiety: Range anxiety can be considered a major roadblock to EV adoption due to the shorter range causing charging fear for the users. Today Tesla's Model S has the longest range of 370 miles per charge but being expensive and not available in the Indian market we don't have access to it. On the other hand, EVs available in the Indian market do not have a range of more than 500km per charge (Singh, 2021).

5.2 Battery technology: For electric vehicles to be successful in India, where many people drive longer distances, battery technology is essential. Customers experience range anxiety due to the short range of electric vehicles compared to gasoline-powered automobiles. The high price and the long-term performance deterioration of batteries due to harsh temperatures are a point of concern. India cannot currently manufacture modern battery technology domestically as a result there is a greater expense and reliance on foreign nations. In addition, India's supplies of essential raw materials (lithium, cobalt, nickel, and graphite) required for battery production, are restricted. Henceforth, import taxes, a lack of scale in home production, and a lack of technological expertise all contribute to the high cost of batteries.

5.3 Adequate Electricity Supply: As per research 3% of people in India still lack adequate energy supplies, and the architecture of the current power system will not be sufficient to handle the increased load of EV charging. Fast charging stations for EVs consume a lot of electricity, which might put pressure on regional distribution systems. Also, with an increase in the requirement for electricity India might need more fossil fuels to meet the rising demand for energy since it produces 57.7% of its electricity from fossil fuels, primarily coal (49.3%) resulting in more toxic emissions into the environment causing air pollution (Wikipedia, 2023).

5.4 Anti-EV elements: Anti-EV activists supposedly fringe elements hired by oil companies or fossil fuel dealers try to thwart growth of EVs. Amsterdam recently witnessed an anti – EV vandalism case involving damaging of 2 Teslas.

5.5 Land availability: availability of land to set up charging stations in urban areas where land scarcity is present is a difficult task. Moreover, a substation nearby is a requirement for a charging station.

5.6 Regulation and encouragement: For the proper efficiency of this new technology in the Indian market clear rules and regulations are required. The Indian electric mobility market at present needs regulations to ensure safety, reliability, and sustainability in the industry. Along with the development of standards, guidelines as well as clear policies, incentives, and consumer protection for the success of electric mobility in India.

5.7 Consumer perception: the consumer perception of this technology is all that matters. Here many consumers are unaware and under informed about electric automobiles. Due to a lack of reliable information, there are many misconceptions and myths regarding EVs, including ones related to their high purchase prices, short range, battery life, maintenance requirements, and performance.

5.8 Charging infrastructure: The lack of charging stations is a key barrier to the adoption of electric vehicles in India as without infrastructure people cannot travel longer distances. Electric vehicles have a limited range of travel and require charging stations on the community level or the option of charging while driving. And these facilities needed to be spread all over the cities for easy access which is at present missing in Indian cities. Currently, an abundance of fuel stations already exists in the country creating difficulty in establishing charging stations (Sarode & Sarode, 2020). Also, the availability of land at subsidized prices and building a charging station requires a significant amount of money which at the current level of utilization hampers the commercial viability of the business (Bank, 2022). Further, limited demand, high installation cost, lack of clear policies and regulations, and technical and infrastructure challenges are some of the other major reasons for the lack of charging infrastructure.

5.9 Affordability of e-vehicles: As compared to an ICE vehicle, prices for EVs are quite high in India; for example, the minimum price for an electric vehicle is about 1.3 million (13 Lakh INR), which is significantly more expensive than a car that uses

conventional fuel, which is 0.5 million (5 Lakh INR). This is due to the import of lithium used in battery production, accounting for around 50% of the cost of a vehicle (Singh, 2021). With different geopolitical events and shortage of raw materials for battery manufacturing price fluctuation and availability become another point of concern making it difficult to determine the EVs' long-term running cost in the country.

VI. POLICY INTERVENTIONS TO ENCOURAGE GROWTH OF E-MOBILITY

To use electric vehicles on a larger scale and to meet all the targets set by different official bodies it is essential to address all the challenges mentioned above. In the coming future, four transformative low-carbon technologies – LEDs, solar energy, wind energy, and EVs will reconfigure several industries in India in parallel to other tech-driven developments like shale gas or e-commerce (Srikanth, 2018). Although the government is currently working on a variety of plans and initiatives, these are not sufficient to meet the objectives established for 2030. Hence, below are some recommendations that can be adopted in the transition to low-carbon, environmentally friendly, and secure energy future-

6.1 Policies and regulations: The Indian government is currently developing NEMMP and FAME, among other policies and programs, to achieve electric mobility targets by 2030. However, there is the need to work in a more precise manner because these projects and policies do not offer a clear road map for their execution. At this point, the government needs to deliberately focus more on the projects and programs in phases over three to five years. Additionally, each phase's progress needs to be properly tracked, and insights for the next phase should be provided. To be more strategically minded, the Indian government may work on a few pilot projects for some of the most polluted cities (see Table 1), which at least have some fundamental infrastructure, including a steady supply of electricity and a grid distribution system. And these if worked well can be later replicated in other Indian cities.

6.2 Incentives for Encouragement and Promotion: Leading nations in the field of electric mobility have already made a variety of incentives and motives available through various stakeholders to promote electric automobiles. To encourage the usage of EVs among its people, the Indian government must offer incentives for registration and road tax, insurance benefits, free parking, different toll benefits, purchasing subsidies, and land for the construction of public charging facilities for EVs, in addition to enhancements to those that already exist. Currently, the Indian Government has no proposals to support and promote the manufacturers developing Lithium-ion batteries. At least the government should provide some incentives even for a shorter period to encourage the companies to invest in this field so that we can achieve the set 2030 electric mobility goal.

6.3 Provision of electricity in every household through a Grid system: Today the country's 3% of the population barely has any access to electricity, and the other half still suffers from quality and irregularity making it difficult to achieve the desired targets (Agrawal, Mani, Jain, & Ganesan, 2020). The government needs to work parallelly on improving the basic infrastructure requirements of grid-based electricity systems by setting up power plants, the transmission of electricity over high-voltage transmission lines, and distribution of the households and businesses through local networks for the ease of adoption of these vehicles.

6.4 Battery swapping and other charging solutions: Battery swapping technology is the best option for drivers to continue their journey without waiting for their vehicles to recharge, saving a lot of time. However, this technology has not gained much attention due to its high cost and lack of standardized battery sizes. Companies like Tesla have options for battery swapping but this should be made more common for the users for every type of electric vehicle for consumers convenience.

6.5 Affordability of electric vehicles: Today most of the parts for EVs and their batteries are being imported to the country leading to an increase in prices. Separate research organizations should be established and the Indian government must take action to design and construct self-made solar cells and modules. Automakers should be able to build batteries at lower costs developing domestic battery production, and in the long run, the nation may start exporting electric batteries. This may also result in economies of scale, which would increase the number of jobs in this sector across the nation. Therefore, the government should work to increase domestic battery production, which will lower the cost of electric vehicles.

6.6 Research and development: With the need of an hour, the Government of India should focus on research to secure raw materials for the batteries (such as lithium, nickel, and cobalt). Hence, developing research facilities to recycle or reuse Li-ion batteries to reduce the need to import such expensive materials. Different government controlled and private exploration/mining organizations must be directed to explore cobalt and nickel in India (Srikanth, 2018).

6.7 Consumer perception: The Indian government apart from providing different kinds of subsidies or incentives should also conduct workshops and other group activities or spread knowledge through social media platforms to make people more aware of the benefits these vehicles bring with them.

VII. CONCLUSIONS

In the study, an effort is made to understand the need, present conditions, obstacles, and policies required for the adoption and promotion of electric vehicles in the Indian market.

7.1 The implementation of EVs in India majorly aims at reducing greenhouse gas emissions from fossil fuels and cutting oil expenses. The Indian Government's plan to electrify all vehicles by 2030, is going to be a roller coaster ride that will depend on how the entire ecosystem will work and develop from access to electricity, availability of infrastructure, consumers' attitude, market development, growth, and finally how the city and urban planners help in the process to develop policies and norms for it.

7.2 With the ongoing scenario of raw materials for automobiles, decline in fossil resources, and increase in fuel prices, India needs an energy transition. Some of the obstacles to achieving the goals can be categorized majorly as a lack of basic infrastructure for charging, affordability, high battery costs, and driving range, of these vehicles. Also, the country needs to think about how to produce an abundance of electricity without the use of fossil fuels. The electric vehicle manufacturers too should have a scheme with a proper timeline and investment strategies to develop a manufacturing ecosystem and scale up the sales and availability of EVs in the country at lower prices.

7.3 Policymakers and city planning authorities should make planning norms, and byelaws facilitating the development of charging infrastructure at the city, zonal, and neighborhood levels. The government is working efficiently to promote EVs in the market to achieve its 2030 targets, but these efforts are not enough.

7.4 The government needs to work in a more detailed and time-framed manner with short-term goals. There is a need to work on some pilot projects first and then replicate them throughout the country. Currently, if the government works on affordability and infrastructure, which are the basic challenges in adoption, then the users will be willing to accept EVs in the future. As a result, along with the expectations of reducing carbon emissions, air pollution, and enhancement of energy security, the country can also become an automotive export market. These transitions will change the business model in the country as well as the usage patterns for the customers.

VIII. CONFLICT OF INTERESTS

The authors declare no conflict of interest

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