Opportunities and Challenges of Electric Vehicles in India

Menonjyoti Kalita[1]
[1]Assistant Professor,
Jorhat Institute of Science & Technology,
Jorhat (Assam)- 10

Golam Imran Hussain[2]
[2]Assistant Professor,
Jorhat Institute of Science & Technology,
Jorhat (Assam)- 10

***Abstract*- With the development of new technology, there is a advancement in automobile sector. Electric vehicles are alternatives to internal combustion engines vehicles. The emission of lower CO_2 in electric vehicle is increasing the demand in every country. The Indian Government is also planning to increase the electric vehicle in the automobile industries. In this paper the opportunities and challenges of the electric vehicles in Indian market is discussed. Economic, social, technical and environmental factors affecting the electric vehicles market in India are discussed in this paper. The battery and infrastructure development is related to economic and technological factors as discussed. Recommendations are then made according to the challenges and as to promote the market growth of electric vehicles.**

Keywords: Automobile, Internal Combustion Engine, Electric Vehicle, CO_2

I. INTRODUCTION

Electric vehicles (EV) market is growing rapidly all over the world. In India also the EV is market has gained significant momentum in present time. The market is growing more after the implementation of FAME (Faster Adoption and Manufacture of Hybrid and Electric Vehicles) scheme in 2015 by Ministry of Heavy Industry and Public Enterprises. The total EV sales in 2018 hit 365,920 Units and expected to grow at a CAGR of 36% till 2026. The EV battery market in India is estimated to be US$ 520 Million in 2018 and forecasted to grow at a CAGR of 30% till 2026. The total MWh addition in 2018 hit 4.75 GWh and expected to grow till 28.0 GWh by 2026.[1]

Electric vehicles are solutions to be independent and free from imported energy resources. India is one of the largest exporters of crude oil in the world. Electric cars can bring a major change to India in becoming self-sustainability. EV could also be the alternatives to decrease the carbon dioxide gas [2]. Major cities like Delhi, Mumbai are facing a major problem of air pollution. Carbon dioxide from automobiles is one of the causes of air pollution.

An EV can be used for flexible load for standardizing the grid with substantial share of fluctuating renewable energy generation [3]. EV emits 30-80 % less greenhouse gas when compared with Internal Combustion Engine (ICE) Vehicle [4]. EVs do not consume any energy when it is stationary as compared to ICE vehicles which fuel is consumed when it is in idle [5]. EV is recognised as promising alternatives to vehicles and will potentially replace ICE Vehicles in the near future [6].China, Europe and the United States are the largest markets for EV [7].

The electric vehicles have low emissions, high efficiency and smooth operation. The energy consumption and emissions for plug in hybrid electric vehicles in China found that compared to gasoline vehicles there is 37.5% less energy consumption and 35% less greenhouse gas emissions [8]. Government have started financial policies to encourage EV adoption however decision makers have to take a long term perspective to get them implemented efficiently [9][10].

II. OBJECTIVE OF THE STUDY

To understand the Indian Automobile Production and Sales

To identify the opportunities and challenges of using electric vehicles in India.

III. RESEARCH METHODOLOGY

The study is done to present information about the Indian Automobile Market and the challenges and opportunities in the EV industry. Secondary data was used for the study. Secondary data was accumulated through sources i.e. online sites, journals, articles.

IV.LIMITATION OF THE RESEARCH:

Due to the practical and time constraints the research provides a review of EV based on the secondary data only.

V.DATA ANALYSIS:

Automobile Production Trends in India is shown in Table 1. All the categories of the vehicles are shown in the table [6].

Table 1: Automobile Production Sales (Source: SIAM India)

Automobile Production Sales					
Category	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**
Passenger Cars	2,422,158	2,565,970	2,711,911	2,746,658	2,710,057
Utility Vehicles	626,296	717,809	909,555	1,093,346	1,098,578
Vans	172,965	181,266	180,204	180,263	217,412
Total Passenger Vehicles	**3,221,419**	**3,465,045**	**3,801,670**	**4,020,267**	**4,026,047**
M&HCVs	268,558	341,287	342,761	344,592	444,202
LCVs	429,740	445,405	467,492	550,856	667,974

Total Commercial Vehicles	**698,298**	**786,692**	**810,253**	**895,448**	**1,112,176**
Three Wheelers	**949,019**	**934,104**	**783,721**	**1,022,181**	**1,268,723**
Scooters	4,722,747	5,276,138	5,926,499	7,117,795	7,095,163
Motorcycles	13,011,219	12,816,203	13,088,208	15,167,481	16,502,734
Mopeds	755,345	737,886	919,032	869,562	905,189
Total Two Wheelers	**18,489,311**	**18,830,227**	**19,933,739**	**23,154,838**	**24,503,086**
Quadricycle*	**-**	**531**	**1,584**	**1,713**	**5,388**
Grand Total	**23,358,047**	**24,016,599**	**25,330,967**	**29,094,447**	**30,915,420**

The automobile market in India is categorised as total passenger vehicles, total commercial vehicles, three wheelers and two wheelers. In the bar diagram we can see that the most available vehicles are total passenger vehicles and two wheelers. Therefore EV market should concentrate in these vehicles to obtain the market in India.

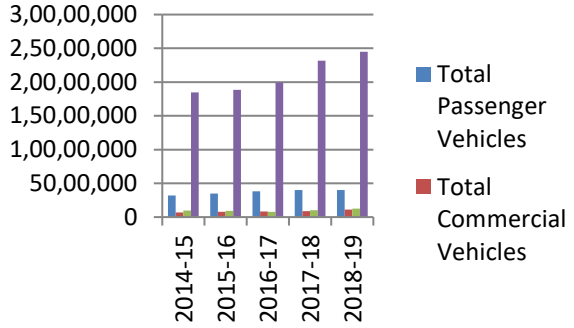

Figure 1: Bar Chart of Automobile Production Sales

The trend of EV sales in India is shown in the bar diagram [12]. From the bar diagram it can be well understood that the sales of EV is increasing in the last three years. More and more consumers are attracted towards EV.

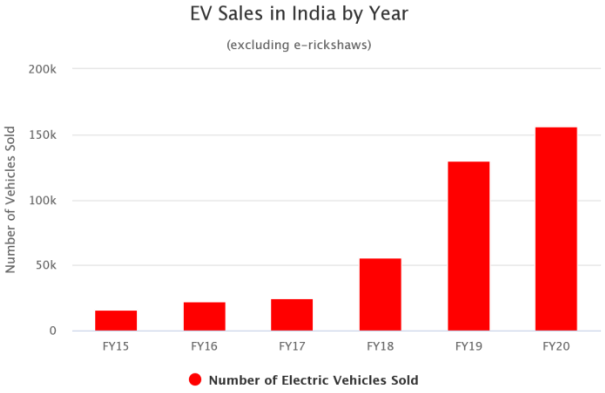

Figure 2: Bar Chart of **EV sales in India**

VI. CHALLENGES AND OPPORTUNITIES OF ELECTRIC VEHICLES IN THE FOLLOWING FIELDS

A. Economic

The economic challenge is a major challenge of EV in India. In the developing nation EV adoption and large market growth is difficult. Economic challenges have different aspects.

a) Electric Vehicles

Although gasoline and diesel are costly than electricity due to their high initial investment of EV, the price are more [13]. Since the systems of EV is not matured enough and most of the assembly process are to be done manually, mass production of the expensive parts of EV are still not economically justified, causing the selling price to be expensive in order for the company to maintain a healthy profit margin [14.]. Indian population consist of middle class people and the people may find difficult in high initial investment.

b) Battery

The materials used in constructing the batteries in EV have to maintain certain quality and it results high cost [15]. High performance battery is produced but cost also becomes higher. The lithium-ion (Li-ion) batteries used in EVs present a very concerning. It has been reported that the extraction of cobalt, the essential component of the rechargeable Li-ion batteries, is linked to child labor [16]. With laws and policies introduced to improve the standards of ethical mining, the supply of the mineral will reduce while the demand stays high, resulting in further increase of the price of cobalt [17].

Li and Ouyang shows that by reducing the battery costs of EV, it would help to decrease the total expenditure of consumers and allow them to afford higher charging price for the battery [18]. The high cost of batteries is the reason the price of EVs will remain expensive even if government purchase subsidies were offered in many countries [17].

c) Infrastructure

Infrastructure for charging is necessary and is categorised as oublic,semi public and private charging infrastructure which are public, semi-public and private charging infrastructure. Public charging infrastructure is open to the public and can usually be found at public parking area while semi-public charging infrastructure is only accessible by a certain group of people. Private charging infrastructure refers to the one that is installed in a private garage or household [17]. Schroeder and Traber have found that high initial investment costs and low utilization rate have caused low profitability for the charging stations in Germany [19]. In developing countries like India the high initial cost is one of the challenges

B. Technology

a) Electric Vehicle

Manufacturing and development of energy storage systems for electric vehicle has become an issue due to availability of raw materials [15]. This is because the energy storage system in an electric vehicle utilizes high grade materials to ensure high performance and provide safe operation without corrosion and explosion [20]. A modern electric vehicle system is designed to be able to

manage all of the possible energy resources effectively given the availability of the energy [20]. Another major issue with the current energy storage systems is the size and cost. Out of the total cost of the electric vehicle, one-third is dedicated towards the energy storage system. The cost of the energy storage system is high because it includes the cost of materials, packaging, power conversion, replacement, operation, maintenance as well as labor [20].

b) Battery

The use of Li-ion batteries has been increasing in popularity and has become the dominant battery technology for the automotive industry [21]. For a smooth operation, every energy storage system needs to be protected and maintained. Electric vehicles that are equipped with Li-ion batteries are faced with safety and cost issues that are related to thermal effects in the batteries [22]. In electric vehicles, the Li-ion batteries need to be protected from overcharging and over discharging. This is because it is proven that when the Li-ion battery is over discharging, high rates of heat generation and electrochemical reaction occur and thus the batteries are prone to an increase in temperature [23]. The increase in temperature within the Li-ion batteries is the main cause of safety issues such as swelling, thermal runaway, electrolyte fire and explosions [24].

c) Infrastructure

EVs are powered by energy storage like batteries instead of fuel, they have to be recharged. This in return requires extra energy to be delivered from the existing power grid and power stations. Thus, renewable alternatives in generating energy like wind and solar energy need to be utilized [25]. This means that the charging price could be influenced by the technologies used in the power grids and the charging infrastructure itself. In the meantime, charging technology could affect the charging time and thus the number of EVs in the market [26]

C. Environmental

EV reduces the emission gases. But he power generation process for charging EVs also produces greenhouse gas emissions. The emission of greenhouse gases into the atmosphere causes global warming [27]. The processing and production of energy storage systems as well as the disposal of electrochemical batteries may cause respiratory, pulmonary, and neurological diseases. Therefore, safety measures must be taken into consideration during the production of energy storage systems especially the batteries [28]. EVs are not totally clean from emission throughout its life cycle but with the advancements in manufacturing technology and utilization of alternative energies, the overall environmental impact can be reduced [15].

D. Social

Social aspect also plays important role as it indirectly attract the customers to adopt EV, consumer's attitudes and the performance of the EVs simultaneously [29]. Psychological factors include the consumers' perception on the cost, benefits as well as their attitude towards new technologies and social influence [30]. Range anxiety is a phenomenon where EV drivers are in a continuous state of worrying about the possibility of being stranded with a discharged battery due to its limited range [31,32]. Consumers' attitude is a major influence in their decision on whether they should invest in EVs. In the case of EVs, their attitude towards new technologies has a huge influence in their decision [15]. Although there is a significant amount of early adopters investing in EVs, majority of consumers are reluctant in adopting new technologies [33].

VII. CONCLUSION AND RECOMMENDATION

In this paper challenges and opportunities of electric vehicles are reviewed. As told by market researchers the future of transportation of IC will be replaced by EV. Moreover from the recent years sales it can be seen that the market of EV is growing day by day. International Energy Agency (IEA) has projected the global stock increment of EVs from 3.7 million in 2017 to 13 million by 2020 and eventually reaches 130 million in 2030. On the other hand, the sales of EVs are estimated to have a growth of 24% averagely throughout the projection period. The sales would increase from 1.4 million in 2017 to 4 million of EVs by 2020 and in time reaches 21.5 million of sales by 2030 [34].

Not only the technological and economic factors must be given importance, the satisfaction on customers based on social factor must be given equal importance. The consumers have to be made aware regarding the use of EV. The social factors besides the government are also taking many policies to adopt the EV. The charging infrastructure is one of the main concerns of the EV market expansion. More and more public and private sector has to come up to set up the charging infrastructure. There are many challenges that are being faced in the initial investment and adoption of market, but due to the opportunities the EV market will expand.

VIII. REFERENCE

[1] Indian Electric Vehicle Market Overview Report 2019-2026, (2019) 1st Edition
[2] R.T. Doucette, M. D. McCulloch, Modelling the prospects of plug in hybrid electric vehicles reduce CO_2 emission, Applied Energy (2011) 2315-2323.
[3] W. Kempton, J. Tomic, Vehicle to grid power implementation from stabiling the grid to supporting large scale renewable energy, J. Power Sources 144(1) (2005) 280-294.
[4] F. He, D. Wu , Y. Yin, Y. Guan, 2013. Optimal deployment of public charging stations for plug-in hybrid electric vehicles. Transportation Research Part B: Methodological, 47, Pp. 87–101.
[5] A. Kihm, S. Trommer, 2014. The new car market for electric vehicles and the potential for fuel substitution. Energy Policy, 73, Pp. 147–157.
[6] Global EV Outlook. 2016. International Energy Agency, Paris.
[7] T. Gersdorf, P. Hertzke, P. Schaufuss, S. Schenk, 2020. Mckinsey electric vehicle index: Europe cushions a global 525 plunge in ev sales. URL:https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/ 526 mckinsey-electric-vehicle-index-europe-cushions-a-global-plunge-in-ev-sales#.
[8] Jian Liu & Georgina Santos (2015) Plug-In Hybrid Electric Vehicles' Potential for Urban Transport in China: The Role of

Energy Sources and Utility Factors, International Journal of Sustainable Transportation, 9:2, 145-157.
[9] Sierzchula, William & Bakker, Sjoerd & Maat, Kees & van Wee, Bert, 2014. "The influence of financial incentives and other socio-economic factors on electric vehicle adoption," Energy Policy, Elsevier, vol. 68(C), pp 183-194.
[10] X. Zhang, J. Xie, R. Rao, Y. Liang, Policy Incentives for the Adoption of Electric Vehicles across Countries. Sustainability 2014, 6, 8056-8078.
[11] Annual Report 2018-2019, Society of Indian Automobile Manufacturers, 2019,16-17
[12] https://dazeinfo.com/2020/05/28/ total-electric-vehicle-sales-in-india-by-year-graphfarm
[13] J. Kroll, A. Kooy, R. Seebacher, 2010. Torsional Vibratiion Damping for Future Engines. Symp. A Q. J. Mod. Foreign Lit.
[14] B. Sapinski, J.J Snamina, 2017. Automotive vehicle engine mount based on an MR squeeze-mode damper: modeling and simulation. Journal of Theoretical and Applied Mechanics, Pp. 377.
[15] M.K. Hidrue, G. R. Parsons, W. Kempton, M. P. Gardner, 2011. Willingness to pay for electric vehicles and their attributes. Resource and Energy Economics, 33 (3), Pp. 686–705
[16] G. Hilson, 2008. A load too heavy': Critical reflections on the child labor problem in Africa's small-scale mining sector. Children and Youth Services Review, 30 (11), Pp. 1233–1245.
[17] M. Faizal, S. Y. Feng, M. F. ,Zureel , B.E. Sinidol, D.Wong, G.K. Jian, A Review on Challenges and Opportunities of Electric Vehicles (EVS)Journal of Mechanical Engineering Research and Developments (JMERD) 42(4) (2019) 130-137.
[18] Z. Li, M. Ouyang,2011. The pricing of charging for electric vehicles in China—Dilemma and solution. Energy, 36 (9), Pp. 5765–5778.
[19] A.Schroeder, T. Traber, 2012. The economics of fast charging infrastructure for electric vehicles. Eergy Policy, 43, Pp. 136–144.
[20] M.A. Hannan, M.M Hoque, A. Mohamed, A. Ayob, 2017. Review of energy storage systems for electric vehicle applications: Issues and challenges. Renewable & Sustainable Energy Reviews, 69, Pp. 771–789.
[21] D.R. Wright, N. Garcia-Araez, J.R Owen, 2018. Review on high temperature secondary Li-ion batteries. Energy Procedia, 151, Pp. 174– 181.
[22] J. Smith, R. Singh, M. Hinterberger, M. Mochizuki, 2018. Battery thermal management system for electric vehicle using heat pipes. International Journal of Thermal Sciences, 134 (6), Pp. 517–529.
[23] A. Mahmoudzadeh Andwari, A. Pesiridis, ,S. Rajoo, R. Martinez-Botas, V. Esfahanian, 2017. A review of Battery Electric Vehicle technology and readiness levels. Renewable & Sustainable Energy Reviews, 78, Pp. 414– 430.
[24] Ogura, K., Kolhe, M.L. 2017. Battery technologies for electric vehicles. Electric Vehicles: Prospects and Challenges.
[25] F.A. Azidin, M.A. Hannan, A. Mohamed, 2013. Renewable Energy Technologies and Hybrid Electric Vehicle Challenges. Prz. Elektrotechniczny, 89 (8), Pp. 150–156.
[26] Y. Li, 2016. Infrastructure to Facilitate Usage of Electric Vehicles and its Impact. Transportation Research Procedia, 14, Pp. 2537–2543
[27] E. F Choma, C.M.L. Ugaya,2017. Environmental impact assessment of increasing electric vehicles in the Brazilian fleet. Journal of Cleaner Production, 152, Pp. 497–507.
[28] P. Weldon, P. Morrissey, M. O'Mahony, 2016. Environmental impacts of varying electric vehicle user behaviours and comparisons to internal combustion engine vehicle usage - An Irish case study. J. Power Sources
[29] S. Steinhilber, P. Wells, S. Thankappan, 2013. Socio-technical inertia: Understanding the barriers to electric vehicles. Energy Policy, 60, Pp. 531– 539.
[30] Q. Zhang, H. Li, L. Zhu, P.E. Campana, H. Lu, F. Wallin, Q. Sun, 2018. Factors influencing the economics of public charging infrastructures for EV – A review. Renewable & Sustainable Energy Reviews, 94, Pp. 500–509.
[31] M. Nilsson, 2011. Electric Vehicles: An interview study investigating the phenomenon of range anxiety. Qual. Interview Study Range Anxiety, Pp. 1–15.
[32] B. Feng, Q. Ye, B.J. Collins, 2018. A dynamic model of electric vehicle adoption: The role of social commerce in new transportation Inf. Manag., Pp. 1–17.
[33] O. Egbue, S. Long, 2012. Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. Energy Policy, 48, Pp. 717–729.
[34] Global EV Outlook. 2018. Towards cross-modal electrification. International Energy Agency, Paris