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ELECTRIC VEHICLES: REVIEW ON CURRENT TRENDS, POTENTIAL AND CHALLENGES

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Abstract

With the increase of the effect of global warming, the automobile industry globally is shifting towards environmentally friendly vehicles with better range and performance than that of conventional vehicles. Electric vehicles can be considered that effective solution to reduce the greenhouse effect. Though various researches on the attributes and characteristics of Electric vehicle are going on even then the development and modeling of Electric vehicle is not at the required level.

This article describes the concepts, market, characteristics, trends, challenges, and future of Electric vehicle. This article also aims to highlight and suggest some solutions for the challenges that are ahead of us.

Keywords: *Electric vehicles, current trends, location studies, market potential, future research*

Introduction

The market of Electric vehicle is growing in a big way globally. India also aims towards e-mobility completely by 2030. The demand for this type represents both a challenge and an opportunity to capitalize on new vehicle technology and in the process, reap substantial economic development benefits. Electric vehicle develops the creation of additional opportunities by the improvement in the quality of life, reducing energy spending and decreasing reliance on foreign oil[1].

However, the widespread use of Electric vehicles faces hindrance due to factors like the limited battery capacity, which cruising between 150km and 200km[2]. Many restrictions are introduced in the travel behavior of Electric vehicles' drivers due to the driving range limit, because of insufficient coverage of charging stations infrastructure in the near future time period.

The advancement in Electric vehicles will lead to some profound changes including technology, manufacturing systems, distribution and aftermarket service, and support. The manufacturing of Electric vehicles is less complex compared to ICE vehicles due to fewer moving components.

In this article, various topics will be explored, but the core focus and structure of this article are described as follows.

- It comprises the study on the design of charging stations and location to set up the charging stations. These factors are typically concerned with the acceptance and development of EVs in the market.
- We will observe the behavior, demand and market potential of EVs from the diverse aspects like infrastructure challenges and opportunities. The characteristics of EV's behavior will also be discussed in comparison with conventional vehicles.
- Finally, the potential future and research direction for Electric vehicles will be suggested and discussed.

Designing charging stations and their location studies

For EV drivers the charging facilities are absolutely essential. There are many concerns regarding the location and type of charging stations by the EV companies and government due to the excessive cost of these facilities. Although the construction and expansion of charging station infrastructure are under planning by many cities[3]. There are many examples of EVs like Nissan Leaf, Chevrolet Volt which recharge their vehicle battery by commending it into power grid either at home or office[4]. The charging time period of the battery is extensive thus EVs can be used merely for short distance travel. There are many pieces of research going on by the EV companies to overcome the limited range problem by charging it fastly within few minutes at fast charging stations. An optimum design of a fast charging station for EVs was proposed by Bai et al.[5] to minimize the load on the power grid while supplying vehicles with the required power. Qiuet al.[6] analyzed the characteristics of EVs' arriving time and charging duration in fast charging stations.

For countries like India, the government is trying hard to convince people to enter Electric vehicle the part of our road transport system. Although people are reluctant to purchase Electric vehicle. The range of Electric vehicles comprise the most critical factor due to which people are not willing to buy it. The charging stations play a vital role to remove "Range Anxiety" from the mind the people.

On comparing with the conventional vehicles, the Electric vehicles take more time to recharge, and the operating cost of charging stations are moderately high[7]. In the case of India, the road network of 54 lakh km has absolutely no infrastructure for supporting EVs, thus country needs an extensive network of EV charging stations as the government is aiming towards e-mobility by 2030.

The improvement in the profitability of fast charging stations and decrement in high energy demand from the grid can be attained by the inclusion of renewable generation and storage system. For example, the charging stations of Electric vehicle can also be powered by solar energy. On the roof of charging station number of solar panels can be placed and these solar panels will be used to deliver power to the charging point. With the use of solar energy, there will be a reduction of the load on power grid a considerable amount of fossil fuel used in producing electricity can also be saved.

There is a subsidiary problem with regard to the location of fueling stations of EV which includes battery recharging, exchanging and other refueling options[8-10]. During the earlier days of EV, much money was wasted to install charging stations in impractical locations by companies and local governments. But no one was at fault that time it was solely because of the lack of knowledge and information about EVs.

Several factors which affect the siting of charging stations:

i. **Connection to electrical power :**

A number of options are present for the connection of EV supply equipment to electrical power. Attaching a new circuit to the surviving one represent the most fundamental choice on the site. The connection on a dedicated circuit to the electrical panel should be made by EV supply equipment. There will be an increase in the cost as the distance between the electrical panel and EV supply equipment increases. For the fast charge capabilities, creative connections are required to supply to the utility owners.

ii. **Power capacity :**

Due to EV charging, power load caused and it is corresponding to the number of EVs charged and type of equipment used on the site. For Level 1 EV supply equipment power capacity is a minor, localized issue. There is no assurance that the available space in the existing electrical panel has electrical load capacity for EV charging.

iii. **Environmental factors :**

While designing the charging station for outdoor use under wet conditions, try to prevent installation in flood-prone areas to prevent the components of the EV charging stations come in contact with water. As a precautionary measure wall or pole mounted EV supply equipment can be considered to set up where there could be an occurrence of localized pooling.

Solar energy can be combined with the EV charging stations installed. The location must be decided on while keeping in the mind about solar access. Siting of EV charging stations provides the most adequate protection of EV supply equipment against harsh weather conditions is in enclosed locations.

While evaluating the siting always considers the issues related to light, flooding, cold weather and moisture.

EV market current trends and potential

While the growing price of conventional vehicles people has started searching for other alternatives with more reasonable cost. This is causing the shifting of attention of consumers' towards EV. There are other factors such as environmental concerns like global warming and increase in government initiatives towards the environment's protection are the fueling factors for the growth of EV market globally. EV possesses several advantages but despite their advantages, limited range and high initial cost are causing the resistance in the sale of EVs at large scale.

The market of EV was valued at $118,8645 million in 2017 globally but at a CAGR of 22.3% from 2018 to 2025 it is projected to reach $567,299 million by 2025.

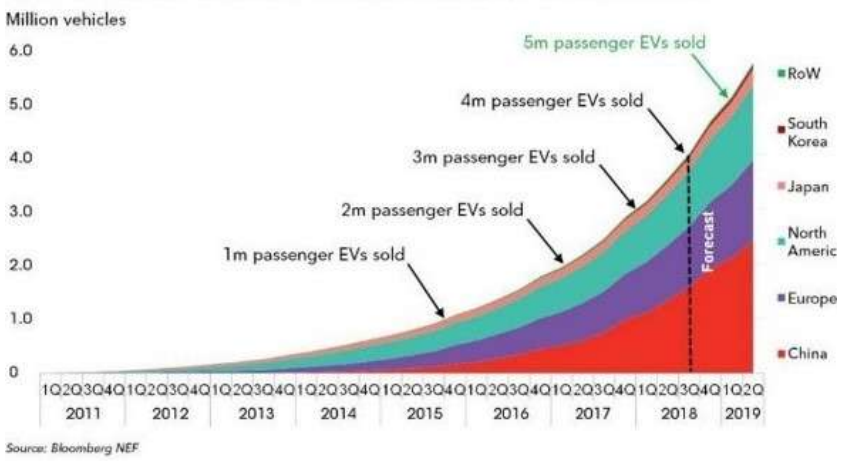


Figure: 1

Various models are proposed, and numerous studies take place regarding the market potential and behavior study of EVs. An analyzation regarding the willingness of customers paying for EVs and their attributes using a stated preference study was done by Hidrue[11]. It analyzed that the driving range, fuel cost savings and charging time are considered as the most salient factors and battery cost must decrease before finding a mass market without subsidy for EVs.

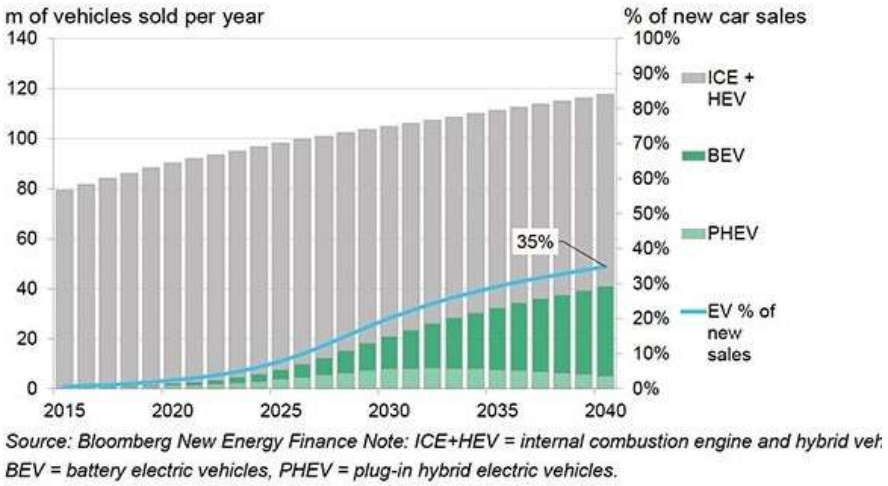
A model was proposed by He also to capture the interactions among public charging opportunities, prices of electricity and destination and route choices of EVs[12].

Potential future and research suggestions

Little previous research has been done on multi-class EVs. There are various types of EVs, and different EVs have different battery capacities or range limits. On top of that, the corresponding charging system (e.g. connectors and plugs) differs.

In the near future, e-mobility would not be something of luxury, but it would be something necessary for the survival because the pollution level is alarming and the only solution is the green sources and transmission of energy. On that account, EVs are inevitable when it comes down to it, so it is worthier to foresee and put together about how the developments are going to occur rather than dodging the change. The earlier this realization occurs, the better. It is required to lay prescriptive guidelines and a time managed framework as to how changes are going to occur and how to make the most of it. There are strengths and weaknesses in every domain which need to be contemplated upon and eradicated respectively.

Recent advances in technology suggest that driving range can be extended, charging time shortened and battery cost lowered. Also, after a few years of massive production, the unit cost for EVs, like most new technologies, is likely to fall[11].As a result, it is beneficial to penetratethe market for EVs in the future when there are large push and sizable investment of resources in favor of EV.



Source: Bloomberg New Energy Finance Note: ICE+HEV = internal combustion engine and hybrid vel
BEV = battery electric vehicles, PHEV = plug-in hybrid electric vehicles.

Figure: 2

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