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Research and Application of New Energy Electric Vehicle Charging Technology Development

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Abstract: Recent investigations indicate a significant growth in the number of new energy vehicles in the automotive market, particularly with the increase in pure electric vehicles. The future development of new energy electric vehicles relies heavily on charging technology. It is imperative for the industry to intensify research efforts in charging technology and ensure its effective development and application. This paper provides an analysis of the current development status of new energy vehicles and examines the charging methods and application prospects of electric vehicles, based on an understanding of the background and importance of new energy vehicle development, for reference.

1. Introduction

The widespread use of automobiles in daily life has brought about significant environmental pollution, posing a crucial constraint to the development of the industry and hindering the healthy development of the ecological environment. The research and development of new energy electric vehicles are crucial in meeting the current environmental protection needs and promoting the green development of the transportation industry. Therefore, it is imperative for relevant professionals to strengthen their research efforts on new energy electric vehicles and effectively implement the development of charging technology to provide reliable support for the practical application of electric vehicles.

2. Background of New Energy Vehicle Development

Driven by the increasing number of vehicles, China is facing a more severe energy crisis, which urgently requires effective measures from professionals. Additionally, the operation of automobiles inevitably leads to environmental pollution, demanding special attention from relevant personnel. Therefore, by intensifying research and development efforts and promoting new energy vehicles, we can reduce the demand for fossil fuels and effectively mitigate environmental pollution, thus purifying urban air and shaping a healthier urban image. According to surveys, China currently has a wide variety of new energy vehicles. With adherence to national policies and increased research efforts in energy storage technology, pure electric vehicles and plug-in hybrid electric vehicles have gained widespread application in China. With a focus on planning the electric vehicle market,

relevant departments have issued corresponding policies and subsidies to promote the steady development of the new energy vehicle industry. In 2017, relevant departments prioritized improving the energy efficiency of passenger vehicles and drew on the management experience of advanced countries to strengthen the effective regulation of new energy vehicles. Building upon the foundation of effective passenger vehicle standards in China's automotive industry, the continuous introduction of supportive policies stimulates consumer purchases of electric vehicles, thus facilitating further development of the electric vehicle industry. Surveys indicate that by 2019, China's new energy vehicle stock had reached 3.44 million units [1].

3. Importance of New Energy Vehicle Development

New energy electric vehicles belong to emerging energy sources and effectively meet the current environmental protection needs of the transportation and automotive industries. They possess the characteristics of green and eco-friendly technologies. By applying them in practice, they can promote energy conservation and contribute to the sustainable development of automotive enterprises. This is significant for driving the structural adjustment of the automotive industry and further optimizing and upgrading the industry as a whole. Simultaneously, implementing electric vehicle charging technology can overcome past limitations and ensure the efficient operation of electric vehicles, contributing to the improvement of China's energy scarcity and ecological environment protection. Considering the current rapid development of the Chinese automotive industry, intensifying efforts in product innovation and implementing corresponding reforms can enhance the core competitiveness of the automotive industry, keeping it at the forefront of the industry. Furthermore, the implementation of new energy electric vehicle development can facilitate the structural adjustment of the automotive industry, gradually transitioning it toward green development and enhancing the overall competitiveness of the Chinese automotive industry. However, in the process of new energy vehicle development, addressing power consumption capabilities and charging issues requires the concentrated efforts of professionals. By leveraging electric vehicle charging technology, the operational capabilities of new energy vehicles can be effectively improved, ensuring they meet the diverse needs of residents, enhancing comfort and satisfaction, and improving the prospects for the application of new energy vehicles [2].

4. Charging Methods for New Energy Electric Vehicles

4.1. Conductive Charging

Currently, pure electric vehicles and plug-in hybrid electric vehicles are more commonly seen in the new energy vehicle market, and portable charging cables are usually provided upon purchase for home charging. This charging method mainly involves conventional charging, also known as slow charging, which utilizes constant voltage and constant current to charge the vehicles. Research conducted on a 50 kWh battery indicates that with a charging current of 10-16A, the vehicle can run for over 14-25 hours after being fully charged. For residents, charging the electric vehicle in the evening after work and continuing until the next day can achieve a half-full battery, following the principle of charging every 2-3 days, effectively meeting the daily travel needs of residents.

Considering the living conditions, new energy vehicle owners should strengthen communication with power grid companies and install charging piles in designated parking spaces, facilitating subsequent vehicle charging operations and enhancing the convenience of using electric vehicles. Meanwhile, at a charging speed of 1 kW/h, it takes approximately 8-10 hours to fully charge the vehicle's battery, effectively reducing charging costs and ensuring the stable operation of electric vehicles. This method is currently widely applied in the industry. Normally, the power of civilian

charging equipment ranges from 5 to 10 kW, using a three-phase four-wire system. This charging method has relatively lower charging currents, effectively prolonging battery life. However, it also faces the issue of insufficient charging rate [3].

In addition to the aforementioned charging methods, fast charging is also commonly seen in the Chinese market, mainly using battery charging. However, it imposes stricter requirements on the onboard battery and requires careful selection of charging stations during actual usage. It should be noted that fast charging is relatively specific and requires the selection of corresponding fast charging methods based on the specific type of electric vehicle, with the entire operation process following the manufacturer's instructions. Currently, this type of charging method typically has a power output of over 30 kW, using a three-phase four-wire system for power supply. However, increasing the charging speed also leads to more significant heat generation in the battery, which affects battery life. As a result, this charging method often requires certain maintenance costs in the later stage.

The charging methods mentioned above all fall under the category of conductive charging and are widely used in the market. While each has its advantages, they also have certain limitations. Overall, conductive charging methods have longer charging times, charging limitations, and a variety of interface and protocol types. Firstly, compared to refueling conventional vehicles, electric vehicles can be refueled within 2 minutes. However, regardless of the conductive charging method used, electric vehicles require at least 15-30 minutes to reach 80% charge. Moreover, due to the nature of conductive charging, electric vehicles need charging cables as a medium. Slow charging cables weigh over 10 kilograms, and fast charging cables, due to higher direct current, are even bulkier, significantly affecting the convenience of residents' travel. Additionally, because there is a wide range of new energy vehicles with different charging interfaces and protocols, and variations in the use of charging stations, it is difficult for different electric vehicles to match the corresponding charging interfaces.

4.2 Battery Replacement

Battery replacement technology allows for the quick replacement of electric vehicle power batteries, addressing the issue of slow charging in electric vehicles. It significantly improves the charging speed and enhances the comfort and convenience of residents' travel, reducing the waiting time for charging. By implementing centralized battery charging scheduling, it reduces the impact of charging on the power grid and improves the scientific planning of the grid's distribution. Research shows that this technology has a good market potential, and Chinese brands of new energy vehicles can support fast battery replacement services. Battery replacement technology can also be applied in large-scale events, such as the Olympics and World Expos. In the transportation sector, battery replacement technology has proven effective. For example, in Hangzhou, over 200 electric taxis use battery replacement technology. Implementing battery replacement technology effectively enhances the technological advancement of electric vehicles and further promotes their development. However, there are certain challenges with the current application of this technology. The existence of multiple electric vehicle manufacturers with different models and battery types complicates the process, as battery replacement services are typically tailored to specific vehicle models. Additionally, in practical usage, vehicle owners often fail to timely communicate their battery replacement needs to the battery swapping stations, resulting in inefficiencies and unstable battery supply. Furthermore, the location of battery swapping stations can also impact the effectiveness of battery replacement.

4.3 Wireless Charging

Currently, cable-connected charging is the common method used for electric vehicles, providing high safety and effective charging. However, among end-users, cables are bulky and difficult to carry, and the connector interface can be inconvenient and prone to defects. For instance, if the charging location is an airport or if the vehicle needs to move from one place to another, reconnecting the cable becomes impractical. To address this issue, the industry emphasizes the use of wireless charging technology to meet the charging needs of electric vehicles and enhance the application advantages of charging technology. Wireless charging technology development started as early as 2004 by foreign automotive manufacturers. Currently, there are four main types of wireless charging technology, including electric field coupling and radio wave transmission. However, these methods have relatively low transmission efficiency and cannot meet the charging requirements of electric vehicles, so they have not been widely adopted. The industry mainly focuses on electromagnetic induction and magnetic resonance technologies for wireless charging. Implementing wireless charging technology can significantly enhance the convenience of electric vehicle charging. However, there are challenges with the current application of this technology. For example, wireless charging technology has lower efficiency compared to conductive charging, with an efficiency rate of around 90% during charging peaks, while conductive charging can exceed 95% efficiency. Additionally, the transmission power of wireless charging technology is currently limited to around 10 kW, which is insufficient to meet the charging needs of electric vehicles. Safety is another concern with wireless charging technology. As it mainly relies on electromagnetic methods, charging in densely populated areas or with short distances between the vehicle and charging station can increase the risk of radiation leakage. Wireless charging technology is being applied not only in the new energy vehicle sector but also in the consumer electronics industry. Further research is needed to address the limitations of wireless charging technology and improve its effectiveness and value in the new energy vehicle industry[4].

5. Trends in the Development of New Energy Electric Vehicle Charging

The development of electric vehicles has significantly increased the demand for their application, as they are used in various scenarios and modes, leading to different requirements for the electrical grid. Therefore, the industry needs to strengthen the construction of charging facilities, improve the density of charging facility arrangements, and further enhance the intelligence level of charging facilities to effectively meet the charging needs of residents and improve the convenience of their travel. Research shows that in the future, both electric vehicles and charging facilities will become part of the Internet of Things. Leveraging the internet, they can provide car owners with more intelligent services, including charging reservations and payments. Additionally, internet technology applied in electric vehicles has significantly developed the connected car ecosystem.

In the future, with the integration of the internet and services, open internet connectivity can be effectively established, providing more convenient services for car owners, improving the range of electric vehicles, and optimizing cross-border transportation capabilities.

Currently, electric vehicle technology is not only applied in power infrastructure but also widely used in customer service systems. In recent years, the increasing number of electric vehicle applications has placed more stringent requirements on charging infrastructure. Although China is continuously improving the distribution density of charging infrastructure, the variety of electric vehicle types and energy matching issues remain important factors limiting electric vehicle usage. Therefore, personnel need to balance the public area charging load and conduct in-depth research. By adopting mobile energy storage and generation, coupled with internet-based consumption models, the current shortage of charging infrastructure can be mitigated to some extent, helping car owners quickly find appropriate charging stations and charge their electric vehicles, thus improving

the convenience of electric vehicle usage for car owners. Furthermore, these approaches can help address the issue of uneven energy distribution. Overall, electric vehicles act as mobile energy storage units and can effectively compensate for the inconvenience of charging through vehicle batteries. In recent years, research institutions have further developed bidirectional charging technology, which can improve the level of grid management and meet the charging demands of electric vehicles, showing promising prospects.[5]

Focusing on the improvement and optimization of charging technology, strengthening research and development efforts in charging technology can further enhance the development level of new energy vehicles. Considering the favorable development momentum of the new energy vehicle market, personnel should strengthen the standardized management of the market and provide appropriate guidance to help the new energy electric vehicle industry smoothly transition through the phase of decreasing government support and promote the long-term development of new energy vehicles. However, in subsequent work, it is important to start with traditional charging technology, further enhance the construction of charging stations, and reasonably plan the layout of charging facilities based on current practical conditions. Simultaneously, personnel should prioritize wireless charging technology and conduct research on battery swapping stations to maximize the charging speed of electric vehicles, providing effective support for their operation. In addition, by establishing an interactive mechanism between energy and information based on effective charging infrastructure research, research on vehicle-grid integration technology should be strengthened, and corresponding new charging station construction should be supported. By comparing the compatibility of integration technology with new charging station construction and improving the Internet+ model, the comfort of new energy vehicle applications can be effectively enhanced, providing users with better services. Currently, the development of vehicle-to-home and vehicle-to-grid technologies has matured. By leveraging vehicle-to-home technology, the limited supply of the grid can be overcome, ensuring the charging needs of electric vehicles by using home and building infrastructure to power the vehicles, thus ensuring the operation of new energy vehicles. Meanwhile, in the vehicle-to-grid system, it can effectively facilitate grid regulation and improve the stability of power supply services.

6. Conclusion

To sum up, by strengthening the research and development of charging infrastructure technology and simultaneously improving the functionality of terminal equipment while increasing the number of access points reasonably, the connection needs between vehicles and charging stations can be effectively met. In the future, new energy vehicles will often require private or dedicated charging stations to ensure that they can be charged anytime and anywhere, improving the convenience of people's travel. By developing intelligent electric transportation management systems, services such as charging station positioning and reservations can be provided to users, effectively enhancing the convenience of using new energy vehicles for residents.

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