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A Detailed Study on Electric Vehicles

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Abstract- Over the past several years, there has been an escalating interest, echoing enthusiasm, for electric vehicles. Electric vehicles (EVs) are becoming more typical in the transportation sector in recent times. As the current progression suggests, this form of transportation is more prone to oust internal combustion engine (ICE) vehicles in the coming years. Each of the essential EV components has many technologies that are being used right now or can become eminent in the future. With the right administration, EVs could be turned into a crucial contributor to the successful implementation of the smart grid concept, despite its several flaws. This paper gives an outline of the recent work of electric vehicles in the domain.

Keywords- Electric Vehicle, Electric Propulsion, Energy Sources, Charging time, Battery Capacity, Mileage, Economy

I. Introduction

In the past few years, electric vehicles (EVs) are mustering popularity, and there are multiple reasons behind this. Electric vehicles (EVs) based on the electric propulsion system generate thrust by different types of electric propulsions i.e. this system generates energy collected by either solar arrays or a nuclear reactor, thus eliminating the need of storing propellants on the vehicle. No internal combustion engine is used. All the power is based on electric power as the energy source. Thus, reducing their contribution to greenhouse gas (GHG) emissions. In 2019, the transportation sector was the most significant contributor to greenhouse gas emissions, with about 29 percent of emissions.[1] EVs are preferred by the majority of the people as an EV does not contribute to noise pollution, easy to operate, does not have the fuel costs associated with conventional vehicles and as an urban vehicle, it is highly useful. One of the qualities that attract people is the high efficiency in power conversion through its proposition system of electric motor. It does not use any stored energy or cause any emission while not in use or sitting idle. As EVs can provide instant torque, which makes them highly favoured for motorsports. In the late 19th century and the early 20th century, EVs became 28% of the total vehicles and were preferred over commercial vehicles with internal combustion engines.[2] But the ICE types of vehicles gained a boost due to low oil prices. Soon the monopoly of the ICE vehicles started, and they became more advanced, and EVs got lost into oblivion. Some of the leading car manufactures like Toyota, and Honda had brought out their own EVs which are were received by the consumers in the 20th century. Currently, the market is dominated by Chevrolet Nissan, and Tesla. Being an evolving and expanding technology, electric cars nevertheless have limitations that must be overcome to enable them to penetrate deeper into the market. This paper was created as an effort to sum up all there is, to know about EVs including their future scope in the transport market.

II. Why Electric Vehicles?

As EVs are becoming more mainstream, that leads to a drop in the prices appealing to a larger audience who want to switch from ICE vehicles to EVs. From the environmental perspective, you save a lot on fuel and not contribute to noise pollution. EVs could help you save significant amounts of money on maintenance costs in the full lifetime of the vehicle. These cars are mapped out to be quite efficient as possible. A fully electric car has three crucial parts firing up the car: the motor, inverter, and onboard charger. Leading to barely any wear and tear on the vehicle and very less strain on the engine motor, with hardly any moving parts prone to damage. Which therefore means that having your EV reconditioned and the repair costs are negligible. Re-charging your car at home is quite fast, cost-efficient, and easy. There is a one-time charging unit that needs to be installed. Once installed, the car can be charged by plugging in the charging cable when the car isn't being driven. When you sit back to calculate the cost per mile of an EV, it might cost a quarter or under of what a conventional petrol or diesel vehicle might. There is a myriad of options to build an EV with. They can solely be driven with stored electrical power, some could be dependent on ICE for power, and there are also some vehicles that could use both the configurations, electrical motors the Internal Combustion Engine jointly. EVs could be regarded as a merger of different sub-components. Each of these components interconnects with each other to make the vehicle drivable. Although, EVs powered with the batteries are the most used ones. There are different types of EVs currently in use:

- Battery Electric Vehicle (BEV)

Electric Cars which use batteries to generate power to run the motor are known as BEVs. They rely solely on the energy stored battery packs; hence the distance span of these vehicles depends on the capacity of its battery.

- Hybrid Electric Vehicle (HEV)

This type of car employs both an electrical power and ICE to power the vehicle. When the power requirement is low, the car uses the electric propulsion system, hence reducing the fuel requirement, GHG emissions. When higher speed is required, the car switched to ICE. Both work together and improves the car performance.

- Plug-in Hybrid Electric Vehicle (PHEV)

The PHEV concept came to light to provide a power range in the HEVs. As the name suggests, its similar to the HEVs as it uses both, an ICE and
an electrical power, but the main feature different is that these cars use electric
propulsion as the main driving force, hence requiring a bigger battery capacity than HEVs.

- Fuel Cell Electric Vehicle (FCEV)

These vehicles use fuel cells that produce chemical reactions to generate electricity. The preferred choice of fuel is Hydrogen, also calling these vehicles hydrogen fuel cell vehicles. Hydrogen is stored in pressurized tanks and Oxygen from the atmosphere is used to combine and generate power to run the motors. In case, extra power is produced, it can be stored in batteries and used later.

III. Electric Vehicle (EV) History

As the technologies advanced with the increase in the income of the people, experimentation with the newer technological transportation started. Leading to the first concept of an electric car being introduced over two centuries ago in the 19th century. Electric cars are in high demand today for many of the exact reasons they were first known for. Their discovery and evolution are regarded as more of a series of discoveries and creations that would in the end amalgamate into the electric car. Even though the experimentation with the production of separate parts like batteries and the electric motors started in the early 19th century, it wasn't until the early 20th century when people started using EVs as the main source of transportation. In the series of innovations, first came the smaller version of the electric car powered by a new motor by a Hungarian priest and physicist, Ányos Jedlik. It is the first known production of an electric car. Then came the motorized crude electric carriage developed by Scotland's Robert Anderson in the early 1830s. Around the same time in the Netherlands, Professor Sibrandus Stratingh and his assistant Christopher Becker from Germany also built a small-scale electric car that was powered by non-rechargeable cells. In both cases, the main setback was the batteries (galvanic cells) weren't rechargeable. It wasn't until the late 1850s when rechargeable batteries came into light. Around the year 1884, Thomas Parker helped deploy electric-powered trams and electric cars in England. By 1890, a Scottish man - William Morrison living in Des Moines, Iowa had filed for a patent on the electric carriage he had built. Being

a self-propelled vehicle, its 24 battery cells needed recharging every 50 miles. As the 20th century was round the corner, the primary form of transportation was still the horse. People started earning more money and turned to the newly developed motor vehicle which was available in 3 versions - gasoline, steam, and electric. Steam cars weren't developed until the late 1860s, although steam trains and factories were operating over a century ago. Steam vehicles would require a long time to start, hence limiting their range. Then came the gasoline-powered car in the 1800s, which wasn't preferred by the people because changing the gears was difficult, it was noisy, and required a lot of manual effort to drive. On other hand, electric cars didn't have any of the issues, they were easy to drive and required less maintenance. Hence, EVs became quite popular for short trips in the city. Many innovators around the world started improving on the existing model of the car and now as we have it, it is one of the most famous forms of transportation.

IV. Pure Electric vehicle

A pure electric vehicle (PEV), also known as all electric vehicle, operates mainly on electricity as its name suggests. An on-board battery pack module as shown below, stores the electricity which is used to power the vehicle. The battery charge can also be additionally extended while the vehicle is being operated through the regenerative braking system. The otherwise lost kinetic energy from the braking is saved in a storage battery which can be used later to power the motor when in need. While the vehicle is not in use, the battery pack is recharged by plugging the vehicle into an external electric power source such as a charging station or a home outlet.

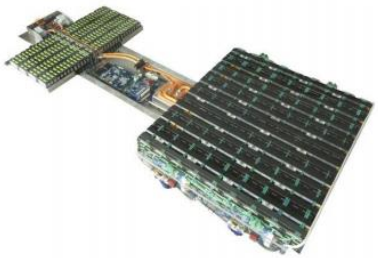

Figure 1. Typical PEV battery pack

Since there is no gasoline engine in pure electric vehicles, they do not have any tailpipe emission. However, these vehicles do cause emissions which take place elsewhere, such as the electric power plant and the manufacturing facility with amounts varying greatly based on the source of electricity and maybe the energy used. Compared to the gasoline vehicles, all electric vehicles are more energy efficient as they are able to convert about 59%-62% of the electrical energy provided by the grid to power the wheels, whereas a typical gasoline vehicle is only able to convert about 17%-21% of the energy stored in gasoline useful power.[3] Their driving range on a full charge battery typically ranges between 60-100 miles, with a few exceptions which can reach up to 200-300 miles, as in Tesla Model S 8D ($85,000) with a boasting rating of 270miles on a full battery charge. To recharge the battery pack fully it typically takes between 4-8 hours, according to the kind of charging technology use. Option for 'superfast charging' is also available which can recharge the vehicles battery to 80% capacity in about 30 minutes, but these may increase the cost of the vehicle.

V. Charging Basics with charging time, battery capacity, mileage, economy

The charging equipment for all plug-in vehicles is referred to as EVSE (electric vehicle supply equipment) and it is classified by the speed at which the vehicles battery is charged. Charging time of the vehicles vary depending on several factors such as the batter's capacity, its type, how depleted the battery is, the type of EVSE used and the amount of electricity supplied. Currently there are different types of EVSE; AC Level 1 Charging, AC Level 2 Charging and DC Level 2 Charging, also known as DC Fast Charging. In the first two methods, alternating current is used and in the third method, direct current flow is used. Following table provides a summary of their most important features.

Type	Voltage Input (Volts)	Charging Rate (Miles of range per 1 hour of charging)
AC Level 1	120V AC	2-5 miles/charging hour
AC Level 2	240V AC	10-20 miles/charging hour
DC Level 2	480V AC three Phase	50-70 miles in 20 minutes

Table 1. Charging Equipment

The AC Level 1 EVSE provides charging to the battery through a 120V AC plug with the help of a power cord. Most of the electric vehicles in the market uses AC Level 1 charging corset and therefore no additional charging equipment is needed to be purchased by the owner. This kind of charging technique provides slowest charging rate. This kind of charging can be very beneficial if one has to charging their vehicle form home. The AC Level 2 charging equipment used a 240V electrical supply, which helps in offering charging rate higher than the AC Level 1 does and thus it reduces the vehicles charging time considerably. This is widely used for public charging equipment and also for home charging, where the EV owner can fully charge their vehicle overnight. AC Level 2 charging equipment uses the same type of connector as used in AC Level 1 charging and therefore all the commercially available plug-in electric vehicles have the ability to charge using either of these two charging methods, there some exceptions like Tesla vehicles which uses special adapter to do so. The DC Level 2 charging equipment provides the fastest charging method which is currently available in the electric vehicles. With the help of 480V input, it enables fast charging along with heavy traffic corridors at installed stations. This particular type of charging method offers a restricted charge, stopping at 80% of the battery's state of charging level, or it may change the charging rate after the limit is reached, which helps avoiding potential damage to the vehicles battery.[4]

VI. Advantages of EV

Fuel for electric vehicles can be harnessed from any source of electricity which is available in mist homes and business places. Hydrogen and carbon monoxide which are responsible for environmental pollution by 985 can be reduced by using these vehicles. There is very small percent or no emission by these vehicles.

VII. Disadvantages of EV

These vehicles can be used for limited distances as the vehicle may breakdown if there is no power left in its battery. Air conditioning and radios may drain the battery which may again reduce the life of the battery per charge. These vehicles are heavier because of the weight of the electric motors, batteries, chargers, and controllers. These vehicles are more costly than other vehicles as the cost of parts used in these vehicles is more.

VIII. Future of EV

The future electric vehicles will most likely carry lithium-ion phosphate (LiFePO4) batteries. The LiFePO4 batteries are rechargeable and powerful which is why they are used in electric bikes and scooters. Other technique that may be used in the future electric cars will be increased use of supercapacitors and ultracapacitors which is useful for storing and delivering electrical charge. Markets for electric vehicles will be wide open if the manufactures of electric vehicles provide the vehicles with the range of about 300miles and the charging time around 5-10 minutes. There are many researchers already working on improving the battery technology by increasing the driving range and decreasing the charging time. All these factors will ultimately determine the future of electric vehicles.[5]

IX. Conclusion

As seen in the above report, the electric vehicles have many advantages and benefits over the IC engine and hybrid vehicles. They are cleaner and are much more efficient, however, it has some disadvantages at the same time. These vehicles are heavier, limited to some distance and higher cost. The future of electric vehicles completely depends on the changes made in batteries in the future. As of today, there are electric vehicles available in market, but there are some disadvantages which needs to be improved in future. If the disadvantages are improved, then the electric vehicles have promising future.

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