Review On Challenges of Electric Vehicle

Ganesh Inkar[1], Gaurav Jadhav[1], Atharva Kamthe[1], Suyog Ghode[1], Vivek Hake[1], Pallavi Golam[1]

Prof. Sachin Komble[2]

[1]Research Scholar, Department of Mechanical Engineering VIT Pune

ganesh.inkar21@vit.edu , gaurav.jadhav21@vit.edu , atharva.kamthe21@vit.edu , vivek.hake21@vit.edu , pallavi.golam21@vit.edu

sachin.komble@vit.edu

Abstract—Electric vehicles (EVs) are playing a major role in the development of the automobile sector because of their lower environmental impact, increasing cost of fossil fuel, and energy efficiency. There are many advantages of electric vehicles over internal combustion (IC) engines, like zero emissions, but there are some challenges too. In this review paper, the challenges of electric vehicles are reviewed. Electric vehicle use faces numerous economic and technological challenges, including charging infrastructure, high EV prices, which is a major issue for people purchasing EVs, range limitation, battery monitoring and recycling, and the major and most recent issue of EV heating and exploding. The paper provides an overview of such challenges and their impact on society. EVs are ahead of ICE vehicles because of their potential to reduce greenhouse gases and significantly reduce pollution, but the challenges should be addressed and there is a need to overcome them to create more impact on people, which will lead to a better, more energy-efficient, and pollution-free environment. Also, there is more need for the implementation of fuel cells because of merits like silent operation, modular structure, and high efficiency.

I. INTRODUCTION

Electric vehicles were introduced as an alternative to fossil fuels to reduce pollution, The popularity, and sales of electric vehicles (EVS) are rapidly increasing due to their energy efficiency and the potential to reduce greenhouse gases. Generally, EVs are categorized into battery electric vehicles (BEV), hybrid electric vehicles (HEV), plug-in hybrid vehicles (PHEV), and fuel cell electric vehicles (FCEV). In the Indian scenario, the electric vehicle industry is in the emerging stage. The first company that launched an electric car was Mahinda in 2010 later they launched a new model in the year 2013 the sales were not that high due to the existing challenges. Compared to ICE vehicles, EVs have taken a step ahead because of their prominent technologies like regenerative braking systems in which the kinetic energy of the vehicle is utilized for recharging batteries. Also, the EVs don't consume energy while they are not moving or idle, which in IC engine vehicles they consume the energy they while are not moving or idle, which is also the major merit of EVs. Many people in many countries are unaware due to challenges such as high cost, which is a major factor contributing to the decline in interest in electric vehicles (EVs) and charging infrastructure, which is also a major factor. In developing countries, charging stations are generally available in major cities, but in rural areas, the number is zero. Also, the latest challenge is the heating issue of the batteries, which is leading to a disaster because of which fear has been created among the people, and nowadays they are not going for EVs and are preferring ICE vehicles. Another challenge is the range limitation which is also a key factor limiting the spread and adoption of EVs the approximate range of an electric vehicle is 100-300 miles; for a greater range, luxury cars are required, which the average man cannot afford. Many other issues, such as battery replacement costs and longer charging times, have a negative impact on sales. Rapid growth in this field is expected in the next few years by working over the challenges mentioned above.

Fig 1- Electric vehicle

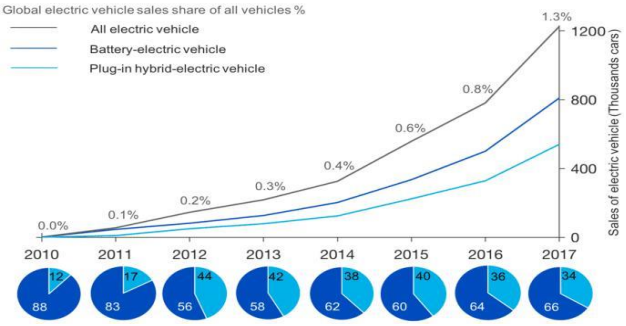
Comparison between the cost of three different fuel types – The unit cost of gasoline (petrol), diesel, and electricity is assumed as Rs. 106 /liter, Rs. 92.72/liter, and Rs. 8/kwh.

Fuel	Petrol	Diesel	Electricity
Cost per liter	106	92.72	8

II. PURCHASING INCENTIVES

The goal of purchasing incentives is to reduce the purchasing cost of vehicles. Several forms of purchasing incentives – are classified into four types.

1) **Point of Sale Grant Incentives** – This incentive mainly reduces the purchasing cost of vehicles. These grants are applied during the purchasing time of the vehicle.
2) **Post-Purchase Rebates –** These are the incentives provided to the consumers after they purchase the vehicle. They are provided mainly in the form of cheques. The buyer receives payment after they purchase Battery electric vehicle.
3) **VAT and purchase Tax Exemptions –** This incentive allows consumers to pay lower or zero VAT or even no purchase tax for some vehicles.
4) **Income tax credits –** This incentive allows buyers of BEVs to pay the least income tax bill at the end of the financial year.



Nowadays the cost of EVs is slightly lower due to the subsidies or incentives provided by the government, but the subsidies are short-lived. As the sales increase, the subsidies will be cancelled. In the absence of subsidies, sales will surely go down. In this context, this article reviews and discusses the various challenges from different aspects of electric vehicle usage.

III. DISCUSSION

1) High purchase cost
2) Range anxiety
3) Charging infrastructure
4) Battery technology
5) Heating issue
6) Manufacturing challenges

1) High purchase cost – High purchase cost is also a major challenge as covid -19 has badly affected the automobile industry, and the sales of electric vehicles are reduced. This pandemic has affected many people economically which has affected the industry. Electric vehicles are initially more expensive than ICE vehicles. for example, the Tata Nexon price starts approximately from $7.19 lacks while the same car EV starts from $13.99 lakh. The challenge for manufacturers is the cost of the battery. The battery packs are more expensive and there is a need to replace the engine vehicles that are less expensive than electric vehicles. It is not only the cost of battery there is also a need to find alternatives for many other components for cost-effectiveness. The government is providing subsidies for purchasing EVs but that will not go on for too long. There is a need that automobile brands should work towards developing new technologies which will make vehicles more affordable. The merit of EVs is the low maintenance and running cost as compared to petrol or diesel cars the only point is the high initial cost that needs to be focused on. Thus, the high cost of an electric vehicle is a big hurdle for the consumer. The price difference is mainly due to the high cost of batteries. Despite of high purchasing cost, some buyers are going for electric vehicles those who can afford the high purchasing price. In long-range vehicles, large batteries are required that led to high costs which is also a major challenge.

2) Range Anxiety – Range anxiety is the thing that an EV driver feels when the battery is about to die, and sources of electricity are not available. Many studies have proven that the driving range and charging infrastructure are the important reasons why people do not consider EVs when buying a new vehicle. Range anxiety can even feel in gasoline-engine vehicles but finding the gas station is not a difficult task. therefore, finding a gas station is not as difficult as finding a charging station. Charging stations in developing countries are generally available in metro cities but in rural areas, the number even goes to zero. The luxury EVs have more range but a common human being cannot afford that. The solution for this is the Plug-in hybrid electric vehicle (PHEV) in which range anxiety is not the issue. For the shorter distance, the vehicle operates on electricity, and when the battery is minimum or about to die the gasoline engine starts. The advantage is that the vehicle can be charged or if the fuel level goes low gas finding a gas station is not a difficult task. The solution to deal with range anxiety is proper planning while going for long trips, selecting a route for the charging stations can be one of the solutions. Another solution for this is renting a vehicle while going for long routes.

3) Charging Infrastructure – Due to the rapidly increasing sales of electric vehicles, there is more need for charging infrastructure to meet the demands. The lack of charging infrastructure is affecting the sales of vehicles. This is the major factor affecting the growth of electric vehicles in the market. There must be the option of establishing a charging station in the society or workplace so that the time required for charging the vehicle at the charging station will be saved. Such steps are needed in today's world for more development of EVs. In addition to the policies which are promoting the sales of electric vehicles, there is more need for charging infrastructure as well. The government has released the guidelines this year for the development of electric vehicles and to create a positive impact on the consumer. For the development of electric vehicles in India, there is more need for robust charging infrastructure. Considering the status of charging infrastructure only a few cities are mostly ahead in it. In addition to these, an electric grid is also needed to power these stations. The high cost of charging stations is also a major challenge setting up charging stations at every location is a major task. Along with setting up the charging station the safety concerns such as proper technical safety when charging the vehicle at the charging station is also an important parameter. The Indian government has announced the battery swapping policy, an alternative by which the discharged batteries can be replaced with the charged ones which save time, also it is efficient and cost-effective. To implement the swapping technique for vehicles proper planning and execution are required covering all the requirements such as the availability of batteries. Setting up a charging station is not an easy task, and government also realizes it that is why subsidies are provided by the government. The government has come up with subsidies for land, but there is more need to be done. The development of charging infrastructure cannot be ignored. Along with battery swapping, other alternatives needed to be founded. So that the electric vehicle will be a good choice for transport for people. To support the huge network of electric vehicles there is more requirement for smart chargers. The charging stations are not sufficient there is more need for charging facilities at workplaces and parking to minimize the load on charging stations which will lead to time savings. Fig 2 shows the charging infrastructure of electric vehicle.

Fig 2- Charging infrastructure

4) **Battery Technology –** Development in battery technology is the major reason for the deployment of electric vehicles. Recently the technology has moved from lead-acid batteries to lithium-ion batteries also many researchers are working on high-energy density batteries for various applications. Different charging methods are considered for charging the electric vehicle batteries –

- Constant current
- Constant voltage
- Constant power
- Trickle current
- Taper and float charging

Nowadays the combination of the above methods is done for better control of battery charging. The lithium-ion batteries are used because of their high energy density, less self-discharge, and low maintenance but battery degradation is the major issue that is negatively affecting battery charge range the reasons for battery degradation are physical and chemical processes. The chemical failure includes electrolyte decomposition, loss of lithium, etc. Many other reasons for battery degradation are poor design and integration, manufacturing errors, and packing conditions Looking at battery ownership an owner has to buy the additional battery pack that can be used as a replacement when the battery of the vehicle gets discharged. The fast charging of batteries is the major target of the automobile industry.

5) Heating Issue – Overheating of an electric vehicle is the major issue. Electric vehicles are generally equipped with a small cooling system and all the EVs don't contain a cooling system and all the cooling systems are not that effective. The heating of electricity depends on different factors like driving patterns, the age of the vehicles, and the materials that are been used in manufacturing the vehicle.

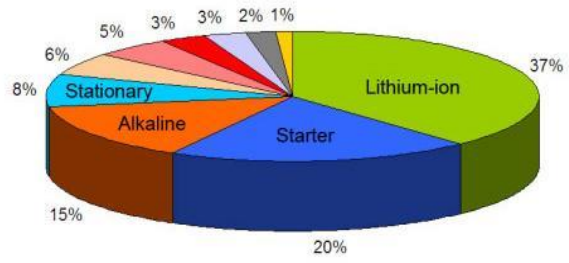


Fig 3- Chemistry of battery

The heating issue is majorly observed in vehicles that have been used for a longer time. Heating is caused due to the moving parts. There may be chances of overheating of the vehicle and that may lead to an accident if there is not proper heat dissipation. Due to improper insulation, the outside temperature may cause heating of the battery as the outside temperature is more as compared to the battery coolant temperature. The outside temperature cannot be controlled there is more need to focus and improving the cooling system. Fig 3 shows the chemistry of battery. The heating of the battery is also dependent on various factors like –

- Driving Habits
- Charging pattern
- Battery system

1) **Driving Habits –** If the vehicle is driven for long hours at high speed and the heating of the vehicle takes place there is a need to take a break at regular intervals for preventing the heating of the battery.
2) **Charging Pattern –** The charging pattern is also one factor that causes heating, it is recommended to charge the vehicle in indoor conditions than outside generally If it is too hot.
3) **Battery system –** The cooling system manufactured by different manufacturers gives different cooling rates. A well-designed cooling system has more ability for heat dissipation.

The heating issue can be solved in various ways like upgrading the cooling system if the vehicle is not equipped with a better cooling system it needs to be upgraded. Different cooling methods include fan cooling, using PCM (phase-changing material), and liquid cooling. Parking the vehicle in a shed can also affect the heating of the vehicle if the vehicle is exposed more to sunlight heating rate increases. The simple solution for that is to park the vehicle underneath the shed. Using too many applications while driving may cause heating, if we run many applications on our smartphone the devices get hotter the same as in the case of batteries in an electric vehicle. There is an eco-mode in most of the EVs that increases the efficiency by limiting the power electronic system. Avoiding traveling during hot hours can reduce the heating issue. The vehicle should not be overcharged which can be also the major reason for the heating of the vehicle. These are some ways to reduce the heating issue of an electric vehicle.

6)Manufacturing Challenges – Having many benefits including economic and environmental, there are challenges of availability and high cost of the material used in electric vehicles. Different materials like copper, magnets, lithium, and many other materials are needed to be imported from outside countries and the price of the materials is increasing day by day. Lithium-ion batteries are widely used in electric vehicle batteries because of their high density, less discharge, and low maintenance but the material lithium is available in other countries like China, Australia, and Argentina. Another material that is been used in batteries is mined in DRC (Democratic Republic of Congo). Many other raw materials like manganese, graphite, and cobalt are rare earth materials. The availability of these materials may not be available for battery production. Reducing the cost of batteries is an important step in the success of the electric vehicle.

IV. CONCLUSION

Hybrids, plug-in hybrids, and electric vehicles can improve vehicle fuel efficiency, but increase initial costs compared to conventional vehicles. In general, lower oil consumption and higher therefore productivity have economic benefits for buyers, society, automakers, and policymakers. This white paper provides a detailed review, overview, and guidelines of the literature on his HEV, PHEV, and BEV penetration studies in the Indian market. Recent initiatives and various subsidies from the Indian government will help boost e-mobility in India. Developing new Vehicle-to-charge batteries when non-traditional energy sources are not available. This technology is an important aspect of energy security, and the renewable energy, which is clean energy, and offers great potential to address the very important issue of global warming. This paper provides an overview of the obstacles and problems of electric vehicles in the Indian context and is the main novelty of the paper.

V. FUTURE PROSPECTS

Despite tremendous success in the past years of an electric vehicles but there are significant challenges. In order to overcome these challenges automobile manufacturers and researchers need to do intense and significant work and focus on areas such as fuel cells. If the electric vehicle is charged by using solar power at the home itself that will benefit the growth of electric vehicles. Looking at the future potential of the electric vehicle the growth is enormous. There will be more advancements in technology in future the electric vehicle can power themselves by harvesting energy from the environment. The vehicle that will run by harvesting the energy from the environment will require less maintenance and they can run on alternative sources such as wind. Another challenge of electric vehicles is us of electricity and which is also causing pollution, the charging station is the solution to this, which is also creating employment. Lithium-ion batteries have replaced ordinary batteries like alkaline. This is a major challenge for the manufacturers and there is a need for various plans to overcome the challenge. From the study looking at the present challenges and prospects, there is a need for more development in technology and a need to find more alternatives

VI. REFERENCES

[1] Aghabali, I. *et al.* (2021) "800-V electric vehicle powertrains: Review and analysis of benefits, challenges, and future trends," *IEEE Transactions on Transportation Electrification*, 7(3), pp. 927–948. Available at: https://doi.org/10.1109/tte.2020.3044938.

[2] Ahmed, M.R. and Karmaker, A.K. (2019) "Challenges for electric vehicle adoption in Bangladesh," *2019 International Conference on Electrical, Computer and Communication Engineering (ECCE)* [Preprint]. Available:https://doi.org/10.1109/ecace.2019.8679288.

[3] Banol Arias, N. *et al.* (2019) "Distribution System Services provided by electric vehicles: Recent status, Challenges, and future prospects," *IEEE Transactions on Intelligent Transportation Systems*, 20(12), pp. 4277–4296. Available: https://doi.org/10.1109/tits.2018.2889439.

[4] Beaudet, A. *et al.* (2020) "Key challenges and opportunities for Recycling Electric Vehicle Battery Materials," *Sustainability*, 12(14), p. 5837. Available at: https://doi.org/10.3390/su12145837.

[5] Gandoman, F.H. *et al.* (2019) "Concept of reliability and safety assessment of lithium-ion batteries in electric vehicles: Basics, progress, and challenges," *Applied Energy*, 251, p. 113343. Available at: https://doi.org/10.1016/j.apenergy.2019.113343.

[6] Goel, S., Sharma, R. and Rathore, A.K. (2021) "A review on barrier and challenges of electric vehicle in India and vehicle to grid optimisation," *Transportation Engineering*, 4, p. 100057. Available at: https://doi.org/10.1016/j.treng.2021.100057.

[7] Habib, S. *et al.* (2018) "A comprehensive study of implemented international standards, technical challenges, impacts and prospects for electric vehicles," *IEEE Access*, 6, pp. 13866–13890. Available:https://doi.org/10.1109/access.2018.2812303

[8] Husain, I. *et al.* (2021) "Electric Drive Technology Trends, challenges, and opportunities for future electric vehicles," *Proceedings of the IEEE*, 109(6), pp. 1039–1059.Available:https://doi.org/10.1109/jproc.2020.3046112.

[9] Juan, A. *et al.* (2016) "Electric vehicles in Logistics and transportation: A survey on emerging environmental, strategic, and operational challenges," *Energies*, 9(2), p.86.Available at: https://doi.org/10.3390/en9020086.

[10] Jussani, A.C., Wright, J.T. and Ibusuki, U. (2017) "Battery global value chain and its technological challenges for Electric Vehicle Mobility," *RAI Revista de Administração e Inovação*, 14(4), pp. 333–338.Available- https://doi.org/10.1016/j.rai.2017.07.001.

[11] Kumar, R. *et al.* (2020) "Addressing the challenges to electric vehicle adoption via sharing economy: An Indian perspective," *Management of Environmental Quality: An International Journal*, 32(1), pp. 82–99. Available at: https://doi.org/10.1108/meq-03-2020-0058.

[12] Lipu, M.S. *et al.* (2021) "Review of electric vehicle converter configurations, control schemes and optimizations: Challenges and suggestions," *Electronics*, 10(4), p. 477. Available at: https://doi.org/10.3390/electronics10040477.

[13] Wang, Z. *et al.* (2021) "Challenges faced by Electric Vehicle Motors and their solutions," *IEEE Access*, 9, pp. 5228–5249. Available at: https://doi.org/10.1109/access.2020.3045716.

[14] Xingyi Xu (no date) "Automotive Power Electronics-opportunities and challenges [for electric vehicles]," *IEEE International Electric Machines and Drives Conference. IEMDC'99. Proceedings (Cat. No.99EX272)* [Preprint]. Available at: https://doi.org/10.1109/iemdc.1999.769086.

[15] Xiong, R. *et al.* (2020) "Research progress, challenges and prospects of fault diagnosis on battery system of electric vehicles," *Applied Energy*, 279, p. 115855. Available https://doi.org/10.1016/j.apenergy.2020.115855.

[16] Komsiyska, L. *et al.* (2021) "Critical Review of Intelligent Battery Systems: Challenges, implementation, and potential for electric vehicles," *Energies*, 14(18), p. 5989. Available at: https://doi.org/10.3390/en14185989.

[17] Ahmad, F. *et al.* (2020) "Battery swapping station for electric vehicles: Opportunities and challenges," *IET Smart Grid*, 3(3), pp. 280–286. Available at: https://doi.org/10.1049/iet-stg.2019.0059.

[18] Capuder, T. *et al.* (2020) "Review of challenges and assessment of Electric Vehicles Integration Policy Goals: Integrated Risk Analysis Approach," *International Journal of Electrical Power & Energy Systems*, 119, p. 105894. Available at: https://doi.org/10.1016/j.ijepes.2020.105894.

[19] İnci, M. *et al.* (2021) "A review and research on fuel cell electric vehicles: Topologies, power electronic converters, energy management methods, technical challenges, marketing and future aspects," *Renewable and Sustainable Energy Reviews*, 137, p. 110648. Available : https://doi.org/10.1016/j.rser.2020.110648.

[20] Chan, C.C. and Chau, K.T. (no date) "An overview of electric vehicles-challenges and opportunities," *Proceedings of the 1996 IEEE IECON. 22nd International Conference on Industrial Electronics, Control, and Instrumentation* [Preprint]. Available at: https://doi.org/10.1109/iecon.1996.570892.

[21] Gao, Y., Farley, K.B. and Ho Tse, Z.T. (2014) "Investigating safety issues related to electric vehicle wireless charging technology," *2014 IEEE Transportation Electrification Conference and Expo (ITEC)* [Preprint]. Available at: https://doi.org/10.1109/itec.2014.6861757.

[22] Wang, J. *et al.* (2021) "Nonisolated Electric Vehicle Chargers: Their current status and future challenges," *IEEE Electrification Magazine*, 9(2), pp. 23–33. Available at: https://doi.org/10.1109/mele.2021.3070935.

[23] Aljaidi, M., Aslam, N. and Kaiwartya, O. (2019) "Optimal placement and capacity of electric vehicle charging stations in urban areas: Survey and open challenges," *2019 IEEE Jordan International Joint Conference on Electrical Engineering and Information Technology (JEEIT)* [Preprint]. Available at: https://doi.org/10.1109/jeeit.2019.8717412.

[24] Liang, K. *et al.* (2021) "Advances and challenges of Integrated Thermal Management Technologies for pure electric vehicles," *Sustainable Energy Technologies and Assessments*, 46, p. 101319. Available at:https://doi.org/10.1016/j.seta.2021.101319.

[25] Chakraborty, S. *et al.* (2012) "Embedded Systems and software challenges in electric vehicles," *2012 Design, Automation & Test in Europe Conference & Exhibition (DATE)* [Preprint]. Available at: https://doi.org/10.1109/date.2012.6176508.

[26] Georgakos, G. *et al.* (2013) "Reliability challenges for electric vehicles," *Proceedings of the 50th Annual Design Automation Conference on - DAC '13* [Preprint]. Available at: https://doi.org/10.1145/2463209.2488855.

[27] Baran, R. and Legey, L.F. (2013) "The introduction of electric vehicles in Brazil: Impacts on oil and electricity consumption," *Technological Forecasting and Social Change*, 80(5), pp. 907–917. Available at: https://doi.org/10.1016/j.techfore.2012.10.024.

[28] Teixeira, A.C. and Sodré, J.R. (2018) "Impacts of replacement of engine powered vehicles by electric vehicles on energy consumption and CO 2 emissions," *Transportation Research Part D: Transport and Environment*, 59, pp. 375–384. Available at: https://doi.org/10.1016/j.trd.2018.01.004.

[29] Wolbertus, R. *et al.* (2021) "Charging infrastructure roll-out strategies for large scale introduction of electric vehicles in urban areas: An agent-based simulation study," *Transportation Research Part A: Policy and Practice*, 148, pp. 262–285. Available at: https://doi.org/10.1016/j.tra.2021.04.010.

[30] Liu, Z. *et al.* (2021) "Comparing total cost of ownership of battery electric vehicles and internal combustion engine vehicles," *Energy Policy*, 158, p. 112564 .Available:https://doi.org/10.1016/j.enpol.2021.112564.