COMPARATIVE ANALYSIS OF ELECTRIC VEHICLES

Ishita Gupta[1],Anita Khosla[2]

[1,2]Department of Electrical and Electronics Engineering

Manav Rachna International Institute of Research and Studies, India

***Abstract* -This study will present a comprehensive look at the various types of electric vehicles and conventional vehicles. There is a growing sense of urgency for electrical vehicles in this era of global warming and harsh climatic changes due to it. There is a need to understand that out of the available range of conventional and electrical vehicles which will be the best. The focus of this review paper is to compare the features of all available vehicles and appropriate which is the best alternative. The vehicles which will be taken into account to find the most suited one are conventional vehicles and various electrical vehicles.**

***Keywords*- Electric vehicles, Conventional Vehicles, BEV, HEV & PHEV**

I.INTRODUCTION

Worldwide pollution has gained attention lately. The danger which is conventional gasoline vehicles have been posing to human health as well as the health of our plant is not one dimensional and is bound to thicken in impact following the worldwide upsurge in automobile industry.

A huge number of conventional motor vehicles occupy the sheets of all the countries of the world. This implies that those vehicles consume millions of liters petrol daily. The fuels on combustion contaminate the atmosphere releasing carbon monoxide, hydro carbons, lead and other particles. Once emitted into the air, diffusion of this air pollutant occurs, the degree of which depends on topographic, climatic and nuterological condition (zannetto, 1992). Since the 1880s it has been recognized that transport is the major source of air pollution. [1]

So, what is the solution to this extraordinarily hazardous problem? The evolution of electric vehicle has given a hope towards a light at the end of the tunnel.

Another major reason to bring forward the issue of conventional vehicles is the limitation of natural resources. Petroleum is the basis of the roadways worldwide. It comes as no surprise that the resources such as petroleum are depleting at a very high pace. These resources required millions of years due to burial heat and pressure. Until and unless a strong substitute is found, the doom of the whole transport system globally is certain. This is why electric vehicles are the need of the hour.

In this research, emphasis will be on learning about their construction, features, mechanisms and costs and then compare it with the conventional gasoline vehicles and thereby try to conclude as to which the best alternative is.

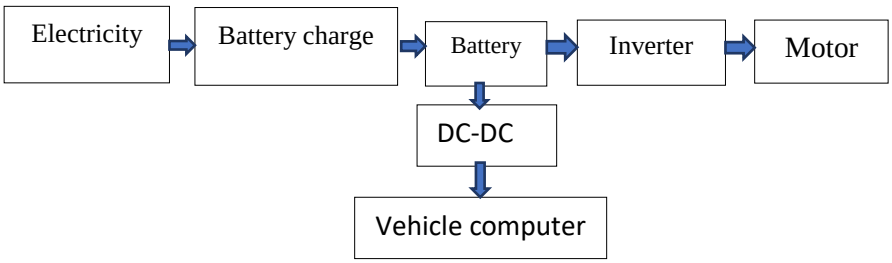

Fig.1 Circuitry of a Typical Electric Vehicle

II.TYPES OF ELECTRIC VEHICLES

On the basis of various parameters such as operating range, refueling, speed, type of fuel and method of charging vehicles are divided in following types:-[2]

1) Convention vehicles
2) Battery electric vehicles(BEV)
3) Hybrid electric vehicles (HEV)
4) Plug in hybrid electric vehicles(PHEV)
5) Fuel cell electric vehicles

III.CONVENTIONAL VEHICLES

Conventional vehicles also known as gasoline vehicles consist of an internal combustion engine. In this configuration fuel is injected into either the intake manifold or the combustion chamber where it is combined. It is then combined with the air fuel mixtures ignited by the spark from a spark plug. Refueling a conventional vehicle is very easy and does not consume much time. This is a huge benefit of gasoline vehicles over electric vehicles. [3] An all electric vehicle might take a whole& hours to change. [3, 12]

Another benefit of gasoline vehicle is their range. They can go for a long way where as electric vehicle might not be able to go over 60-120 miles in one charge. AEVs have an average a shouter range than gas powered cars.

The affordability of gasoline vehicles as compared to electric vehicles is indisputable. The battery packs which are used in an electric are expensive and may need to be serviced or replaced more than once.

IV. BATTERY ELECTRIC VEHICLES / ALL ELECTRIC VEHICLES (BEV/AEV)

Battery electric vehicles get all the powers from its battery packs since it has neither internal combustion engine nor fuel tank. It operates by using high capacity batteries. [4]

To recharge the battery pack is by plugging the vehicle to a charging point. The first benefit of electric cars which is the most important is energy efficiency of these EVs. Efficiency means how much fuel has actually converted into energy for powering its wheel. [5, 13, 14]

AEVs convert about 59% to 62% but gasoline vehicles only convert about 17 to 21 %.

Another major benefit is that electric vehicles majorly reduce emissions. Electric vehicles can travel 43 miles for $1.00.

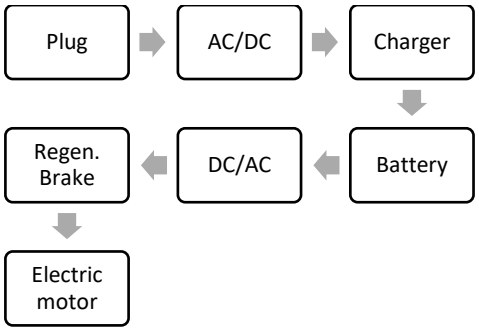

Fig.2 Circuitry of BEV

V.HYBRID ELECTRIC VEHICLES

Hybrid electric vehicle uses a gasoline engine and also an electric motor. The power to the car is given together by the engine & motor simultaneously. This will help enhancing the amount of travel per gallon of fuel.

Conventional HEVs use their gasoline engine to keep their modesty sized batteries charged as you drive.

The HEVs deliver better fuel economy than their gas counter parts because they can recap the energy while braking.

One problem with HEVs is that they do not tend to get substantially improved mileage during movement on a highway.

They can't be plugged & changed. They are only changed by the help of their engines. This is why the dependency on chargers increases. [6, 11]

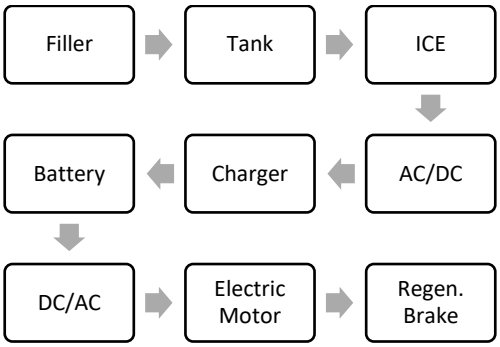

Fig.3 Circuitry of HEV

VI.PLUG-IN HYBRID ELECTRIC VEHICLES

A plug in hybrid vehicle uses a gas engine and an electric motor but in different ways. The PHEVs run using its electric motor powered by the battery.

A PHEV would not use the gas until its change is not finished. The gasoline works as a backup plan in PHEVs rather than working simultaneously. Once the battery runs out it has to be charged using a plug in the electric charger.

This ability to charge batteries allows the PHEVs to run purely on electric power, but the fuel saving capacity of PHEVs requires a larger battery pack which increases the cost of its upfront.

Apart from the cost of its battery pack even the cost of charger might go up to a several hundred dollars.

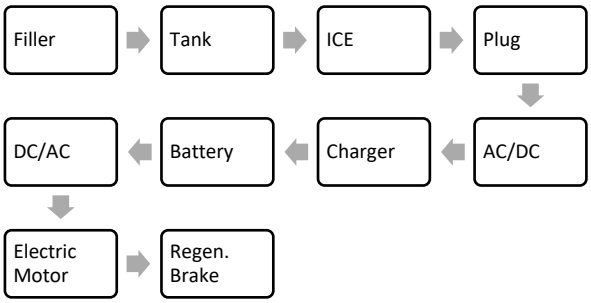

Fig4. Circuitry of PHEV

VII.FUEL CELL ELECTRIC VEHICLES

Fuel cell electric vehicles use a similar propulsion system as electric vehicles but energy is stored as hydrogen and then converted to electricity. FCEVs are fueled with pure hydrogen gas stored in a tank. They can fill in less than 5 minutes and range is over 300 miles. [7]

The tanks and stacks together weigh less than so the payload is greater. Hydrogen Energy density is about 120 MJ/kg which is a much higher than gasoline having ED of 45.8 MJ/kg.

The main challenge with the hydrogen is its transportation and storage since it has to be stored under a lot of pressure or liquefied directly.

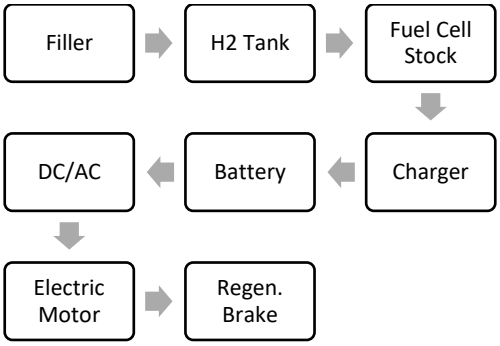

Fig.5 Circuitry of FCEV

	Conventional	BEV	FCEV	HEV	PHEV
Example	Volkswagen Golf GTI	Tesla 5	Toyota Mirai	Toyota Prius	Mini countryman
Efficiency	-	75%	22%	54%-15%	60%-17%
Emission	-	-60% CO2	-50% CO2	-57%- +11% CO2	-58%- 2% CO2
Cost	$32.158,60	$21.304	High cost	$34-35000	$35.815

Table1. Comparison of various conventional and EVs

VIII. WORKING OF ALL TYPES

Gasoline vehicles- Diesel as well gasoline vehicles work on exactly the same principle. An internal combustion engine is present. The only difference between the two is that gasoline vehicles use a combustion engine which is ignited by spark whereas diesel vehicles' engines are ignited by compression. The battery will provide the electricity to power the engine. The fuel injection system injects fuel into the combustion chambers of the vehicle for ignition of the fuel. The fuel pump pushes the fuel from the fuel tank to the ICE. The ICE fuel either gets introduced to the combustion chamber. It is then mixed with air and ignited by a spark. The exhaust system throws out the gases from the engine through the tailpipe.

All Electric Vehicles: - All electric vehicles depend on batteries for their power generation. The battery in the electric vehicles drives everything, including the accessories also. Like the radio or the windows. Electrochemical cells consisting of positive and negative electrodes and when they're connected, electrodes flow from negative to positive terminal. This rapid movement produces enough energy to drive the vehicle.

Hybrid Electric Vehicles: - There are two types of hybrid vehicles, fully hybrid and partially hybrid.

Fully hybrid vehicles use electricity from the battery only when the car needed low power and gasoline is used when car needs to run on high power. Low speeds resulted in usage of battery while higher speeds use gasoline to run the vehicle.

Partially hybrid vehicles use electricity from the battery when the gasoline is exhausted. The electrical motor alone cannot power the vehicle. Whenever energy is needed the electric motor acts as a back up to the conventional engine.

***Plug-in Hybrid Electric Vehicles*:**-PHEVs work in two modes, fully electric and hybrid. Fully electric mode is one where battery puts out all the energy of the car and in hybrid both battery and gasoline is used to run the car. PHEVs typically startup in all-electric mode, running on electricity until their battery pack is depleted: ranges vary from 10 miles to over 40. Certain models switch to hybrid mode when they reach highway cruising speed, generally above 60 or 70 miles per hour. [8]

***Fuel cell electric vehicles*:-**The FCEVs derive their power for the electric motor and battery by converting hydrogen gas into electrical energy. Fuel-cell vehicles are only beginning to appear in the markets, but offer significant promise as a low-carbon clean technology. The process of reverse electrolysis occurs in Fuel cell type of technology wherein hydrogen and oxygen react with each other Hydrogen is pushed in from the fuel tank and oxygen is taken in from air. The combination of hydrogen and oxygen results in formation of heat and water which is given out as vapor. They are therefore completely emission free. [9, 10]

IX.CONCLUSION

After a whole and comprehensive research, it is evident that Electric Vehicles will be the solution to the rapid global warming problem that we collectively as a part of humanity are facing. Global CO2 emissions were around 6.6 Gt in 2007 and are predicted to be about 9.0 Gt by 2030. These statistics make it pretty clear how desperately we need to adopt electric vehicles in the near future. It is discovered that Electrical vehicles will be a costly approach when it comes to choosing vehicles but according to saving environment in the bigger picture, choosing alternate technologies would be the only thing that is considered smart and efficient. In the terms of efficiency as well as initial cost, Battery Electric Vehicles come out to be winner but hybrid electric vehicles are the best when it comes to fuel efficiency.

References

[1] Yilmaz, M. and Krein, P.T., 2012. Review of battery charger topologies, charging power levels, and infrastructure for plug-in electric and hybrid vehicles. IEEE transactions on Power Electronics, 28(5), pp.2151-2169.

[2] Vazquez, S., Lukic, S.M., Galvan, E., Franquelo, L.G. and Carrasco, J.M., 2010. Energy storage systems for transport and grid applications. IEEE Transactions on Industrial Electronics, 57(12), pp.3881-3895.

[3] Hawkins, T.R., Singh, B., Majeau-Bettez, G. and Strømman, A.H., 2013. Comparative environmental life cycle assessment of conventional and electric vehicles. Journal of Industrial Ecology, 17(1), pp.53-64.

[4] Yilmaz, M. and Krein, P.T., 2012. Review of the impact of vehicle-to-grid technologies on distribution systems and utility interfaces. IEEE Transactions on power electronics, 28(12), pp.5673-5689.

[5] Un-Noor, F., Padmanaban, S., Mihet-Popa, L., Mollah, M.N. and Hossain, E., 2017. A comprehensive study of key electric vehicle (EV) components, technologies, challenges, impacts, and future direction of development. Energies, 10(8), p.1217.

[6] Hannan, M.A., Azidin, F.A. and Mohamed, A., 2014. Hybrid electric vehicles and their challenges: A review. Renewable and Sustainable Energy Reviews, 29, pp.135-150.

[7] Sabri, M.F.M., Danapalasingam, K.A. and Rahmat, M.F., 2016. A review on hybrid electric vehicles architecture and energy management strategies. Renewable and Sustainable Energy Reviews, 53, pp.1433-1442.

[8] Karbowski, D., Rousseau, A., Pagerit, S. and Sharer, P., 2006, October. Plug-in vehicle control strategy: from global optimization to real time application. In 22th International Electric Vehicle Symposium (EVS22) (pp. 1-12).

[9] Rubino, L., Capasso, C. and Veneri, O., 2017. Review on plug-in electric vehicle charging architectures integrated with distributed energy sources for sustainable mobility. Applied Energy, 207, pp.438-464.

[10] Pollet, B.G., Staffell, I. and Shang, J.L., 2012. Current status of hybrid, battery and fuel cell electric vehicles: From electrochemistry to market prospects. Electrochimica Acta, 84, pp.235-249.

[11] Richardson, D.B., 2013. Electric vehicles and the electric grid: A review of modeling approaches, Impacts, and renewable energy integration. Renewable and Sustainable Energy Reviews, 19, pp.247-254.

[12] Grover Ashish, Anita Khosla, "Design and simulation of 20MW Photovoltaic Power Plant using PVSyst" Indonesian Journal of Electrical Engineering and Computer Science, Vol 18,2020

[13] Grover Ashish, Anita Khosla, "Integration Schemes for Hybrid Generation Systems" International Journal of Innovative Technology and Exploring Engineering, 2019

[14] Khera Richa, Anita Khosla, "Advancement in Photovoltaic Based DC-DC converter topologies" INDIAcom 5th international conference on computing for sustainable Global Development,2018