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# *Research on Charging Mode and Efficiency of New Energy Vehicles*

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***Abstract:*** With the increasingly serious global environmental problems and the depletion of fossil fuel resources, new energy vehicles, especially electric vehicles, have become a key way to achieve sustainable development. However, the main challenges limiting the wide application of new energy vehicles remain the diversity of charging methods and their efficiency. This paper based on existing literature and data research systematically analyzes the technical characteristics, efficiency and application scenarios of DC fast charging, AC home charging and other charging methods. By discussing the energy efficiency of charging equipment, the energy loss during charging, and the factors affecting the charging mode and efficiency, this paper aims to provide methods and strategies to improve the charging efficiency. In addition, the study also assesses the impact of different charging methods on the development of the new energy vehicle market, revealing the importance of efficient charging methods in driving market growth. Through the comparison of DC fast charging and AC home charging, the existing problems and future optimization direction of current charging methods are revealed.

***Keywords:*** New Energy Vehicles, Charging, Battery, DC Charging, AC Charging

## 1. Introduction

In recent years, with the intensification of environmental problems and the looming energy crisis, governments and enterprises around the world are actively promoting the development of new energy vehicles. New energy vehicles, especially electric vehicles (EVs), are considered an important way to combat climate change and achieve sustainable development due to their low carbon emissions and high energy efficiency. With the progress of technology and policy support, the market share of new energy vehicles is steady. According to the China National Bureau of Statistics, in the first three quarters of 2024, the output of new energy vehicles increased by 33.8%, while the output of related charging piles increased by 57.2%. In the first half of 2024, the output of new energy vehicles increased by 34.3% year-on-year, and the output of supporting products charging piles and automotive lithium-ion power batteries increased by 25.4% and 16.5%, respectively increasing, and it has gradually become the main force to replace traditional fuel vehicles[1]. Although new energy vehicles have significant advantages in reducing emissions and reducing energy consumption, their charging methods and charging efficiency still face many challenges. The slow charging speed, the imperfect charging infrastructure, and the high energy loss during the charging process are the main problems affecting the user experience and market popularity. Therefore, improving the efficiency

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and convenience of charging methods has become the key to promoting the further development of new energy vehicles. The purpose of this study is to systematically analyze the main charging methods of new energy vehicles and their efficiency, and reveal their advantages and disadvantages in practical applications. Through in-depth analysis of the status quo and technical bottlenecks of charging methods, theoretical support and practical guidance are provided for the wide application of new energy vehicles. On the basis of clarifying the existing problems, this study will explore how to improve the efficiency of charging methods and reduce the energy loss in the charging process through technological innovation and management optimization, so as to achieve a more economical and environmentally friendly charging experience.

## 2. Charging methods of new energy vehicles

### 2.1. DC fast charging

DC Fast Charging is a prevalent method employed at public charging stations, capable of delivering substantial electricity to electric vehicles in a brief duration. to facilitate a vehicle's traversal of 100 kilometers within 10 to 12 minutes. Such charging stations are usually distributed in major urban traffic arteries, service areas and along expressways to provide convenient charging services for long-distance driving and high-frequency electric vehicles. Dc fast charging relies on high-power charging equipment and advanced power electronics technology. Charging equipment typically includes high-voltage charging piles, converters, and control systems capable of converting alternating current from the grid to direct current to charge the battery directly. This charging method requires the device to have a high voltage and current stability to ensure a fast and safe charging process.

Although DC fast charging can significantly reduce charging time, its charging efficiency is affected by a number of factors, such as the battery's chemistry, ambient temperature, and the size of the charging current. Usually, the efficiency of fast charging is relatively high, but as the charging progress advances, the charging speed will gradually decrease, especially when the battery is close to full charge, which is mainly to protect the battery and avoid the loss caused by overcharging. The construction and maintenance costs of DC fast charging stations are relatively high, and frequent use of DC fast charging might have adverse effects on battery health, such as accelerating battery aging or reducing battery capacity[2].

AC home charging is the most common form of charging and is suitable for home users with a high frequency of daily use. Home charging stations are usually installed next to garages or fixed parking spaces, using the home power supply system to provide energy for electric vehicles, which is convenient for users to charge at night or when the vehicle is idle. The efficiency of home charging is closely related to the voltage and current of the home power supply system and the performance of the charging equipment. Under normal circumstances, the efficiency of home charging is relatively stable, but the charging time is longer, generally taking 6 to 8 hours to fully full the battery. For daily short-distance driving users, this way can meet their needs very well[3].

### 2.2. Principle and application of wireless charging technology

Wireless charging technology achieves non-contact charging through electromagnetic induction or magnetic resonance. This technology provides users with a more convenient charging experience, avoiding the inconvenience of plugging and unplugging cables in traditional charging methods. At present, wireless charging technology is gradually applied to some high-end electric vehicles. Although its efficiency is still lower than wired charging, with the progress of technology, this gap is gradually narrowing[4]. The establishment of public charging stations is a crucial infrastructure to facilitate the proliferation of electric automobiles. As the quantity of new energy cars increases, the proliferation and allocation of public charging stations are continuously expanding to accommodate

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customers' daily charging requirements. In addition to traditional wired charging stations, wireless charging stations and solar charging stations have also begun to be piloted in some areas in recent years, providing more diverse charging options. The sustainability and reliability of charging facilities are key factors to ensure the normal operation of new energy vehicles. Future charging facilities should be designed with energy efficiency, maintenance costs and environmental impact in mind to ensure their long-term stability and economy[5].

## 3. Charging efficiency of new energy vehicles

### 3.1. Definition and measurement method of charging efficiency

Charging efficiency refers to the proportion of the actual energy stored by the battery to the total input energy during the transmission of electric energy from the grid to the electric vehicle battery. It is usually expressed as a percentage. The measurement methods of charging efficiency include the ratio analysis of energy input and output, real-time monitoring of power consumption, etc. An efficient charging process minimizes power loss and stores more power efficiently in the battery.

### 3.2. Energy efficiency analysis of charging equipment

The efficacy of charging apparatus is influenced by several elements, including the charger's design, power conversion efficiency, and transmission line resistance, among others. While high-power charging devices can diminish charge duration, they may also incur significant energy losses. The loss primarily manifests as thermal dissipation, energy conversion inefficiencies, and similar factors.

Energy efficiency is an important index to evaluate the overall performance of charging equipment. It includes not only the efficiency of the device itself but also the coordination of the entire charging system. For example, the use of smart charging systems can optimize power distribution and reduce peak load, thereby improving overall energy efficiency. During the charging process, energy loss is inevitable. The main sources of loss include the internal resistance of the battery, the loss of resistance during transmission, and the reduced efficiency of the power converter. Especially in the fast charging mode, the loss problem is more obvious. In addition to the efficiency of the equipment itself, the cause of energy waste also includes the unreasonable charging behavior, such as frequent charging and discharging, overcharging and so on. By optimizing user charging behavior and charging strategy, unnecessary energy waste can be reduced.

### 3.3. Charging efficiency improvement and optimization methods

Technological innovation is the key to improving charging efficiency. High-efficiency power conversion technology, the utilization of novel materials, and the enhancement of wireless charging technology are all critical avenues for advancing charging efficiency in the future. The intelligent charge management system can dynamically adjust the charging power according to the actual needs of electric vehicles and the load of the grid, thereby maximizing the charging efficiency. By linking with vehicles and the grid, smart charging systems can also optimize energy distribution and reduce energy waste during charging[6].

## 4. Factors affecting the charging mode and efficiency of new energy vehicles

### 4.1. Construction of charging equipment and infrastructure

The number and distribution of charging devices directly affect the user's charging convenience. Insufficient or uneven distribution of devices will increase the waiting time of users, affecting the

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charging experience. Reasonable planning and construction of charging infrastructure can improve the overall charging efficiency. The design and construction of charging stations should take into account various factors such as traffic flow, user demand, and grid capacity. By adopting scientific and reasonable strategies, the allocation of resources can be optimized to reduce unnecessary waste. It is important to consider the location of charging stations in relation to popular routes or destinations for electric vehicle drivers. Additionally, it is crucial to ensure that there are enough charging ports available at each station to meet the needs of users during peak hours. The use of renewable energy sources such as solar power can also help reduce reliance on traditional energy grids and promote sustainable development. Overall, careful planning and consideration are necessary when constructing charging stations in order to provide efficient and convenient services for electric vehicle owners while minimizing negative impacts on the environment[7].

### 4.2. Development of charging technology and battery technology

The development of charging technology directly affects the improvement of charging efficiency. For example, the application of ultra-high-speed charging technology can significantly reduce charging times while improving energy efficiency. For instance, the application of ultra-fast charging technology can significantly reduce charging time while improving energy efficiency. This technological advancement is particularly crucial for electric vehicles (EVs), as shorter charging times and higher efficiency can directly translate into better user experiences and lower operational costs. As the EV market flourishes, some companies are focusing on developing new battery technologies to reduce costs and enhance performance. NAWA Technologies in France, for example, concentrates on improving electrode materials by adopting carbon electrode technology to achieve breakthroughs in battery performance[8]. This technology not only accelerates charging speeds but also increases the energy density of batteries, thereby enhancing the overall system's efficiency. Moreover, 800V high-voltage fast-charging technology is gradually becoming a standard feature in mid-to-high-end models of new energy vehicles, marking a new focus of competition among power battery manufacturers. For example, brands like Skyworth, Xiaopeng, and GAC have started integrating this technology into their latest models to meet consumers' demand for faster charging speeds[9]. These examples clearly demonstrate that ultra-fast charging technology not only significantly shortens charging times but also effectively improves energy conversion efficiency, playing a vital role in promoting the continuous development of the EV industry[3].

Advances in battery technology are another important factor in improving charging efficiency. The development of new high-efficiency batteries can reduce energy loss during charging, while extending battery life and reducing losses caused by frequent charging and discharging.

### 4.3. Policy and regulatory implications

The government's policy support and subsidy measures play an important role in promoting the construction of charging infrastructure and technology research and development. For example, through subsidies and tax incentives, the government can encourage enterprises to invest in the construction of charging facilities and promote the research and development and application of efficient charging technologies. Unified charging standards and specifications help improve charging efficiency and reduce compatibility problems in the charging process. This not only benefits the convenience of users but also promotes the healthy development of the entire industry.

### 4.4. Influence of user behavior and needs

The user's charging habits and preferences will directly affect the charging efficiency. For example, some users may prefer frequent charging, while others prefer centralized charging, and these

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behaviors all have an impact on the overall charging efficiency. Improper user behavior may lead to overuse or inefficient utilization of charging equipment. For example, over-reliance on fast charging results in shorter battery life, which reduces overall energy efficiency. Through user education and charging guidance, equipment utilization can be improved and energy waste can be reduced.

## 5. Conclusion

DC Fast Charging boasts high charging efficiency and a relatively short charging time. This method of charging can directly deliver DC power to the battery of an electric vehicle, bypassing the conversion process performed by the onboard charger, thus enabling faster charging speeds. AC home charging, while slightly less efficient, is more cost-effective and better suited for daily use. Additionally, due to the lack of need for specialized fast-charging infrastructure, the cost of AC home charging is relatively lower, making it more economically viable. Emerging technologies such as wireless charging and solar charging still need to be further optimized in terms of efficiency, but their convenience and sustainability have potential and deserve further study in the future. The advanced nature of the equipment and the perfection of the infrastructure directly determine the level of charging efficiency. Optimization of charging equipment and reasonable layout of infrastructure are the basis for improving charging efficiency. Technological advancement and development are vital to enhancing efficiency. The advancement of battery technology can significantly address the issue of charging efficiency. Efficient and convenient charging methods will significantly enhance users' acceptance of new energy vehicles, and thus promote the development of the market. Although this study provides a comprehensive analysis of NEV charging methods and efficiency, there are still some limitations, such as the regionality of the data and the diversity of charging behaviors. Future study should incorporate more field data and explore the application prospects of new charging technologies.

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