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Case Study on Challenges and Barriers of Electric Vehicle in India

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Abstract: ***Electrical Vehicles can be considered as an essential option for reducing greenhouse gases emission in transport sector. Electrical Vehicles reduces the dependency on fossil fuels such as diesel, petrol etc , also it promotes large scale renewable deployment. However there are various barriers against electrical vehicles in Indian scenario which need to be overcome. This paper provides a general overview on EVs and analysis of barriers against the use of EVs in India. There are some essential barriers such as lack of charging facilities, higher price of EVs as compared to internal combustion vehicles and poor long term planning. So when renewable sources are not available, special features of EVs are mandatory for their operation.***

Keywords: Electric vehicle, Barriers, Indian scenario, Charging facilities.

I. INTRODUCTION

An electric vehicle (EV) is a kind of automobile that is based on electric power usage and uses electric motors. An electric vehicle can be supplied by electricity from different sources such as electric battery, solar cells, etc. EVs are of different kinds such as E-bikes, E-rickshaw or E-car. As the population of India is increasing demand of automobile is also increasing, hence electric vehicles(EVs) are turning out to be a great option towards pollution control , economic balance and energy conservation. Electric vehicle can be charged from the grid and they can be used in place of internal combustion engine vehicles. The emission reduction totally depends on the source of power generation. If power is produced by renewable sources(solar, wind, etc) then reduction in emission is very high as compared to the power produced by non-renewable sources.

Although electric vehicles are good option in automobile sector but still people are going for IC engine based vehicles as there are few barriers and challenges against the electrical vehicles such as life cycle assessment challenges , drive range is not sufficient, charging infrastructure is less etc. Huge amount of CO_2 is produced while manufacturing of electrical vehicles as compared to IC engine vehicles , but ICEV emits approximately 120.1 g/Km of CO_2 on tank to wheel basis which increases up to 180 g/Km whereas EVs emits almost negligible CO_2 on a tank to wheel basis. The total carbon dioxide emission over its total lifetime duration depends on source of the fuel provided , where the manufacturing of vehicle is done and where it is driven.

Multiple factors such as good and large number of charging stations, technological advancements, parking benefits, no fuel cost etc can rise the usage of electrical vehicles in Indian scenario. Currently the production of EVs are very low in Indian market.

The main objective of this research was to present a proper structure for the finding and analyzing of barriers against EVs uptake. The following structure was presented to achieve this: finding barriers by literature review, classification of the found barriers into different categories, the use of the analytical hierarchy process and ,a multi-criteria decision method, to rank the identified barriers in accordance of their impact. The rise of electric vehicle market differs from country to country based on their economical, geographical and technological conditions. Some of the barriers are common in every country globally but some barriers differ.

Brady and Mahony in 2016 [1] studied the stochastic modelling of electric vehicle daily travel and charging profiles, it was to schedule charging profile and travel range for the electric vehicle users across the globe. The results of the research shows the level of uncertainty in charging behavior and travel distance of electrical vehicles. They concluded that modelled charging profiles helps in grid integration studies. S. Steinhilber in 2013 [2] studied the important tools and strategies for introducing new technology by exploring key barriers to an EV in two countries and also concluded that immature developing technology is reason behind non-commercialization of EVs in countries. P. Morrissey in 2016 [3] studied that most of the electric vehicle users prefer to charge their vehicles at home during peak demand time in the evening. Also he concluded that car parking spots were most renowned charging location amongst the users. A. Foley in 2013 [4] examined the electric vehicle charging at peak and off-peak scenarios in a an electricity market in Ireland and concluded that the peak charging is more harmful as compared to off-peak charging. F. Salah in 2015 [5] studied the electric vehicles charging impact on distribution substation. He concluded that dynamic tariffs and high penetration levels increases the risk of overload. Also , the dynamic electricity cost can also risk the substation overloads.

There are various mode of interaction between vehicle and grid such as Grid to Vehicle(G2V) , Vehicle to Grid(V2G) and Vehicle to Building(V2B). In G2V vehicle is charged from the grid. In V2G vehicle discharges power to grid, it also allows bi-directional flow of energy between vehicle and grid. In V2B energy transfers from battery to building.

II. ELECTRIC VEHICLE OVERVIEW

The main motive of electric vehicles is to replace all internal combustion engine with an electric alternative which is electric motor. The primary benefit of electric vehicles is that it does not harm environment. Although the production cost of EVs is very high , but working cost is very low so for long term it is very beneficial. The capacity of a vehicle's motor is approximately 102 kW which is roughly equal to 136 horsepower, but maximum torque can be delivered by electric motors over a wide range of RPM. The major parts of an Electric automobile are battery packs, DC/DC converter, charger, charging port, power electronics controller, drive system and for braking ,regenerative system is used.

The electric motor uses the electric power stored in battery packs and powers the vehicle. When the energy is converted from electrical to mechanical some percentage of energy is lost in the drive train and the motor but most of the percentage of energy from battery gets converted into mechanical energy. Usually , Li-ion batteries are used in electric vehicle because they are lightweight, more efficient and have very less maintenance. But the only drawback is that the manufacturing cost of Li-ion battery is higher than lead-acid battery and nickel-metal hydride battery. The purpose of the charging port is to connect the vehicle and an external supply system for the objective of charging. Charger basically acts as rectifier, it converts the alternative current from the supply to direct current and feeds it in the vehicle. While charging it also keeps a check on certain parameters such as temperature, voltage , current etc. The vehicle accessories requires comparatively lower voltage than the supply hence to run these accessories , DC/DC convertor is used to lower the high DC voltage supply from the battery. The power electronics controller manages the flow of electric power from the battery. Motor drive system is one of the important component of EVs, it transfers mechanical energy into wheels for mobility. Regenerative braking system is used in EVs. It allows vehicle's kinetic energy to be converted back into electrical energy during braking which is stored in devices like batteries, ultracapacitors etc. It can recover up to 15-20% of used energy for acceleration. So it can act as reserve fuel for the vehicle and because of this we can cover more distance and hence the range of the vehicle becomes slightly more.

III. TYPES OF ELECTRIC VEHICLES

Electric automobiles are categorized in to following types : Battery Electric Vehicles(BEV), Hybrid- Electric Vehicles(HEV) and Plugin Hybrid Electric Vehicles(PHEV).

A. Battery Electric Vehicle

These type of automobile consist of very high capacity rechargeable battery pack and no other fuel. The battery packs can be recharged using various source which are external. They store chemical energy which is further supplied to the vehicle. BEVs reduces CO2 emission as well as reduces fossil fuel dependency. Different batteries are used in an electric automobile such as Li-ion battery, Pb-acid battery etc.

The motor of this kind of automobile is always powered by a battery pack which is basically an alternative of IC engine and fuel storage of a conventional vehicle. It is also necessary that if the automobile is not in use it should be plugged in to the charger otherwise battery gets discharged.

B. Hybrid Electric Vehicle

These type of EVs comprises of IC engine as well as motor and hence called hybrid. The batteries of the vehicle gets charged by the engine and also by deaccelerating and braking(Regenerative Braking). Although the cost of hybrid electric vehicle is very high but it has several benefits such as high fuel saving cost and low tailpipe emission. There are several topologies in HEVs depending on type of hybrid system.

C. Plug-in Hybrid Electric Vehicle

These type of EVs consist of an electric motor and internal combustion engine . These vehicles are supplied power by high capacity battery packs as well as petroleum fuel. Although with 120V outlet , charging may take several hours but with 240V outlet it takes 1-4 hours to charge up completely. These vehicles use 40-60% less fuel as compared to conventional vehicles and also it produces less greenhouse gas than conventional vehicles.

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Large number of researches were conducted around the globe on HEVs. In 2008 Galus and Andersson [6] stated in their study that launch of plug-in hybrid automobile will lead to unification of automobile and power supply system, while Rashid Waraich in 2013 [7] used agent based simulation for PHEVs. He also studied the effect of PHEVs on the electric power system.
Saeid Bashash in 2011 [8] proposed a study that deals with the issue of optimized charging pattern of PHEVs. It is for cost control because it not only reduces the fuel cost but also provide 24 hours naturalistic drive cycle for battery discharge.

Jarod Kelly et in 2012 [9] studied about consumption of fuel and electricity by a PHEV. After proper analysis and research he found that on an average a normal PHEV consumes around 7 liters of fuel and around 50 kWh of electric energy per week. He also studied various effects such as effect of location, time and rate of charging on consumption of fuel and electricity.

IV. ELECTRIC VEHICLE SCENARIO IN INDIA

The electric automobile market in India is at very developing stage out of all the vehicle sale, it contributes 1-2%. As per the reports a total of 1.56 lakhs EVs were sold in year 2019-20 whereas in 2018-19 , 1.3 lakhs EVs were sold. So clearly there is 20% growth in vehicle sale in 2019-20 as compared to 2018-19. There is also a vision of 100% EV sale by 2030. As per the data there are only 164 charging stations in India which is very less as compared to other countries this is one of the reasons why India is lacking in development of EVs.
“Reva “ was the first electrical automobile launched by Mahindra in 2001, but due to lack of awareness about electrical vehicles not much units of this car were sold after release. China based companies like BYD Auto Co. Ltd has some contracts for delivering electric buses to different state transport firms.
Mahindra is the first company that came in to electric vehicle scenario in India. They planned to manufacture more than 50000 units of vehicle per year from 2020. The Indian branch of Hyundai Motors is all set to release its electric vehicle “Hyundai Kona” in August 2021. Maruti Suzuki will also launch its electric automobile “Wagon R EV” in August 2021. “Tata Tigor” was launched in the market by Tata Motors company in the year 2018.
For promoting electric and hybrid vehicles, National Electrical Mobility Mission Plan in 2012. The main aim of this mission was to make electric automobiles the first priority of the users so that it can take over IC engine automobiles which will in turn reduce the fuel consumption, be better for the environment etc.
As we know that use of renewable energy sources helps a lot in vehicle charging stations, so a solar based power source of capacity of 100 GW will be arranged by the government by 2022 National Electric Mobility Program was launched in 2018, the main aim was to create proper charging infrastructure also to set a target of more than 30% EVs by 2030. Fast Adoption and Manufacturing of Electric Vehicle(FAME II) was also introduced to encourage the users to buy hybrid and electric vehicles. FAME II was started with a total expense of Rs 10,000 crore in April 2019. Its primary aim is to create a strong and sturdy electric vehicle ecosystem as well as charging infrastructure, so that electric vehicles becomes the first choice of the users and sale of EVs increases. All the electric vehicles that come under FAME II can collectively save up to 75 lakh tonnes of CO2 emission over their complete lifetime. Also at state levels, many states have formulated electric vehicle policies which are being currently followed. While some states are planning to draft their electric vehicle policy.
The Society of Indian Automobile (SIAM) aims to sell 100% pure electric vehicles by 2030. For ensuring the smooth functioning and success of this vision , government ,stakeholders and various manufacturers should come forward and invest in this.

V. CHALLENGES AND BARRIERS AGAINST ELECTRICAL VEHICLE IN INDIA

A. Technical

1) *Limited driving range of the vehicle* : Basically , drive range is the distance that the electric vehicle can cover in one full charge. Practically an electric vehicle has significantly less drive range when compared with IC engine vehicles. Lesser driving range is one of the major barriers against electric vehicle. In India most of the battery based vehicles provide a drive range of 200km – 300km , although some newly launched vehicles can give a drive range up to 452km. So very long trips in an electric vehicle is not practically possible and hence it act as a barrier.
2) *Limited battery life*: As we know that electric vehicles are powered by battery packs so it plays a major role in an EV. However the lifetime of a battery is limited, most of the manufacturers give warranty for maximum 8-10 years. Excessive charging also reduces the battery lifespan. So because the lifespan of the battery is limited so it has to be replaced after a certain period of time which becomes problematic for the user.

3) *Charging time*: In India there are different fast and slow charging points. Hence an electric car can take maximum of 11-12 hours and minimum 1.5-2 hours to get fully charged. Fast charging points are costlier where as slow charging points are comparatively cheaper. So either the user can get fast charging by spending more or slow charging by spending less. In both ways there is a problem. Another factor on which the charging time depends is battery size. Bigger the battery size , more time it will take to get fully charged .

B. Social

1) *Lack of knowledge*: If the users don't have proper knowledge about the product then it leads to market failure. However electric vehicles are considerably new to the market and users don't have proper knowledge about it and hence don't understand the quality and benefits of it and therefore are hesitant to shift on EVs from conventional vehicles.
2) *Lack of Environmental Benefits Awareness*: As we know that emission is a big threat for environment as it harms the environment and electric vehicle basically focus on emission reduction which saves the environment from many harmful gases and pollutants. Many users are not aware of this benefit.

C. Market

1) *Vehicle Service*: For proper functioning of electric vehicle , servicing and maintenance of the vehicle is necessary. Hence there should be sufficient number of trained and skilled individuals who can identify and repair the faults of EVs. This is very essential for uptake of electric automobile.
2) *High Investment*: As the manufacturing cost of electric vehicles is very high, hence the user has to pay high amount to purchase electric vehicle. The battery of the automobile is also very costly and it needs to be replaced in every 8-10 years. So the overall investment in electrical vehicle is much more than conventional vehicle.
3) *Fewer Electric Vehicles*: In Indian market there are very less option available in electric vehicle models, hence the choice for the users is very limited. Whereas if there are more number of models, it will broad up the choice of users which will help in uptake of EVs.

D. Infrastructure

The number of charging stations in India is very low which affects the sale of electric vehicles and hence growth of electric vehicle market is very low. The government should invest more in building up more charging stations and fulfil the electricity demands of them, so that charging requirements of more users can be fulfilled. Places like home, parking etc should be slow charging stations whereas commercial locations and highways should be fast charging stations. So combination of both slow and fast charging is ideal for an EV.

E. Policy

For the uptake of electric vehicle in India , the government has ideas of subsidizing electric automobile charging infrastructures. They also released an order that charging of an EV can be done without any license, it will help to improve the charging infrastructure of the country. The government should also formulate new policies which promotes the use of electric vehicles and also motivate the users to shift to EVs from conventional vehicles.

VI. CONCLUSION

There are various types of electric vehicles such as battery, hybrid and plug in hybrid vehicles ,these vehicles saves the cost of fuel as well as benefits environment by reducing emission of harmful gases such as CO2 but these types of vehicles have higher manufacturing cost so the user has to invest a higher amount initially as compared to conventional vehicles.

This paper includes a brief on types of electric vehicles and their scenario in Indian market also the steps taken by government to promote the electrical vehicles by formulating various policies. Also, government is aiming to achieve 100% electric vehicles in public transport and 40% in private vehicles in India by 2030.

This paper mainly includes summary of all the challenges and barriers that are being faced by electric vehicle particularly in Indian market.

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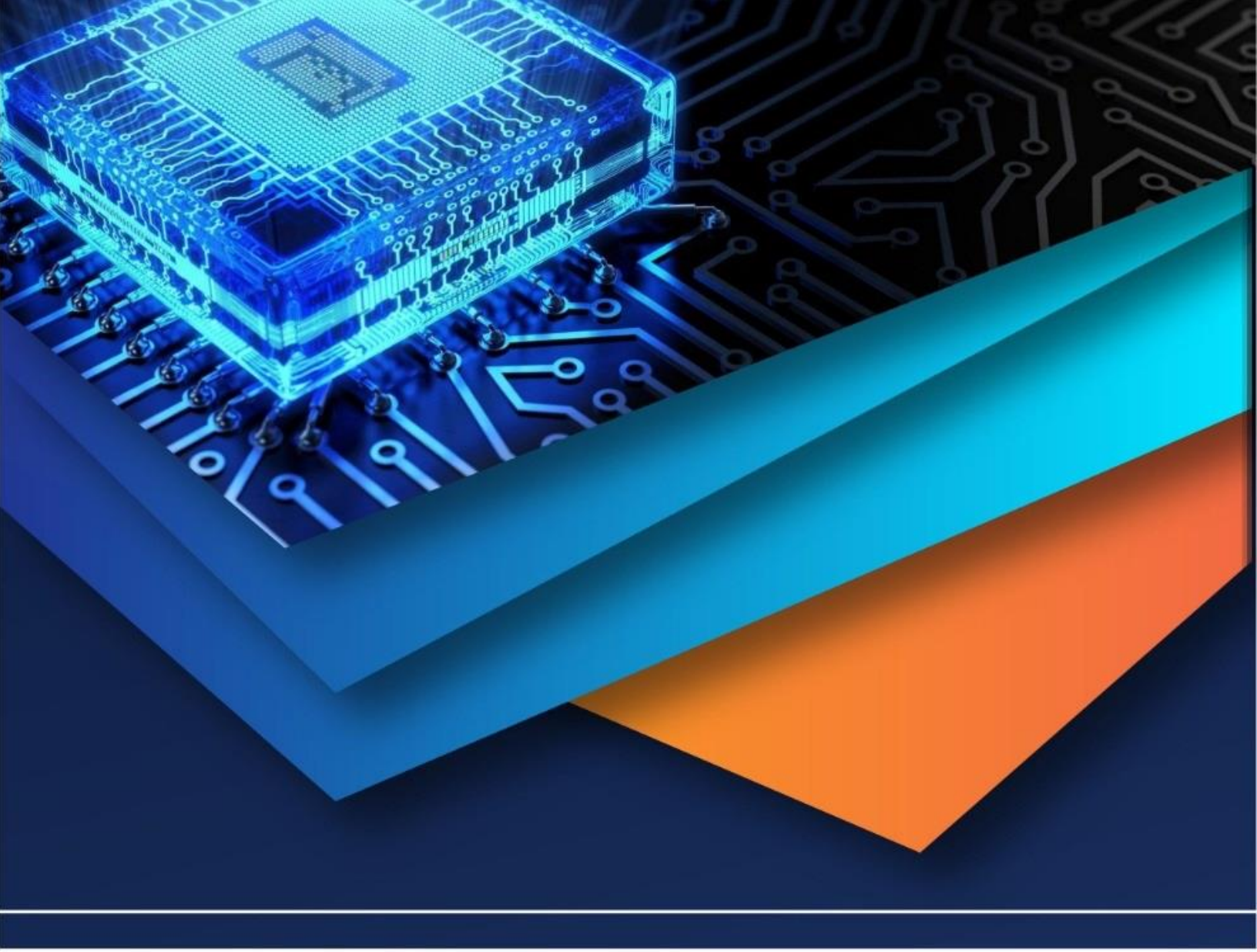

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