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Hybrid Vehicle: A Trend and Advanced Technologies

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Abstract: *With the rapid advancement in 21st Century, there has been HEVs are likely to reduce greenhouse This may lead to cleaner operations. Nowadays, fossil fuels are also decreasing Due to these reasons Automobile Companies have started doing research for making Hybrid Technology usable into the daily life. This study focused on the technical aspects of various types of HEVs and Advance technologies of Hybrid electric vehicles. Also, here discussed its environmental impacts. This paper is based on the explanation of such technologies, their function, drawback of this technology, efficiency of Hybrid Cars, Case studies on the present commercial hybrid cars such as Toyota Prius series, Astrolab,etc and the fuels and raw materials used in the Hybrid Cars. Paper concludes on the advantages and dis-advantages of Hybrid Cars and how this technology will take over the world in future and would become the alternative for Petrol and Diesel Cars.*

Keywords: Hybrid Electric Vehicle; Hybrid Solar Vehicle; Plug in Hybrid Electric Vehicle; Toyota Prius Series.

I. INTRODUCTION

With the invention of Internal Combustion Engine by Nicolas Otto, there was revolution in Automobile field. Later on, Petrol and Diesel became the main source of fuel for these vehicles. This technology made Human Efforts very easy through commercializing in the market. As, the world went through 20th Century, there happened many advancements for making this technology efficient and cost-effective. Due, to which it became the commercial success and its use in the day-to-day period increased. People could reach thousands of kilometers/miles in hours with the help of this technology. As we know everything has its own positive and negative side. The rate of Carbon Monoxide (CO) and Carbon Dioxide (CO2) suddenly increased at the dangerous level in the beginning of 21st Century which made a negative impact on Ecosystem, reason for Global Warming, Health related issues, etc.

This forced Scientist, Researchers and Policymakers to focus or made them start thinking for Green Technology or the technology which can stop the adverse effect happening on Nature. Hence, the 21st Century will become the Century for Evolution in various technologies with the main focus in Automobile Sector. The technologies which will change the face of AutomobileSector would be “Hybrid Electric Vehicle”, “Hybrid Solar Vehicle”, “Hydrogen Fuel Cell”, etc. From all this Hybrid Electric Vehicle is considered as the most industrially matured technology and has efficiency more than cars running on Petrol/Diesel/CNG while Hybrid Solar Vehicle has lower efficiency than vehicle running on Petrol/Diesel/CNG. So, this technology is for drivers who want to cover less distance. To overcome this constraint, “Plug-In Hybrid Electric Vehicle” came into existence.

“Toyota Prius Series” is an example of Hybrid Electric Vehicle technology, “Astrolab” is an example of Hybrid Solar Vehicle and “Chevrolet Volt” is an example of Plug-In Hybrid Electric VehicleRegenerative braking is an energy recovery mechanism which slows down a vehicle by converting its kinetic energy into another form, normally into electrical energy, which can be used immediately or stored until needed in high voltage batteries. The electric motor is operated in reverse during braking or coasting, acting as generator. The rotors of electric traction motor are coupled with wheels, they experience opposing torque as current is induced in the motor coils. [12] The wheels transfer kinetic energy via drivetrain to generator. At the same time, generator resistance produced from the electricity created, slows the vehicle. When more braking torque is required than the generator alone can provide, additional braking is accomplished by friction brakes.

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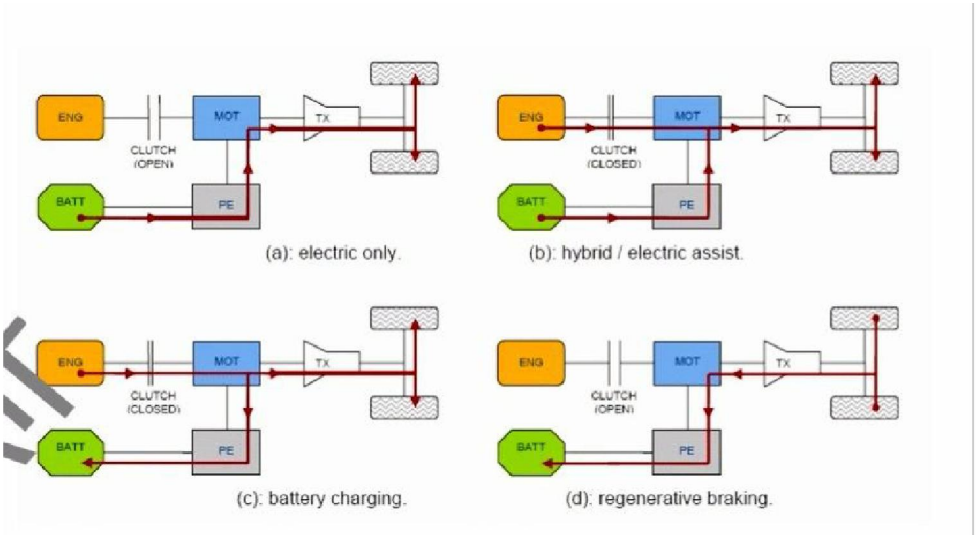

Fig 1: Working Principle of Hybrid Vehicle

II. TYPES OF HYBRIDS VEHCILE

A. Hybrid Electric Vehicle (HEV)

A hybrid electric vehicle is a type of hybrid vehicle which combines a conventional internal combustion engine propulsion system with an electric propulsion system. Or in a technical way, a Hybrid Electric Vehicle is a type of technology which indulges both mechanical drive train and electric vehicle.

A mechanical drive consists of the Fuel tank (containing conventional fuels like petrol/diesel/CNG), the Combustion Engine, the gear box and transmission to the wheels in Fig. 2.

An electric drive consists of the Battery, an electric motor and Power Electronics for control as shown in Fig. 3.

The use of Ultracapacitors [1] has a high potential in the Hybrid Electric Vehicles. They have the advantage of being a more robust power device when compared to batteries (Lithium Ion and Nickel Metal Hydride), as an example during regenerative braking which is considered as a high-powered event.

Classification of Hybrid Electric Vehicle: -

Series Hybrid: As shown in Fig. 2, the traction power is delivered by the electric motor, while the internal combustion engine, via a generator, produces electric power to drive the electric motor. The excess power is then stored in the battery pack. The Internal Combustion Engine is decoupled from the driven wheels and can be operated mostly in the maximum efficiency region. The major shortcomings of the series hybrid drive train configurations are the high power installed in each component and the request of a generator. In fact, the energy from the Internal Combustion Engine is converted twice before to drive the wheels. Thus, the system is more expensive than the parallel one.

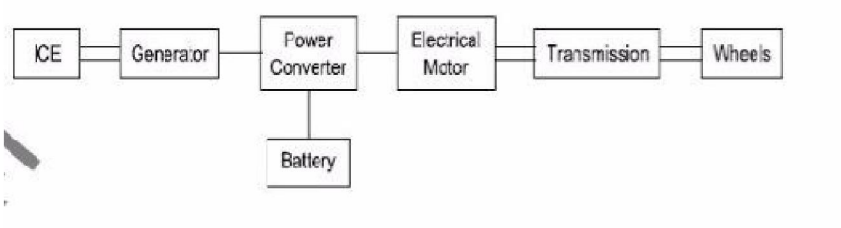

Fig 2: Series Hybrid Structure

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Parallel Hybrid: As shown in Fig. 3, there is direct mechanical connection between the hybrid power unit and the wheels. In addition, this layout has an electric traction motor that drives the wheels and can recuperate a share of the braking energy, in order to charge the batteries (regenerative braking) or help Internal Combustion Engine during acceleration conditions. In fact, Internal Combustion Engine and electric motor are coupled by a mechanical device. Then the electrical machine can be designed with a reduced capability, i.e., cost and volume. There are several configurations depending on the structure of the mechanical combination between the Internal Combustion Engine and the electrical motor. There can be a torque-coupling with a single shaft or two shaft configurations, a speed-coupling with planetary gear unit, a merge of both coupling unit.

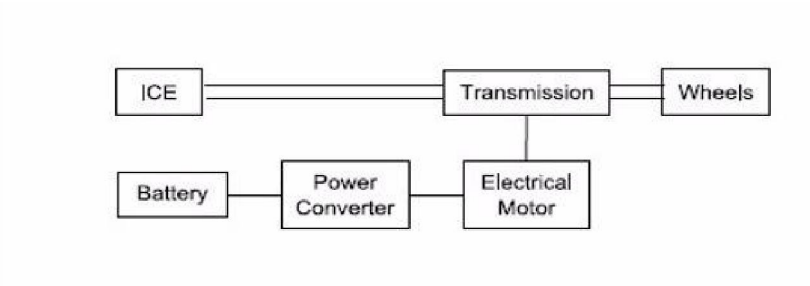

Fig 3: Parallel Hybrid Structure

Series-Parallel Hybrid: As shown in Fig. 4, the series layout and the parallel layout are merged together in order to have both advantages. In particular the ICE is able to supply the electrical motor or charge the battery thanks to a generator.

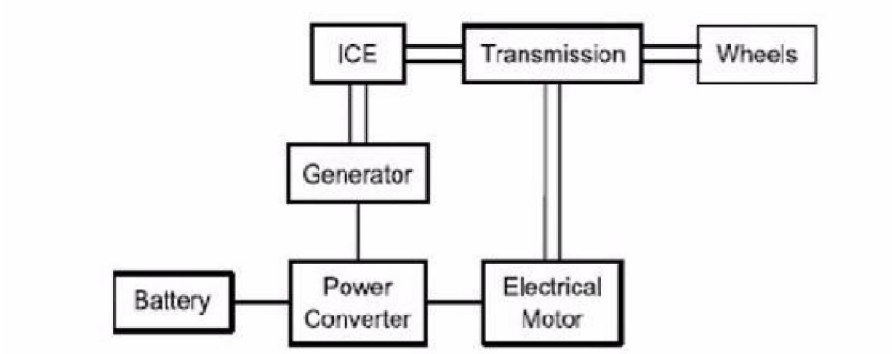

Fig 4: Series Parallel Hybrid Structure

Complex Hybrid: There are two separate mechanical links obtaining a light transmission system and a flexible mounting. As an example, the front wheels are powered by hybrid propulsion, while the rear wheels have a pure electric system. There is a wi-deflexibility on the power flux managing.

Hybrid Solar Vehicle (HSV)

This technology is an integration of Vehicle and Photovoltaic Panels. Normally, photovoltaic panels are mounted on the roof-tops of the vehicles. It is also classified into four types: - Series Hybrid, Parallel Hybrid, Series-Parallel Hybrid and Complex Hybrid. Out of which, Series Hybrid technology is very efficient and more research is going on this type as shown in Fig. 5.

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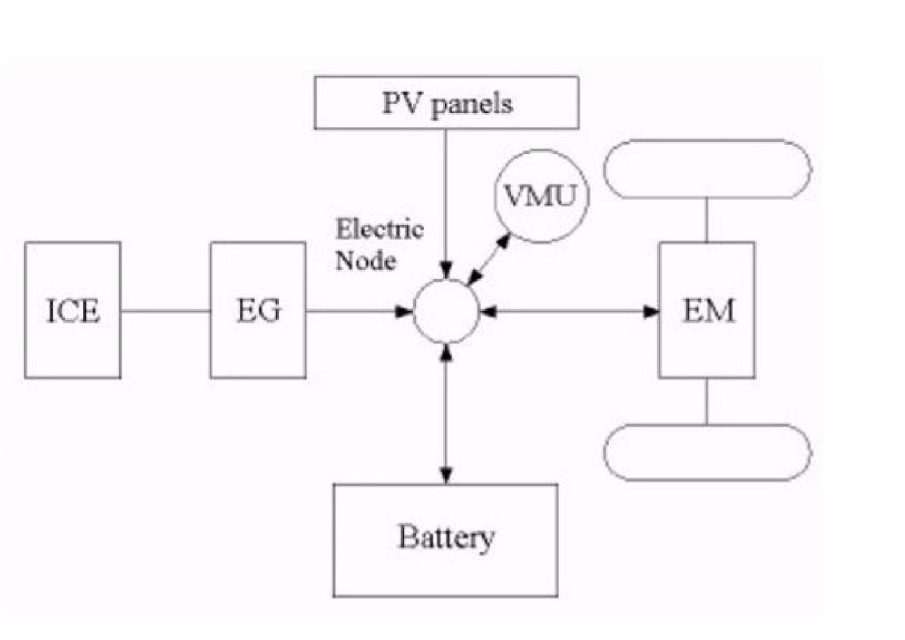

Fig 5: Hybrid Solar Vehicle

Comparison of Hybrid levels of EVs.

Hybrid Type	MicroHybrid	Mild Hybrid	Full Hybrid
IC Engine	Conventional	Downsized	Downsized
MotorPower	3-5 KW	7-15 KW	>30 KW
MotorVoltage	12 V	60-200 V	200-600 V
Hybridization	<10%	10-30%	>40%
EnergySaving	5-10%	20-30%	30-50%
Functions	Start/ Stop Reg. Braking Accessories Powering	Start/ Stop Reg. Braking Electric Assist	Start/ Stop Reg. Braking Electric Traction
Cost	Low	Medium	High
Examples	Mercedes Smart	HondaInsight	ToyotaPrius

The reason for two motors is in the strengths and weaknesses of both types. [11] Specifically, electric motors use no energy during idle - they turn off - and use less than gas motors at low speeds. Gas motors do better at high speeds and can deliver more power for a given motor weight. That means during rush hour stop and go driving, the electric motor works great and, as an added benefit, does not produce any exhaust thus reducing smog levels. At higher speeds - above 40 km/hr - the gas motor kicks in and gives that peppy feel so many car owners look for when driving on the highway. Another benefit of having the gas motor is it charges the batteries while its running. Many an electric car owner has

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been stranded just out extension cord range of an outlet. Hybrid owners can forget about this annoyance; the gas motors starts automatically when the battery gets low and proceeds to charge the battery - a hybrid never needs to be plugged into an outlet. Of course, if you forget to fill the tank. Still, you can carry a gas can a half mile while a tow truck is necessary in a straight electric car. Honda Insight, All this new technology comes at a price: a hybrid car is complex and expensive. It has two motors and all the ancillary systems to manage them plus a heavy battery and a regeneration system used to produce electricity during breaking. All of these systems must work together, adding complexity. While cars and, just as importantly, the computers that control them, have become more reliable, they still suffer from failures. So, owners of hybrids can expect more time in the shop and larger repair bills. Hybrids are the most gasoline efficient of all cars - they typically get 20.4 to 25.51 kmpl (claimed).

Over a ten-year period owning a hybrid will save you only $2,300 - less than the cost difference for comparably equipped cars. Much of the fuel efficiency comes from improvements in aero dynamics,weight reduction and, the biggest change: a smaller, less powerful gas engine. In fact, any car will get substantially better mileage just by reducing the engine size. The main reason this is not done has to do customer demand - they want the extra power and zippiness.

While the US has just started producing hybrids, the Japanese are the recognized leaders. Honda and Toyota are the two largest producers with the Insight and Prius. US car makers are well behind. In fact, during recent introduction of a new hybrid by GM - the Mercury Mariner, they admitted they had to license over 20 separate technologies from the Japanese. US car makers still specialize in SUVs and trucks - Ford has even introduced a hybrid version of its popular Escape SUV. Industry analysts say US hybrids are just token models - not a serious attempt to get into the market.

The reason for hybrid introduction has to do with Corporate Average Fuel Economy (CAFE) regulations. Current standards mandate that average mileage of the fleet of cars sold by an automaker should be 11.69 kmpl. This means that if an automaker sells one hybrid car that gets 25.51 kmpl, it can then sell four less efficient cars - like SUVs and trucks - that only get 8.5 kmpl.

III. CONCLUSION

The role of HEVs in the transport sector is the need of the hour. HEVs offer many advantages as reducing oil consumption, low effects on climate change, low harmful emissions. But technical and socio-economic challenges to use of HEVs. This includes heavyweight and large size of batteries, and the need for fast charging facilities

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