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Current Developments in Power Systems of New Energy Vehicles

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Abstract: This paper reviews the power system of new energy vehicles, focusing on the types and characteristics of new energy vehicles and their power systems, including the advantages of new energy vehicles and the challenges faced in the future. As one of the most critical strategic initiatives in the current national development and construction, the possible development direction of new energy vehicles is discussed under the background of carbon neutrality and carbon peak regulation strategies. A variety of research methods are used, mainly through the collation and summary of relevant literature. The findings highlight the characteristics and shortcomings of existing new energy vehicles and the importance of optimizing the power systems to improve the performance and sustainability of new energy vehicles.

Keywords: new energy vehicles, power systems, literature review, sustainable transportation.

1. Introduction

As one of the strategic new industries in China, new energy vehicles play an important role in promoting the application of renewable energy and improving the development of electrified transportation[2]. Because of the advantages of energy saving and environmental friendliness, such cars have also received more attention. Now many people analyze the interaction between electric vehicles and the power grid, or the interaction between the charging and replacement of new energy vehicles and the Internet of vehicles, and put forward quite bold predictions in this field, such as the trend of future energy diversification[3].

This paper aims to provide an overview of the current developments in new energy vehicles power systems. It begins with a comprehensive discussion of the classification of new energy vehicles and their power systems, and involves a discussion of the future development direction of new energy vehicles

The methodology employed in this study involves a comprehensive literature review of recent research and industry reports. Key areas of focus include advancements in battery technologies, electric motor efficiency, power electronics, and the integration of renewable energy sources into vehicle power systems.

By synthesizing existing knowledge, this review aims to inform stakeholders and researchers about the current landscape of NEV power systems and identify areas for further research and development.

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2. Overview of new energy vehicle

New energy vehicles encompass a diverse array of vehicle types, each utilizing distinct power systems to achieve varying levels of electrification and efficiency. As part of the global automotive industry's transformation towards sustainability, these vehicles are designed to reduce reliance on fossil fuels, decrease environmental pollution, and enhance energy utilization efficiency. Based on their power sources, new energy vehicles can be categorized into the three types, Battery electric vehicles ,hybrid electric vehicles, fuel cell electric vehicles[4].

2.1. Battery Electric Vehicles

Battery Electric Vehicles are driven by electric motors and battery packs, completely eliminating the need for a gasoline engine. They rely on rechargeable battery packs for zero-emission propulsion, leveraging advancements in lithium-ion technology and regenerative braking for enhanced efficiency. After more than a decade of development, China's pure electric vehicles have achieved rapid growth and have become the backbone of new energy vehicle sales.(In 2019, the sales volume of pure electric passenger cars accounted for 80.5% of the total sales volume of new energy passenger cars[5].

Technical Advantages: Battery electric vehicles offer a zero-emission driving experience with lower operating costs.

Challenges: The main challenges include battery costs, range limitations, and the widespread availability of charging infrastructure.

2.2. Hybrid Electric Vehicles

Hybrid Electric Vehicles combine internal combustion engines with electric motors, optimizing fuel efficiency through regenerative braking and seamless power source switching.

Technical Advantages: Hybrid electric vehicles strike a balance between fuel efficiency and environmental performance while maintaining the convenience of internal combustion engines.

By using two or more energy sources , Hybrid electric vehicles can reduce vehicle emissions and fuel consumption while maintaining high performance[1].

Challenges: By the additional technology required for hybrid systems, the purchase cost of hybrid vehicles is usually higher than that of conventional cars.

The issue of battery capacity and lifespan has not been completely resolved.

2.3. Fuel Cell Electric Vehicles

Fuel Cell Electric Vehicles utilize hydrogen fuel cells to generate electricity, emitting only water vapor and offering fast refueling times and long ranges, which are considered to be the most promising products[6].

Technical Advantages: Fuel cell electric vehicles have a clear advantage in terms of range and refueling speed, with clean emissions.

Challenges: As an industry in its infancy, the main challenges for fuel cell electric vehicles to widespread adoption are the challenges in infrastructure development and costs.

In summary, Each new energy vehicles type offers unique advantages and challenges, According to evaluating these advancements, related persons can make informed decisions to promote the widespread adoption of new energy vehicles and mitigate the environmental impacts associated with conventional transportation systems.

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3. Main Types of Power Systems in New Energy Vehicles

According to the newly implemented terms of electric vehicles, hybrid electric vehicles are divided into series hybrid electric vehicles, parallel hybrid electric vehicles, and hybrid hybrid electric vehicles according to the structure of the power system[7].

3.1. Series Hybrid system

Relying on electric motors to drive, the internal combustion engine acts as a generator to provide power to the battery pack.

Delivers excellent fuel efficiency and low emissions in city and low speed driving.

At high speeds, efficiency is reduced due to reduced engine performance.

The core technology is the separation of the electric motor and the internal combustion engine.

Technical Advantages: Since the internal combustion engine can be continuously operated in perfect working condition, it can be designed to be smaller and lighter, helping to reduce the overall weight of the vehicle

Challenges: Because the engine has to go through a secondary conversion to supply power to the generator, it loses a lot of energy, so when the car is driving at high speed, the fuel consumption of the series hybrid system will be higher than that of the ordinary gasoline engine.

3.2. Parallel hybrid power system

Combining electric motors and internal combustion engines, they can work perfectly independent or together.

There are six operating modes, including idle, pure electric drive, pure engine drive, hybrid drive, drive charging and regenerative braking.

Provides the flexibility to optimize fuel economy and reduce emissions in different driving conditions.

Technical Advantages: The system can automatically select the most suitable drive mode according to the driving conditions. For example, at low speeds or when stopping, only the electric motor can be used, while the internal combustion engine can step in to provide additional power when more power is needed.

Therefore, parallel hybrid power system has high flexibility.

3.3. Series parallel hybrid power system

Combining the advantages of series and parallel systems, power is distributed through a complex drive system.

At low speeds an electric motor is mainly used, and at medium speeds it may switch to an internal combustion engine or a combination of both.

Increase efficiency in diverse conditions, reduce engine dependence, and improve driving performance.

Technical Advantages: Through the complex power shunt device, the perfect power distribution can be achieved under different driving conditions.

4. Discussion

The development of new energy vehicle (NEV) power systems faces many challenges, which, must be addressed to ensure their viability and widespread adoption. One of the main challenges is the energy density of the battery, which directly affects the range and performance of new energy vehicles. Current lithium-ion batteries, while improved over time, still have limitations in terms of energy

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storage capacity and charge-discharge cycles. This limits the range of electric vehicles and affects consumer confidence in their utility for long journeys.

Another major challenge is the development of charging infrastructure. For NEVs to become mainstream, a strong and extensive network of charging stations is essential. This will require significant investment and coordination between government, utilities, and private industry. The current scarcity of charging stations, especially in rural areas, hinders the practicality of owning NEVs and slows their adoption.

Cost is also a key barrier to widespread adoption of NEVs. Although the operating cost of new energy vehicles is lower in the long run, their initial purchase price is often higher than that of traditional vehicles. This is partly due to the high cost of battery packs and the complex systems required for hybrid and fuel cell vehicles. Reducing these costs is critical to making NEVs accessible to a broader consumer base.

Looking ahead, the propulsion systems of new energy vehicles are expected to undergo major changes. Advancements in solid-state battery technology are on the horizon, promising higher energy density, faster charging times, and greater safety. For example , with the maturation of electrical engineering automation technology, innovations are likely to bring revolutionary changes to the NEV market, like Improving operational efficiency , enhancing security and stability and optimizing power quality which making them more competitive with traditional internal combustion engine vehicles[8]. This will not only improve the sustainability of NEVs but also contribute to the broader goal of a resilient and smart energy infrastructure. What's more , We can use AI to build models to meet the needs of complex scenarios with high nonlinear and strong uncertainty[9].

The development of new energy vehicles is also closely related to global efforts to achieve carbon neutrality and peak carbon emissions. As countries around the world implement policies to reduce greenhouse gas emissions, NEVs will play a central role in decarbonizing the transport sector. For example, using green electricity substitution and green hydrogen substitution to replace normal energy forms[10]. This will further drive innovation in the power systems with a focus on improving energy efficiency, reducing environmental impact, and combining it with carbon-neutral energy sources.

In short, although the development of new energy vehicle power systems faces considerable challenges, it is expected to make significant progress in the future. Through continued research and development, interdisciplinary collaboration, and international cooperation, the NEV industry can overcome these obstacles and contribute to a more sustainable and environmentally friendly future of transportation.

5. Conclusion

In conclusion, this paper highlights the significant advancements and current challenges in power systems for new energy vehicles (NEV). he development of new energy vehicle power systems is a key driver of sustainable mobility. Innovations in battery technology, electric drive trains and fuel cell systems have made new energy vehicles a viable alternative to conventional vehicles. Despite progress, challenges such as energy density, infrastructure and cost remain.

The future of new energy vehicles depends on several aspects: solid-state batteries can extend driving range and reduce charging time; Government incentives can reduce consumer costs; Interdisciplinary collaboration can accelerate breakthroughs. The integration of new energy vehicles with intelligent systems is expected to improve traffic efficiency and safety.

Consumer education is essential to highlight the benefits new energy vehicles , such as lower operating costs and environmental protection. Electric motor and intelligent interconnection technology innovation is crucial to maintain the competitiveness of new energy vehicles.

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International cooperation is essential to share research results and advance the application of new energy vehicles. A sustainable development strategy that includes raw material management and battery recycling is essential for long-term success.

By addressing these challenges and capitalizing on opportunities, the NEV industry can make a significant contribution to achieving sustainable mobility and emission reduction targets.

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