

Electric Vehicle Infrastructure Market Sustainable Growth in Indian Scenario, Needs and Suggestions

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Abstract— A report by Frost and Sullivan mentions that Indian Electric vehicle market will accelerate by 7% in 2019-20. Honda has announced one electric vehicle model by 2020 and has plans to launch a B segment vehicle in India by 2023. Certainly, Indian Automobile Industry will see many changes and challenges in the near future. Electric Vehicle (EV) technology will have impact on other infrastructure industries like electrical grid, road side electric vehicle charging stations among many others. EV mobility is the new change that the Indian automobile industry is going through. EV mobility will impact the urban as well as the rural landscape in terms of infrastructure. EV charging load will be random and will certainly impact the grid. Promotion of renewable energy at load centre, such as Solar Photo Voltaic or Wind Mill installation will most likely be observed. Electrical infrastructure capacity has to be increased. Such capacity building is an investment and energy is revenue. As vehicle sharing has been well received by Indians; the paratransit options such as Ola, Uber will be equipped with common charging stations. New smart cities will have to be allocated certain space for vehicle parking and charging stations. This paper reads about what infrastructure changes might occur in Indian scenario for sustainable development; by using Multi Criteria Decision Analysis (MCDA) technique to understand how to consolidate the decisions.

Keywords: Charging stations, Electric Vehicles, Electric Mobility, Infrastructure, Multi Criteria Decision Analysis, Renewable Energy

I. INTRODUCTION

The “sustainability” word has percolated to every industry. Transportation or Mobility Industry seems very adaptive to this word as well (Köhler et al., 2009). This paper discusses; how the need for environmental sustainability can create pressure to bring in changes in the life style and behaviour of consumer for mobility needs by adopting EVs in recent future. It has been observed that some major challenges faced by EVs include battery technology, battery costs and charging infrastructure (Egbue & Long, 2012). Studies in Netherland (Sierzchula, Bakker, Maat, & Van Wee, 2014) observe that financial incentives, charging infrastructure, and local presence of production facilities are significant criteria and are positively correlated to a country's EV market share. On the contrary, certain other descriptive analyses suggest that neither financial incentives nor charging infrastructure ensure high EV adoption rates. Charging infrastructure needs standardization for the benefit of society is what the investigation of a study conducted in Spain presented

(Montoya, Martínez-Lao, Torres-Moreno, Manzano-Agugliaro, & Barón, 2017). Analysis of fiscal policies has been important due to conflicts of interests between different stake holders such as the government, consumers, oil companies, automakers and environmentalists as is observed by Fazeli et al (Fazeli, Davidsdottir, Shafiei, Stefansson, & Asgeirsson, 2017). While working on investigation of energy storage size in grid connected Photovoltaic network, (Sachan, 2017) has concluded that ideal number of EVs can be calculated and that the number of EVs should not influence distribution network. In areas with High Occupancy Vehicle (HOV) lane access, particularly in areas with a high density of traffic in carpool lanes, increasing consumer awareness of incentives offered by EVs, can boost EV market penetration (Jenn, Springel, & Gopal, 2018). Along with purchase subsidy, the other factors considered for the quick penetration of EVs in the market are climate change, air quality policies, consumer information schemes and differential taxation applied to various fuels and energy vectors (Georgina Santos and Huw Davies, 2019). The authors are also persistent about the charging infrastructure, purchase subsidies, pilot/trial/demonstrations and tax incentives, and conclude that it can be implemented easily and relatively quickly in most countries in Europe and potentially throughout the world, provided the necessary public funds can be allocated to this purpose. EV routing problem has been discussed and Ant Colony algorithm has been suggested for the same (Zhang, Gajpal, Appadoo, & Abdulkader, 2018) and energy minimizing approach has been studied instead of distance minimizing approach. Constraints like time window constraints, multi-depot constraints and partial recharge constraints have been suggested to be used for the further studies. Car sharing concept and its benefits have been thoroughly studied (Illgen & Höck, 2018), electric one-way car sharing networks will give more practical results for the research gap of realistic modeling of charger infrastructures and vehicle relocations. Road priority, fuel price are positive and statistically significant to predicting the market share of EVs as observed by Wang et al (2019). Their study also helped the policy makers to redesign the policies associated with EVs (Wang, Tang, & Pan, 2019). Analytic Hierarchy Process and the VIKOR optimization techniques have been used for prioritizing four categories of clean energy vehicles like electric, gas, methanol and ethanol.

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The study conducted by Li et al (2019) mentions that the EVs are way better than any other clean energy vehicles (Li, Negnevitsky, Wang, Yue, & Zou, 2019). However, financial and battery-related concerns remain major obstacles to wide-spread Plug in Hybrid Electric Vehicles market penetration (Krupa et al., 2014).

The above mentioned literature has given a holistic idea to understand the requirements of all the stake holders to make policies to penetrate EVs in the market in a sustainable manner. The present paper gives an idea to overcome the constraints and barriers in the market penetration of EVs in the Indian Scenario.

In India, use of EVs has an employment generation objective besides many others. Niti Aayog has drafted a report by considering the following mentioned objectives as well for Electric Vehicles (Juyal et al., 2018). The first objective is to reduce primary oil consumption in transportation. The second is to facilitate customer adoption of electric and clean energy vehicles. The third is to encourage cutting edge technology in India through adoption, adaptation, and research and development. The fourth is to improve transportation used by the common man for personal and goods transportation. The fifth intends to reduce pollution in cities. The sixth objective is to create EV manufacturing capacity that is of global scale and competitiveness. The final objective is to facilitate employment growth in a sun-rise sector.

To achieve these objectives one must have proper planning and meet expectations of customers (Juyal et al., 2018). Based on the 2012-2018 sales data, the vehicles on Indian roads are estimated to consist of 79% of two wheelers, 4% of three-wheelers, 3% is the share of buses and large goods vehicles like trucks, economy four-wheelers are 12% while premium four-wheelers are 2%. It is worthy to observe here that in India, premium four wheelers are only 2% of the total sales. Thus, there is large market to tap the economical aspect of EVs. The other challenge facing the adoption of EVs can be attributed to the electricity network infrastructure and its availability which significantly matters in the whole context.

II. METHODOLOGY & RESULTS

The methodology looks into finding out the barriers and drivers for the EV policy. Then comes the stage of finding out the various factors influencing the barriers and drivers for the adoption of the EV technology. The last step finds out the different stake holders that are a real support for the EV penetration in India.

Financial incentives, urban density, level of education, environmentalism indicator, fuel price, EV price, the presence of production facilities, per capita vehicles, model availability, introduction, date, charging infrastructure, and electricity price have been the key factors selected in the research work as suggested by (Sierzchula et al., 2014). However, its application in the Indian scenario can be an area of discussion. The methodology can use logistic regression under the more conservative assumption that the response variables are ordinal. It aims to keep an eye on the data quality. The methodology plans to interview only the experts with an unbiased approach. Statistical methods can explore correlations and relationships between the

categorical survey data can be performed. These methodologies can be used to understand how EVs can be made more sustainable in Indian scenario.

The points of discussion that the present paper proposes are as under:

There are many areas of studies for Electric Vehicle and its allied research.

Battery Technology (Shi, Pan, Wang, & Cai, 2019)

Routing of Charging Infrastructure (Joo & Lim, 2018)

Electrical grid and impact of Electric Vehicle on it and many more

Electric Vehicle incentives (Wang et al., 2019) and many more areas can be explored.

Indian Transportation market is different and light motor vehicle market can be analysed.

Table 1: Different ways to analyse Electric Vehicle penetration in Indian scenario

Sr.No.	Theme	Parameter 1	Parameter 2	Parameter 3	Parameter 4
1	Electric vehicles can be availed by many when	It has improved technology	It has reduced vehicle prices	It has extensive marketing	It has a competitively priced alternative
2	1. Biggest concerns of Electric Vehicles	Is the battery range	Their costs	Their charging infrastructure	Their reliability and safety
3	Fiscal Benefit is when	Subsidy can be availed	Value Added Tax can be reduced	registration tax is reduced	Circulation tax differences between EVs and their Internal Combustion Engine pair
4	Different states will adopt EVs when	Charging infrastructure is adequate	CO ₂ emissions regulations are strictly followed	User purchase decisions are high	Policy implementation are better
5	Different scenarios can be studied when	No policy implementation is seen	Current policy is better or otherwise	Projected policy helps reach EV goals	Extended policy betters the sustainability aspects
6	2. Routing can be resolved for EVs when	Pollution and Routing Problem are tackled together and route rationalization is done for EVs	Green Vehicle Routing Problem is considered in route planning		
7	Subsidies in India	Individual credit	Fleet credit	HOV lane access	Inspection Exemption
		Time of Use (TOU) rate	Registration fee reduction	Subsidies for EV charging infrastructure	
8	Analysis type used in the study can be based on	Regression analysis	Correlation analysis		

III. CONCLUSION

These are the few methodologies that can be applied for the wholesome understanding of how EVs can percolate in Indian markets. Only financial subsidy will not be sufficient for the actual take off for the Electric vehicle market in India. Besides the financial benefits, social benefits also go hand in hand with EV adoption. Overall health of citizens will improve and fossil fuel consumption will be reduced due to EV adoption. Yet, essential parameters need to be considered and a thorough study has to be done to propose precise solutions for EV adoption. As a future scope of research, the current study proposes to analyse scenarios for EV adoption considering that no subsidies would be provided for EV adoption as this may be a challenge in the percolation of EVs in the market.

To achieve the goal of smart city mission, we have to look at smart transportation and smart grid and both are connected to Electric Vehicle adoption in the market. The current paper is useful for giving way to a new thought and

new ideas and segregation of methodologies for the same which has been lucidly mentioned.

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