A Comprehensive Review on Benefits of Battery in Charging Stations for Hybrid Electric Vehicles

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Abstract*:* The climate protection programs include funding for cleaner energy automobiles with supporting equipment in order to minimize CO2 emissions. One type of alternate energy vehicle is the electric car. The first electric cars were created at the same time as internal combustion cars, or more than 110 years ago, but they haven't gained much popularity. The large batteries and the relatively low autonomy per charge of electric cars were the main factors preventing their widespread introduction. Their significantly insufficient autonomous was caused by the batteries' comparatively low density when contrasted to the energy present in liquid fuel. Although electric cars were mentioned frequently as the auto industry developed, they were typically constructed in tiny experimental runs and were mostly made to order. We will talk about electric and hybrid electric automobiles in this paper. Additionally, a comparison of the various battery types utilized in electric vehicles will be covered which can be integrated in the charging stations.

Keywords:. *Contingency Analysis, load forecasting, short-term load forecasting, Long-term forecasting, Medium-term Forecasting, etc.*

I. Introduction

Mostly with advantages of low pollutants as a crucial step to improve and safeguard the environmental quality, advanced energy cars are a vital route for the continuous expansion of the automobile sector innovation. Due to the growing utilisation hydrocarbon-based mobility, environmental degradation, global warming, as well as shortages are presently major concerns for the automobile industry (Guo et al., 2021) [1]. As a result, alternative powertrain solutions that are highly efficient and environmentally friendly are of significant interest to scientists in the automobile sector. Because of their capacity to recoup braking energy as well as the fact that a structure and improve of regulate freedom in the powertrain brought up by electrification is possible to improve the effectiveness of the powertrain system, (plug-in) hybrid electric vehicles ((P) HEV) have indeed been used all over the world.. One important tactic for addressing problematic areas of the transportation industry, such as the effects of air pollution, climate change, and concerns with energy security, is the adoption of low - emissions automobiles (LEVs) through into sector(Zhou and Du 2021) [2]. Battery electric vehicles, hydrogen fuel cell vehicles, improved biofuel and internal combustion engine (ICE) innovations are important LEV technologies.

Electricity alone is used to power all-electric vehicles (EVs). One or more electric motors that are powered by rechargeable battery packs are used to propel them. Compared to traditional automobiles, EVs provide a number of benefits. EV batteries are made to have a long lifespan; according to a research by the National Renewable Energy Laboratory of the DOE, they might last 12 to 15 years in areas with moderate temperatures and 8 to 12 years in those with extreme temperatures. These batteries are pricey, too, so if they break down, changing them could be pricey.

Regarding the environmental friendliness, lithium-ion batteries (LiBs) with high energy density are becoming more and more popular in electric vehicles (EVs) around the worldwide. Throughout time and then use, battery discharge issues including capacity fading and rising internal resistance are unavoidable (Ahmed et al., 2021) [3].Both users as well as manufacturers struggle greatly because of these. To (i) optimize the battery substances, (ii) enhance battery cell manufacturing, and (iii) direct the design of vehicle battery systems, a complete knowledge of how batteries mature in EVs is critically required. Inducing the automobile sector to increase vehicle fuel economy is air pollution and the international oil scarcity with a reliance on non - renewable resource (Bagheri et al., 2021) [4]. Several nations have concurrently established a timeline for outlawing conventional vehicles in order to reduce emissions and energy resource usage. Clean energy vehicles have become a popular topic in recent years as the science community and automobile businesses have both proposed several technologies to address energy-saving issues. One of the most developed and viable new sources of energy is the HEV. HEVs feature more than one powertrain system to move the wheels than do traditional cars. Plug-in hybrid electric vehicles (PHEVs), hybrid electric vehicles (HEVs), and all-electric vehicles (also known as battery electric vehicles, or BEVs), all use electrical energy to increase vehicle performance. Despite the fact that some these automobiles still use petroleum products in addition to electricity, those three various types are commonly referred to as electric cars, electric vehicles, or simply EVs in casual contexts. An internal combustion engine plus one or more electric motors that draw power from a battery power HEVs. The vehicle's internal-combustion engine runs on gasoline, while regenerative braking instead of a plug-in charger charges the battery.

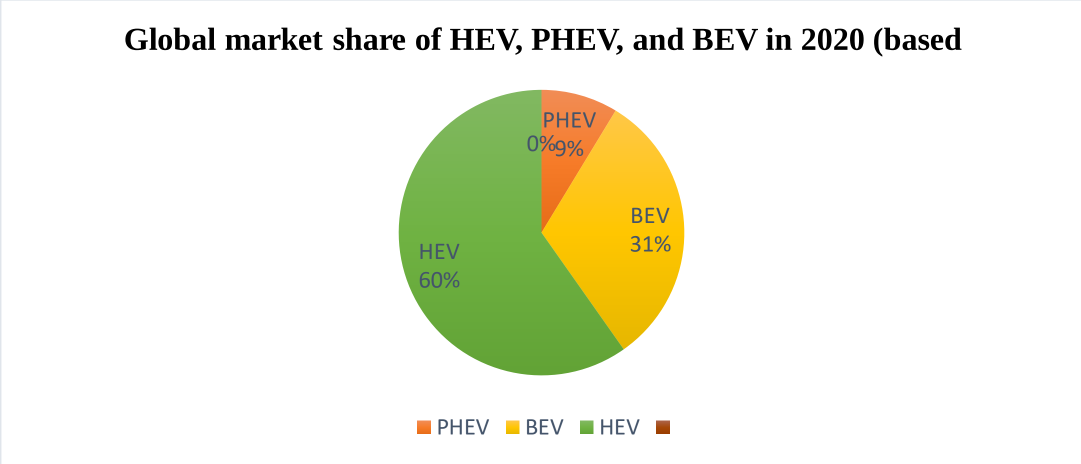

Figure 1 Global market share of HEV, BEV, PHEV

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II. Development of hybrid electric vehicles and its Charging Structure

An electric motor powers an electric vehicle (EV) as opposed to an internal combustion engine, which generates electricity by igniting a mixture of fuel and gases. Consequently, in attempt to remedy issues such as contamination, global warming, the depletion of resources, etc., such a vehicle is considered as a potential substitute for current-generation automobiles. Even though the idea of electric cars has been around for a while, it has attracted a lot of attention in the last ten years due to the growing carbon footprint and other environmental effects of fuel-powered cars. The first significant decision to promote the use of electric vehicles in India was made in 2010.The Ministry of New and Renewable Energy (MNRE) authorized a Rs 95 crore program, as well as the government has offered a financial motivation for makers of EVs sold in India. The program, which went into effect in November 2010, called for incentives of up to 20% on vehicle ex-factory pricing, subject to a maximum. The MNRE later withdrew the subsidy program, though, in March 2012. The "National Electric Mobility Mission Plan (NEMMP) 2020" was unveiled by India in 2013 in an effort to promote the use of electric vehicles, as well as to solve issues with national energy sovereignty, traffic congestion, and the expansion of local manufacturing capacity.

HEVs combine the advantages of internal combustion engine vehicles (ICEVs) and EVs to provide a midterm solution with much less energy usage, lower emissions, as well as greater mileage (Wang et al., 2022) [5]. With a wide range of hybridized proportions, from the most basic start-stop systems to full hybrid vehicles, there are now trustworthy cars on the market. Meanwhile, various HEV variations and combinations have also been created over time. Additionally, (Sagaria et al., 2021) [6] the car industry's promotion of hybrid and electric vehicle powertrains has also been a key step in the mitigation of climate change. Although innovative transportation technologies have been slow to catch on, the industry is beginning to see the advantages of battery electric automobiles (BEV). The power battery utilized in HEVs is primarily used for supplemental power production during acceleration and energy recovery during repeated braking (Chen et al., 2020). Therefore, the power battery in a HEV needs to have a high specific power density, improved resistance to overcharging and overdischarging, and higher potential consistency when changing driving modes frequently. The Ni-MH battery surpasses the traditional lithium-ion batteries for several important indicators.

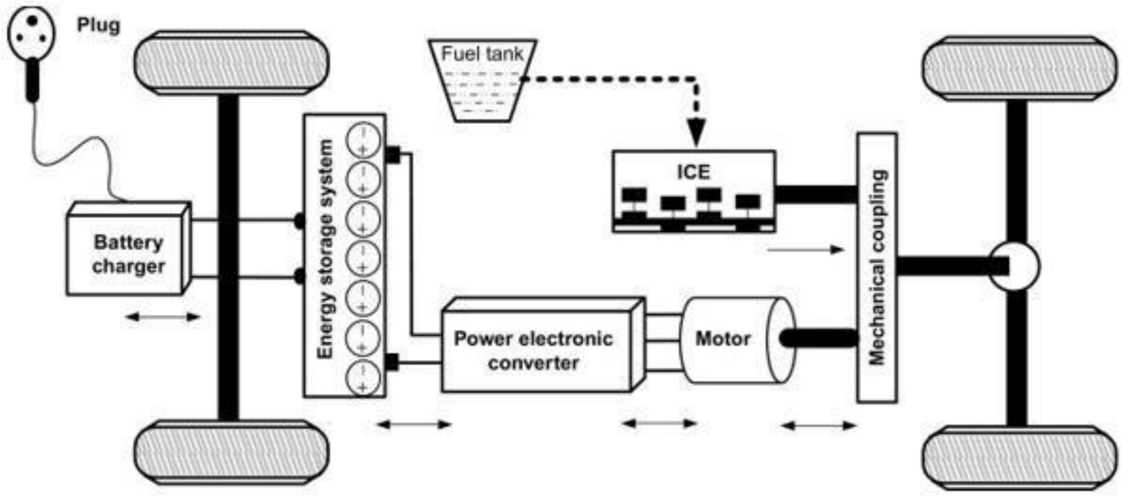

Figure 2 Hybrid Electric Vehicles

Many businesses are looking for fuel substitutes. However, one of the biggest issues is that most alternative forms of energy are more expensive than those that use conventional fuels. As a result, hybrid electric vehicle innovation is starting to appear in the automotive industry, and it successfully cuts fuel usage by adapting one of the electric energy sources. HEV research has been regarded as appealing, especially in light of the expansion of alternative energy sources. Fuel cells, batteries, and supercapacitors are some of the storage systems used in HEVs to retain electrical power (Singh et al., 2021). Different electroactive species, including suspensions of particles (such as polysulfide-based nanofluid), organic materials (such as alloxazines), other inorganic compounds, are used to create the fuel cell (e.g., metal ions).Ni, polymeric, lithium-cobalt oxide (LCO), nickel-manganese-cobalt oxide (NMC), and cobalt are the many kinds of active materials used in batteries.

Parameters	Electric Vehicles	Hybrid Electric vehicles
Primary power source	Electricity	Gasoline fuel
Working mechanism	Electric motor powers the wheels.	The car is propelled by both the IC engine as well as the electric motor.
Battery charging	Need to plug into a power source to charge the battery pack.	don't need to plug into an external power source as the battery gets charged via generator/regenerative braking
Emission levels	EVs produce zero emission.	HEVs are Low Emission Vehicles (LEVs) since they produce fewer emissions than conventional vehicles
Vehicle life	Use an EV until the battery pack lasts	You can drive an HEV for a longer period since an IC engine lasts longer than a battery pack

III. Battery Lifetime in Hybrid Electric Vehicles Charging Stations

All-electric vehicles, plug-in hybrid electric vehicles (PHEVs), and hybrid electric vehicles require energy storage devices, typically batteries (HEVs). When a battery reaches the end of its useful life as well as during manufacture, comprehensive battery recycling would prevent dangerous substances from entering the waste stream. Crucial substances would be reintroduced into the supply chain as a result of material recovery from reprocessing, expanding domestic sources for these materials. The development of battery recycling procedures that lessen the effects of utilizing lithium-ion and other types of batteries in automobiles is now under work. However, different recycling procedures need for various kinds of material recovery separation techniques.

A lithium-ion battery pack is used by the majority of current electric vehicles to store energy. Although alternative battery types, such as solid-state batteries, are anticipated to power the motors of electric automobiles in the future, the architecture in place for large-scale battery manufacturing now favors lithium-ion batteries. Compared to nickel-metal hydride batteries, which have been presently utilized in numerous hybrid vehicles, including those made by Toyota, and ordinary lead-acid batteries, which power the electrics throughout most modern vehicles, lithium-ion batteries have a higher energy density. Simply put, the performance of an electric vehicle with a lithium-ion battery pack is comparable to that of a vehicle with an internal combustion engine and a full tank of gas, as an EV with the ideal balance of battery size, curb weight, and aerodynamic efficiency can travel great distances between charges.

(Li and others, 2021) offers a real-time multi-objective predictive energy management system that can balance the costs of auxiliary power unit fuel, electricity, and battery deterioration. The multi-objective energy management problem is first framed as a total operational cost minimization problem. To control energy usage in real-time, a model predictive control-based real-time multi-objective prediction strategy is used. In order to create a multi-objective optimal energy management strategy (EMS) for hybrid battery/supercapacitor (SC) electric cars, (Nguy et al., 2021) introduces a novel technique. The technique is based on a different strategy that employs Pontryagin's minimal principle (alt-PMP), which outperforms dynamic programming in terms of performance while requiring less computational work. The innovative multi-objective EMS distributes the SC and battery powers to reduce SC subsystem inefficiencies as well as battery deterioration. It has been demonstrated (Lander et al., 2021) that increasing battery longevity by efficient temperature management considerably lowers the cost and carbon footprint of the battery life cycle. In order to determine the life cycle expenses and carbon footprint for the development and usage phase of an electric vehicle, techno-economic and life cycle assessment models implement the battery lifetime simulation for each thermal management system. The cost and carbon footprint of batteries can be lowered by 27% by optimizing the thermal management system for batteries. To statistically examine the academic worth of literature regarding control scheme (MPC) as an energy management strategy (EMS) for hybrid electric vehicles, (Zhou & Du, 2021) creatively combines fuzzy comprehensive evaluation (FCE) approach with analytic hierarchy process methodology (AHP) (HEVs).

Electric vehicles use a variety of battery kinds, each with unique characteristics like how temperature affects them, how long they last, and how energy-efficient they are. Lithium-ion batteries are the most often used batteries in electric vehicles, followed by nickel-cadmium batteries, lead acid batteries, and ultra-capacitors. Nickel-cadmium batteries are also utilized in some automobiles. Check out how these batteries inside the cars compare.

	Lithium ion Batteries	Nickel-Cadmium	Lead-Acid	Ultra-capacitors	References
Easily Accessible/ inexpensive	√	x	√	x	[18-21]
Energy Efficiency	√	√	√	√	[18-21]
Temperature Performance	√	x	x	√	[18-21]
Power density W/Kg	1000-1500	300-1000	180	-	[21]
Life cycle	2000	3000	1000	500000	[20]
Nominal Volt (V)	360	6	6	-	[18,19]
Rated Capacity (Ah)	33.1	180	225	-	[18,19]

IV. CONCLUSION

Many businesses are looking for fuel substitutes. However, one of the biggest issues is that most alternative energy sources are more expensive than those that use conventional fuels. Due to their higher price compared to standard gasoline/diesel vehicles, HEVs may not be an affordable alternative for everyone. In the future, though, new technology might make them more inexpensive. The transition from conventional automobiles to EVs is made possible in large part by hybrid electric vehicles. Improving battery technology could increase their efficiency and make for an enjoyable driving experience. In this paper we have discussed about electric vehicles and hybrid electric vehicles. The comparative analysis of different types of batteries used in the electric vehicles is also provided.

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