Review on Electric Vehicle Technologies

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Abstract

Society is more concern by the causes and effect of Internal Combustion (IC) engine emission on the climate and environment. The major reason due to which the automobile sector had to conceive, discover, design, build, and bring the Electric vehicle (EV) technology into existence. Electric vehicle has the potential to address greenhouse emission and also it acts as an emerging tool for reducing air pollution and providing a clean transportation system. Just in few numbers of years the rapid rise in EV technology has been observed with a huge growth and demand of public. Keeping the advantages and disadvantages in mind of EV from environmental point of view has been discussed. The most important factor for EV technology used is the batteries, hence a thorough study of battery technology- from Lithium batteries to lead acid batteries is analysed. The charging method, standards, and optimization techniques is also been discussed with the essential characteristics of EV technology used in vehicle. Further future trends, demand, supply in EV technology is provided.

Keywords: IC engines, electric vehicle, Batteries, lithiumion, leadacid

1 INTRODUCTION

The automotive industry has become one of the world's most important industries, no not only at economic level, but also in terms of research and development. Automotive industry has always contributed towards the improvement of its own technologies to move great number of vehicles by providing a pleasant and a cozy ride. Apart from this safety and security of the passenger has always been the first priority under any circumstances and never compromised.

Firstly, according to the research report of European Union, it says that 28% of carbon dioxide (CO2) emission is because of transportation sector which has given a snowballing rise to air pollution for the environment, on the other hand the research also stated that 70% of air pollution caused is because of transportation sector emission. Air pollutants that are released in atmosphere due to improper burning of fuel in engine are such as PM, nitrogen oxides (NOx), CO, sulphur Dioxide (SO2) is harmful for the climate and the environment hence Electrical

Vehicle came into picture which have no tailpipe emissions but on the other hand manufacturing of the batteries which is used in electric vehicle use a great deal of energy and often creates pollution but the rate of pollution is comparatively less than what is produced from Internal Combustion (IC) engines (1).

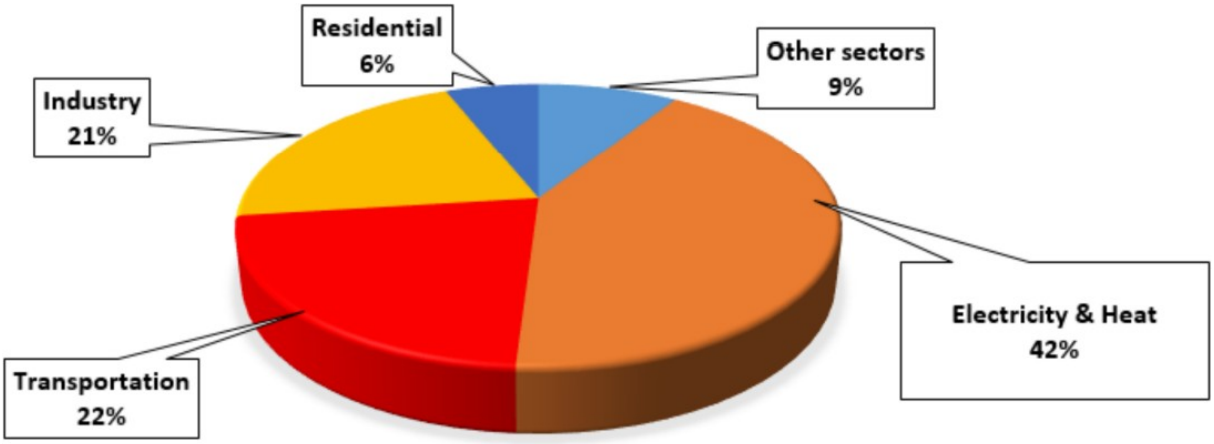

FIGURE 1

1: CO2 Emission by different sector (2).

Above figure shows that Transportation is one of the significant emission sectors, contributing to 22% of the total CO2 emissions in 2020 transportation sector (automobile), and remaining amount of it is use for other services such as Industry, residential, and other services (2).

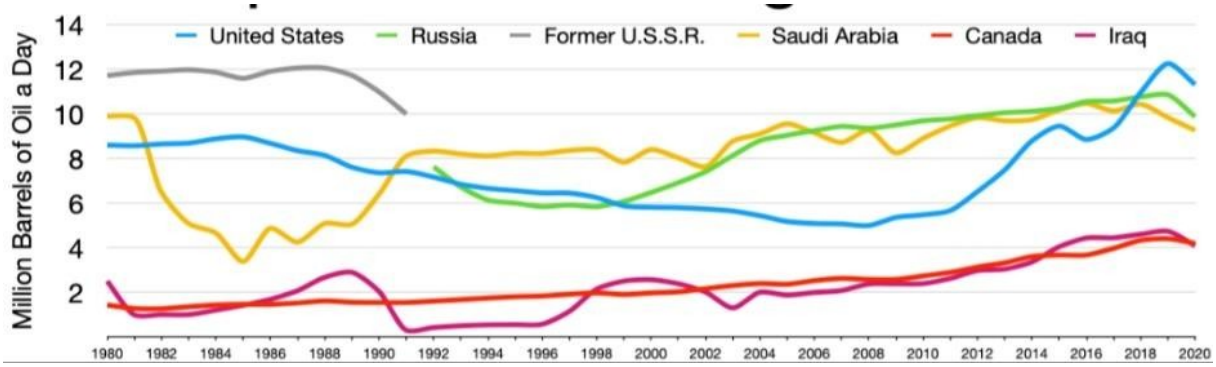

FIGURE 2

2: Top 5 oil producing countries 1980-2020 (13).

The graph here clearly shows the amount of oil extracted from different countries in millions of barrels on a daily basis, based on the study of this graph it is very easy to find out or to get an idea how fast the demand for oil from 1980-2020 has increased (13).

As of the research of U.S. Energy Information Administration's (EIA), the yearly global supply of crude oil in 2019 was about 35.9 billion barrels. A basic calculation has revealed that earth

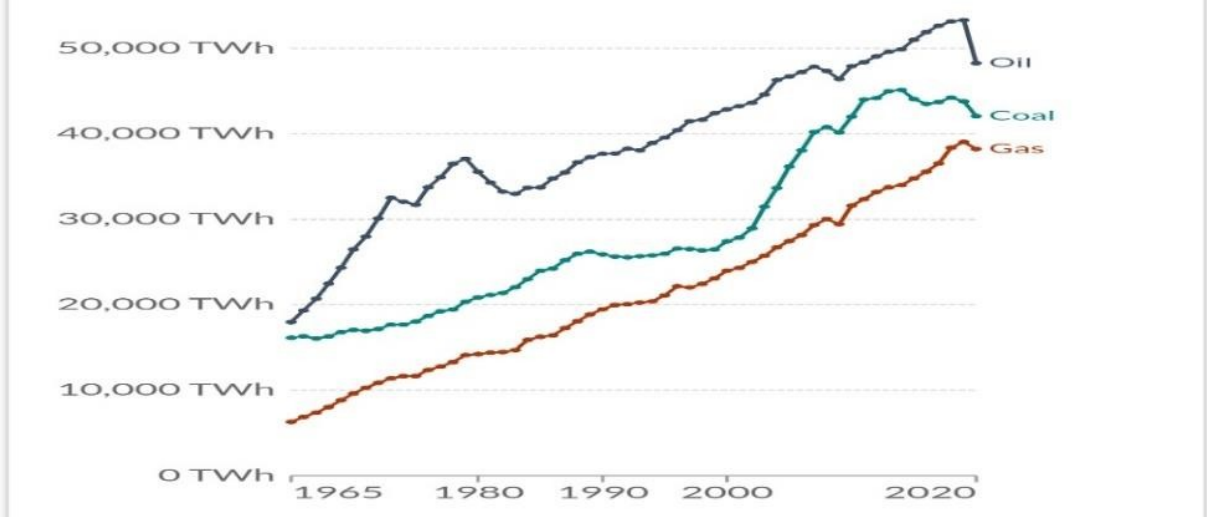

FIGURE 3

3: Fossil fuel consumption, since 1965-2020 (Statical review of global energy) (12).

has nearly 1.688 trillion of barrels of crude oil left, which will last for around 53.3 years at current percentage drill of oil. This stands as the second main reason for which the automotive industry had to do a huge research, calculation and keeping all the sectors of future possibilities in mind, automotive industry thought of a rescue plan which would keep the life of people keep going under the same comfort for travelling from one place to another. So as then after conceive, discovering, designing, and building, Electric vehicle (EV) technology came into existence (12).

2 ELECTRICAL VEHICLE TECHNOLOGY

Bringing the Electric vehicle (EV) into picture is not just 10–15-year-old story, it has travelled a vast and a long journey of nearly 190 years from where it was first invented by a Scottish inventor between 1832-1839, the very first electric carriage in the world. But since electricity during those times was a serious complication EVs were not a viable option. As of now after decades the automobile industry has been exploring option to become more efficient and reliable mode of transportation as EVs technology has come into existence for future. According to the report by consumers, the overall repairing and maintenance cost of EVs has been 50% much lesser than the IC engine cars. As well as the amount of output rate of electricity required to recharge and run the vehicle for a minimum average of 100kms is cheaper as compared to the cost of fuel needed to run any petrol/diesel cars for the same range (9).

3 ANALYSIS ON BATTERIES OF ELECTRIC VEHICLE

Batteries acts as the heart of a EVs system over two decades in EV development and plans. Battery execution is administered by two critical components: energy, which for the most part manages the driving extent or range, and power, which is revealed at top speed and acceleration. There is generally a trade-off between range and performance. Batteries can either have higher energy or higher power, however not both (11). As per the information received by US Department of Energy it says that there are different types of batteries used in EVs such as Lithium-ion battery, Nickel metal-hybrid batteries & lead acid battery.

3.1 Lithium-ion batteries.

It is one of the most popular and widely used recyclable battery in EVs. It is adopted because of its high energy unit output, reduced weight, high efficiency, good high temperature performance and low self-discharge. The battery gets fully charged & discharge and receives 1000 cycles durability. EV generally uses 1800-1200 battery cells. The average battery cost for 1kwh is 15-18k and EVs uses around 28-35kwh lithium-ion battery which would be around 4-5 lakhs. Lithium-ion can be damaged/drained if left uncharged below 10%. Battery has a limited life cycle, it is good to go for 1,60,000 kms on an average battery or it comes with a warranty of 8-10 years (3).

3.2 Nickel metal-hybrid batteries:

It has been widely used in Hybrid-Electric Vehicle (HEVs). It has a much longer life cycle then lead-acid batteries and are safe and tolerant, only the disadvantage of this types of batteries are their high cost and the discharge speed is very fast even the heat generation is much more which can lead to problems. Hence, it is used in hybrid vehicle so as to use it as a backup plan for emergency. Life span of Nickel metal-hybrid batteries is somewhere between 1000-2000 life cycle (around 3-5 years). At the forefront these batteries system has a specific power cell energy data on range from 300 to 900W/kg respectively (based on cell weight). However, the cost of (NiMH) batteries is too high about 280US$/kWh (4).

3.3 Lead Acid Batteries:

These batteries can be designed to get a high-power output even more than lithium-ion batteries. It is inexpensive, safe and also reliable, but the major disadvantages of not using

these batteries in EVs is its low specific energy, poor cold temperature performance and has a short life span as compared to other EV batteries. Life cycle of lead acid batteries is between 500-700 cycles. If there is frequently tapping on battery bank, this could lead to replacement of batteries in less than 2 years of use. The cost of this batteries is nearly similar to lithium-ion batteries that is (469-549$/kWh) including installation, and this range can go higher or lower depending on the size of the system needed (4).

Battery type	Lead acid	Ni-Cd	Ni-MH	Lithium-ion
Energy density [a] (Wh/Kg)	35	40-60	60	120
Power density (W/kg)	180	150	250-1000	1,800
Cycle life [c]	4,500	2,000	2,000	3,500
Cost ($/kWh)[d]	269	280	500-1,000	Consumer electronics: 300-800 Vehicles: 1,000-2,000
Battery characteristics	High reliability, low cost	Memory effect	Currently, best value and most popular battery for HEVs	Small size, light weight
Application	Car battery, forklift, golf cart, backup power	Replacement for flashlight battery	HEVs, replacement for flashlight battery	Consumer electronics

FIGURE 4

5: Technical performance by existing battery types (4).

3.4 Electric motor:

EV use electric motor in order to rotate the wheel which in turns gets the power from the battery. The motor which has been relatively used for EV are DC motor, Induction motor (IM), Permanent Magnet Motor (PM), Switched relevance motor (SRM). Thus, the featured desired for EVs such as high efficiency, high instant power, fast torque response, high power density, low cost, high acceleration and robustness. DC motors are widely used motor back since 1990s. It has a capacity to deliver a torque speed from 0-100kmph somewhere around 8-12 seconds (8).

According to the comparative study done in the review paper it states that the EVs performance directly depends on the electrical motor specification. The carrying out speed of the motor depends on the torque and power speed characters. The performance which is related to speed and power of the motor can be seen in the below graph (8).

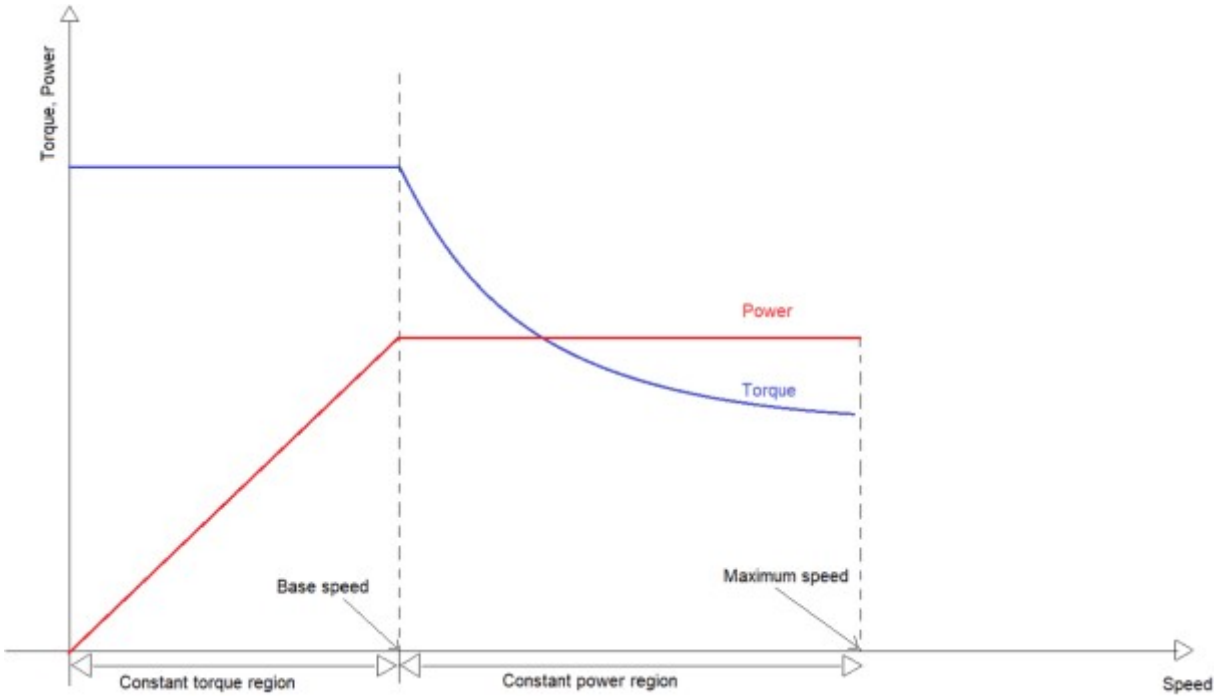

FIGURE 5

6: Performance related to speed and power of motor (8)

4 ELECTRIC CHARGING TECHNOLOGY

Charging plays a major role in EVs. Depending on the speed of charging and duration required to change the vehicle from low to full charge becomes a game changer here. Basically, the charging time of an electric car can take up to 30 minutes to somewhere over 8-12 hours too, depending on the battery size and speed of charging point. A standard EV (60kWh battery) takes about 8 hours to charge from empty to packed with 7kW charging port. The bigger will be the size of the battery the more charging time it will take. EVs need Direct Current (DC) to charge their battery pack. The different charging methods are wired charging, wireless charging and battery swapping system (2).

4.1 Wired charging technology:

This is the simplest and widely used charging technology. They are again classified under 3 categories (Private charging, Semi-public charging and public charging). Wired type charging has direct connection to supply the electricity from the wall mount outlet for charging into EV plug points located on the body of the car. Normally a wired charging technology takes around 8 hours to charge fully and less than 60 minutes by fast charger, with a range of (250-300kms) (5).

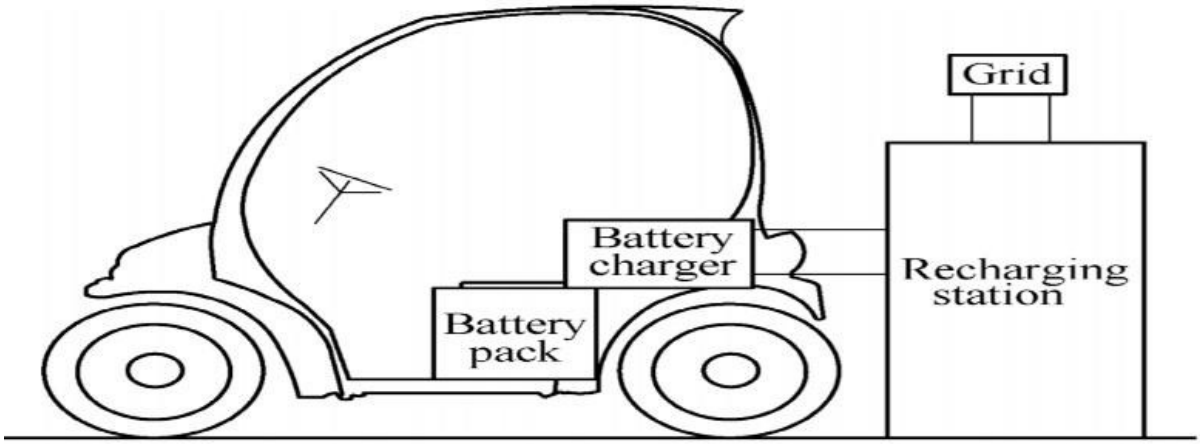

FIGURE 6

7: Wired charging (5).

4.2 Wireless charging technology:

Norway will be the world's first country to install wireless charging station in Oslo. This is a type of charging method to charge EVs without any direct connection of plug connected by means of wire to the vehicle. This technology is also known as "inductive charging". It uses an electromagnetic induction to transfer power wirelessly. A charging system is used to transfer high voltage and current directly from the grid into an inductive plate which is an electromagnet and acts as transformer. The other half is inside the EV, once both come into surface contact the current is flown and charging is initiated. Wireless charging is almost 4 times quicker then wired charging technology. "Plug less" is the only company offering wireless charging for many EVs on road (5).

4.3 Battery swapping technology:

Battery swapping technology which is also known as "Battery Exchange". China is the first country to start with this technology in the year 2021. China will be having its 4000 number of batteries swapping stations by 2025 as per the estimated calculation of China Government. Charging a battery may take hours but swapping a battery can be done in 3-5 minutes. It is the fast process, efficient and convenient to get an EV back on road, especially during long road trip. In this technology driver can disconnect the battery which is completely discharge or about to get discharged at swapping stations and replace it with a fully charge new one. This technology is also said to be the future for EVs (6).

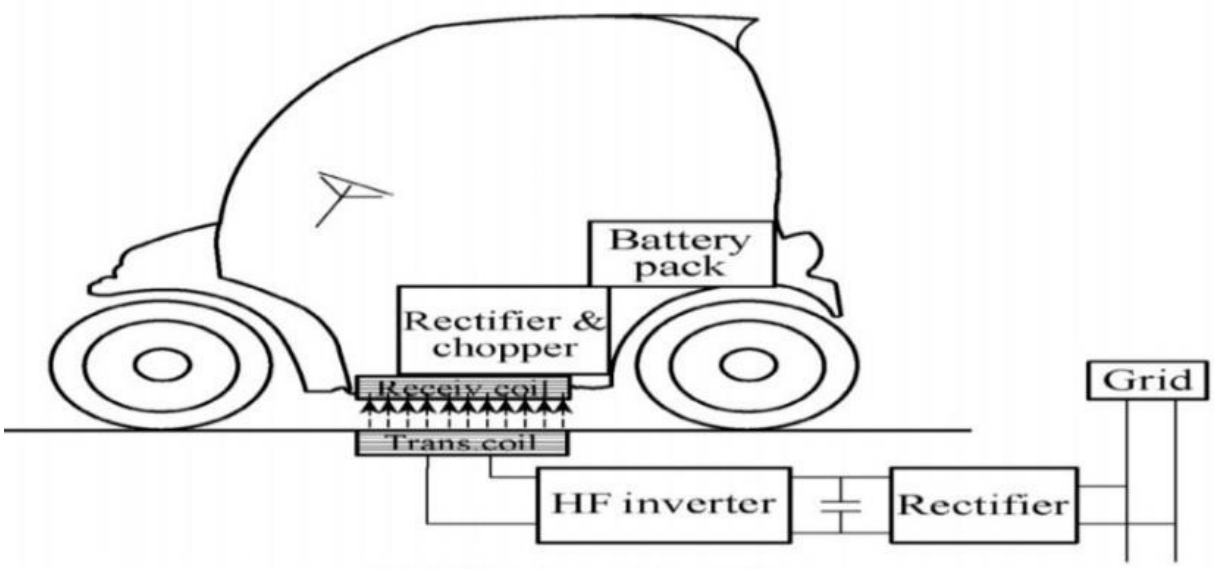

FIGURE 7

8: Wireless charging (5).

5 GLOOM OF ELECTRIC VEHICLE'S

Based on the study and research in (14) it can be concluded that even the EV's has a dark side of using lithium- ion batteries. The main reason is the production of batteries. The area which are rich in lithium reserves around the border of Chilli, Bolivia & Argentina. Only at max 54% of world holds lithium reserves. To get the lithium cell used for batteries it has to undergo 20 different stages and refining processes, which is further not a renewable resource. The paper states that if renewable energy sources are adopted the CO2 emission will be reduced (14). The weight of the battery in an EV's is almost hundred of KG, which is as much as one-third of the total weight of the vehicle. Once the life of the battery is over, it clearly indicates that the disposal of such batteries will be a problem (15).

6 FUTURE SCOPE

Despite of purchase price being so high for EVs as compared to Internal Combustion (IC) engine cars, EV cars have observed a significant sales growth in India. According to increase in the numbers of percentage it is highly expected by IEA (International Energy Agency) that sales will keep on rising in coming years. With reference to the report by IEA for sales in EVs it has reached a 3 million in 2020, up to 40% more growth than 2019 in the whole world. In the first quarter of 2021, global electric cars sales rose by around 140% as compared to same of 2020 (10).

China and Germany are the leading countries for EVs as in the terms of sales, only about 17000 EV cars were on road all over the world, but by the end of 2019, the number of EVs on road has boomed to 7.2 million. EVs are of great interest in India today, 97.5% of all electric vehicle sold in India was two wheelers. Reva was the first compact electric car that was unveiled in India by Mahindra Reva electric vehicles private limited in Bangalore 2001 Almost all the car manufacturers are planning to enter the market of EV in India. First it was just the Tata and Mahindra but now Maruti Suzuki, Hyundai, Toyota, Kia, MG Motors and many other are testing and planning to launch EV in next few years in India. Thus, showing a clear indication for strong growth of sales for EVs in India (7).

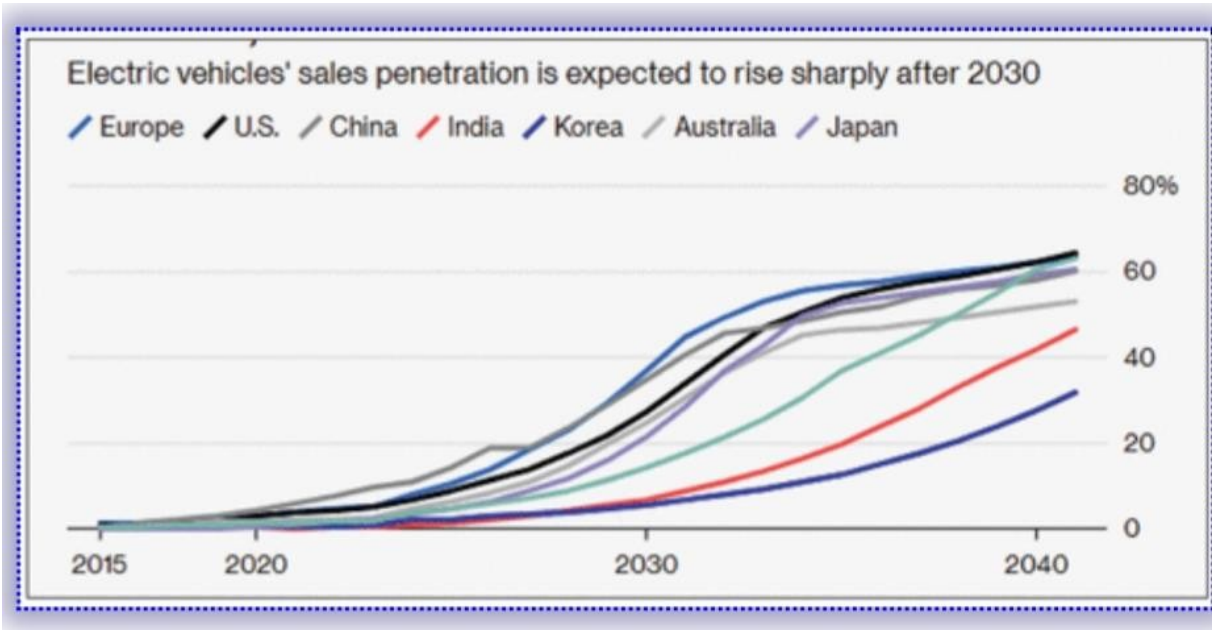

FIGURE 8

9: Projection of electric vehicles (10).

According to the case study done by professor Anantha Murthy (16) the report shows that in the year 2020 around 2,95,497 EV's were sold in India but in 2021 the sales got decrease to 2,38,120 with a decline of 19.4%. Also, as per the data given by Society of Manufacturer off Electric Vehicle maximum rise of sales in India was in the year 2019 with sales number of 7,59,000 (16).

7 CONCLUSION

This paper provided information about the advantages of EV over IC engines vehicles. A brief review study on EV technology and its various part used in EVs was done. In addition, the

paper also identified the types of charging method used for EV technology as well as the future charging method. The development in batteries and charging method will also favor the use of EV technology. The evolution of sales in last few years and also how important EVs are going to be for the betterment of our future is observed. However, the manufacturing part was not covered since the main focus was mainly on the standard and technology of EVs.

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