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Development and Outlook of Fast Charging for Electric Vehicles in China

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Abstract: With the escalating demand for sustainable transportation and the rapid growth of the electric vehicle (EV) market in China, the development of efficient fast charging solutions has gained paramount importance. This paper conducts a comprehensive analysis of the current status and historical evolution of fast charging for EVs in China, focussing on technological advancements such as the emergence of 800V high-voltage platforms and improvements in battery and charging facilities. Moreover, it examines the obstacles faced and proposes potential solutions. Fast charging not only alleviates range anxiety but also significantly boosts the practicality and popularity of EVs, facilitating their widespread adoption. However, despite the considerable progress made, challenges persist, including the high cost and limited coverage of charging infrastructure, as well as potential negative impacts on battery longevity. Achieving interoperability among super-fast charging protocols across different brands and expanding fast-charging station infrastructure will be critical to addressing the issues of slow charging and range anxiety, thereby achieving the full popularization of electric vehicles.

Keywords: EV, Fast charging, 800v high voltage platform, Charging infrastructure.

1. Introduction

In the contemporary era marked by a growing emphasis on sustainable development and environmental protection, the transportation sector is undergoing a profound transformation. EVs have emerged as a key solution to address the challenges posed by traditional internal combustion engine vehicles. In China, the EV market has witnessed explosive growth, driven by factors such as government policies, technological advancements, and increasing consumer awareness. In 2018, the number of electric vehicles in China was 1.78 million. As of the end of June 2024, this figure has reached 18.134 million, an increase of 918% compared with 2018 [1]. However, the development of fast charging for EVs in China has faced several challenges. Past issues included limited charging infrastructure, inconsistent standards, and technological immaturity. The high costs of 800V platforms and the need for power grid upgrades have also posed significant hurdles. Research by scholars Safayatullah, M. et al., and Tu, H et al. shows that fast charging of electric vehicles requires DC charging and stable DC output high voltage requirements, and also introduces the technical details of AC-DC and DC-DC power levels for external charging of electric vehicles [2, 3]. Research by scholars Lau, Y. Y. et al. presents the current status and challenges of electric charging infrastructure

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deployment, while another research on scholars Wang, L. et al. proposes corresponding solutions for the construction of fast charging stations and other infrastructure [4, 5]. Research by scholars Lau, Y. Y. and Ma, S. C. shows China's favorable policies and policy implications for the construction of electric vehicle charging station infrastructure [4, 6]. This paper aims to provide a detailed analysis of the development, review, and outlook of fast charging for EVs in China. It will explore the technological innovations, including the 800V high-voltage platform, assess the challenges faced during the process, and offer predictions and suggestions for the future direction of fast charging technology. The study of fast charging technology like the 800V high-voltage platform in EVs is highly significant. For EV owners, it eases range anxiety and saves time. In the industry, it improves fleet efficiency and EV competitiveness. For society, it promotes sustainable transport and drives technological innovation.

2. The development of fast charging for EVs in China

2.1. An overview of the development of fast charging for EVs

In China, the development of fast charging for EVs has been nothing short of remarkable in recent years. The expansion of fast-charging infrastructure has been exponential. By 2023, there were over 50,000 fast-charging stations scattered across the country, a testament to China’s commitment to promoting EV adoption. Through various subsidy programs, significant financial incentives have been provided to both public and private entities involved in the construction of fast-charging stations. These subsidies have not only increased the quantity but also improved the quality of the infrastructure.

Technologically, the progress has been equally impressive. The power output of fast chargers has seen a remarkable upswing. At present, slow-charging piles typically offer less than 7 kilowatts of power, and depending on the vehicle’s battery capacity and the charger’s power, it can take 6-10 hours or more to fully charge. In contrast, some of the latest-generation fast chargers are capable of reaching charging powers of up to 360kW. With such high-power charging, an EV can be charged to approximately 80% of its battery capacity in just 15-30 minutes [2]. This dramatic reduction in charging time has effectively addressed the issue of long charging durations, which was previously a major concern for potential EV users. Consequently, it has significantly enhanced the practicality and appeal of EVs in China, positioning the country as a front-runner in the global development of EV fast-charging infrastructure.

2.2. Slow charging

Slow charging refers to charging in AC mode through an AC charging pile, with the charging port consisting of seven holes. The charger inside the EV converts AC power into DC power, which is then used to charge the EV battery. The charging power is limited by the EV’s internal charger, which is typically lower in power. One is a home charging pile with a power of about 7 kilowatts. It takes 6 to 7 hours to charge a 50-kilowatt-hour electric vehicle. The other is a portable charger, which can be plugged directly into an ordinary household outlet. The power is relatively small, generally below 2 kilowatts, and a full charge may take more than ten hours or even longer. Due to these factors, AC charging is slow and is thus referred to as slow charging [7].

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Figure 1: DC fast charging [8]

2.3. Fast charging

Fast charging means that the DC charging pile directly converts AC power into DC power with the help of a charging module to charge the EV battery. Its charging port consists of nine holes. The charging power of the DC charging pile has nothing to do with the power of the EV charger, but is determined by the battery management system and the output power of the charging pile itself. Generally speaking, DC charging piles are high-power devices, so their charging time is short and they are called fast charging [7].

Figure 2: AC slow charging[8]

3. Core challenges of fast charging technology

Super fast charging may affect battery life. High-rate charging will cause the battery to decay faster and even become scrapped after multiple cycles. This risk causes some battery manufacturers to consider consumer usage habits in their product strategies, and face the difficult trade-off between meeting fast charging needs and ensuring battery life. In addition, fast charging technology faces many obstacles. Problems with funding and review processes have slowed development. At the same time, there are still many technical difficulties that need to be overcome, such as how to achieve fast charging while ensuring battery safety and stability. This requires experts in related fields to invest more time and energy in research and development breakthroughs.

3.1. Battery life impact

High-rate charging will accelerate the decay of the battery after cyclic use. Data show that, when comparing the lifespans of fast-charging and slow-charging new energy vehicles, those currently using ternary lithium and lithium iron phosphate batteries have lifespans of 2000 charge and discharge cycles, respectively. In fast charging mode, the cycle life of the battery will be reduced. For example,

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if the batteries of two cars are the same and both can guarantee a cycle life of 1500 weeks under slow charging, one of the cars may set the fast-charging mode to charge to 80% in 15 minutes, but the life under fast charging is only 500 weeks. This illustrates the real risk of battery decay associated with high-rate charging [9].

3.2. Cost and technical issues

Funding and review issues are important factors that lead to the slow development of fast-charging technology. The cost of building a battery swap station is about 2 million yuan, which is a heavy burden for car companies. Fast charging technology is strictly reviewed. Although DC charging is the mainstream of fast charging, the relevant modules and technologies are immature and there is a gap from commercial use in the market. In addition, the carrying capacity of power grids varies by region, making it challenging for power grids in non-first-tier cities to support the energy output of super-fast charging piles, which limits the promotion of this technology.

At the same time, breakthroughs in fast charging technology require experts in related fields to spend time to overcome difficulties. For example, 800V high voltage and high power can fundamentally improve the charging speed, which requires vigorously promoting the development of SiC Mosfet core power devices and silicon carbide substrate materials [10]. In addition, fast-charging technology poses great challenges to electrical engineering and material technology. In terms of electrical engineering, the charging process needs to be accurately controlled in real time to prevent the battery pack from accelerating ageing or damage due to high temperature; in terms of material technology, the charging rate of lithium-ion batteries is restricted by the positive electrode, electrolyte, and negative electrode materials, and these materials need to be improved to improve the battery's fast charging ability and life.

4. Future prospects of fast charging technology

4.1. 800v high voltage platform

The 800V high-voltage platform is an electrical system design concept for EVs, and its voltage range is usually between 550V-930V. At present, the voltage platform of the best-selling models in China is generally between 400V and 600V. The 800V high-voltage platform can increase the vehicle's traction power and improve its power performance. Secondly, under the same current, the vehicle's charging power and motor power are both improved, resulting in shorter charging times. Compared with the 400V system, the charging time of the 800V solution can be almost halved when the battery power is the same [11].

Since Porsche introduced the Taycan in 2019, the world’s first mass-produced model equipped with an 800V high-voltage platform, many domestic and international automakers have followed suit or plan to release models equipped with this high-voltage platform. Companies like Xiaomi, Xpeng, Li Auto, Wenjie, IM, and Audi have launched or are soon expected to launch vehicles with this technology. For example, as shown in Table 1, the model ecean-X released by BYD also launched its e-platform 3.0 and 800V supercharging platform, which meets the fast-charging standard of 150km of battery life in 5 minutes of charging. Models of other brands can also be replenished with a range of 400 to 610 kilometers within 15 minutes.

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Table 1: Charging performance of various brands of vehicles equipped with 800v high-voltage platform

Vehicle Model/company	Charging Time(min)	Range(km)
ZEEKR 007	5/15	240/610
Xiaomi SU7	5/15	200/510
Li Auto MEGA	12	500
Geely Galaxy E8	5	180
IM LS6	10	350
Xpeng G6	10	300
Zhijie S7	15	Over 400
Porsche Taycan	15	400
Audi Q6 e-tron	10	250
AITO 12	20	350
BYD ecean - X	5	150

4.2. Promote charging protocol interoperability

Due to the different charging standards in different countries, the globalization process of electric vehicles has been slowed down. In response, the ChaoJi charging standard was launched in 2017, with participation from countries such as Germany and Japan. By 2018, some high-power chargers were deployed, and in 2019, an international joint working group was established. Japan's Chademo 3.0 adopted the ChaoJi interface solution. In 2020, the 900kW charging protocol was released, followed by the first test demonstration. By July 2022, it was unanimously passed by the IEC to become an international standard with widespread global support [5].

ChaoJi charging technology has many features: high power, supported by a liquid cooling and temperature monitoring system, with a maximum charging power of 900kW, significantly reducing charging times; strong compatibility, as it can be forward compatible and compatible with international mainstream charging systems; flexible interface, offering a compact design and combination with an AC interface; it also supports a variety of technical applications, such as plug-and-charge, V2X, automatic charging, etc., and reserves high power space.

Currently, ChaoJi charging technology is gradually being promoted and applied in China. For example, Chaoji charging stations have been built in highway service areas, urban public charging stations and other places in some areas to provide fast charging services to electric vehicle users. As the electric vehicle market continues to develop, the application scope of ChaoJi charging technology is expected to further expand. While the ChaoJi standard offers enhanced charging support for EV development and helps mitigate "range anxiety," challenges related to the construction of charging facilities and compatibility still need to be addressed [12,13].

4.3. Policy support

Policies play a vital role in the development of fast charging technology. The "Guiding Opinions on Further Building a High-Quality Charging Infrastructure System" issued by the General Office of the State Council promotes the construction of DC fast charging and charging network densification in inter-city trunk lines and key areas, promotes the extension of charging infrastructure to urban fringe areas and rural areas, strengthens information interconnection and supporting electricity price policy support, and encourages the development of new technologies that are friendly to the power grid, such as orderly charging. The "Action Plan for Accelerating the Construction of a New Power System (2024-2027)" issued by the National Development and Reform Commission, the National Energy

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Administration, and the National Data Bureau proposes to establish and improve the charging infrastructure standard system and accelerate the formulation and revision of advanced charging and battery replacement technology standards represented by fast charging technology. These policies provide strong support for the development and industrialization of fast charging technology, encouraging companies to increase R&D investments and improve technological levels, contributing to the sustainable growth of China's EV industry [4].

5. Conclusion

The development of fast charging in China has witnessed remarkable progress. Technological advancements, such as the emergence of 800V high-voltage platforms and improvements in battery and charging infrastructure, have significantly reduced charging times. The rapid charging capabilities of various vehicle models exemplify these practical achievements. Looking back, challenges such as limited charging efficiency, inadequate infrastructure, and non-standardized charging protocols posed significant obstacles. However, through continuous efforts and investments, these issues have been gradually addressed. Looking forward, while fast charging technology holds great promise, there are still challenges to overcome. The high cost of infrastructure installation and maintenance remains a concern. Additionally, the potential impact of fast charging on battery lifespan needs to be managed effectively. Despite these challenges, the outlook for fast charging in China is optimistic. Continued research and development, along with government support and industry collaboration, are expected to drive further improvements. The expansion of charging networks, especially high-power fast-charging stations, will enhance the convenience and accessibility of EVs. In conclusion, the development of fast charging for EVs in China is an ongoing journey. With sustained efforts and innovation, it is poised to play a pivotal role in accelerating the widespread adoption of EVs, contributing to a more sustainable transportation ecosystem in the country.

References

[1] *China Economic Network. 2024.7.8. Ministry of Public Security: The total number of new energy vehicles in China is 24.72 million, accounting for 7.18%. http://www.ce.cn/.*

[2] *Safayatullah, M., Elrais, M. T., Ghosh, S., Rezaii, R., & Batarseh, I. (2022). A comprehensive review of power converter topologies and control methods for electric vehicle fast charging applications. IEEE Access, 10, 40753-40793.*

[3] *Tu, H., Feng, H., Srdic, S., & Lukic, S. (2019). Extreme fast charging of electric vehicles: A technology overview. IEEE Transactions on Transportation Electrification, 5(4), 861-878.*

[4] *Lau, Y. Y., Andrew Wu, Y., & Wing Yan, M. (2022). Electric vehicle charging infrastructures in the Greater Bay Area of China: Progress, challenges and efforts. Frontiers in Future Transportation, 3, 893583*

[5] *Wang, L., Qin, Z., Slangen, T., Bauer, P., & Van Wijk, T. (2021). Grid impact of electric vehicle fast charging stations: Trends, standards, issues and mitigation measures-an overview. IEEE Open Journal of Power Electronics, 2, 56-74.*

[6] *Ma, S. C., & Fan, Y. (2020). A deployment model of EV charging piles and its impact on EV promotion. Energy Policy, 146, 111777.*

[7] *Botsford, C., & Szczepanek, A. (2009, May). Fast charging vs. slow charging: Pros and cons for the new age of electric vehicles. In International Battery Hybrid Fuel Cell Electric Vehicle Symposium(pp. 1-9). Citeseer.*

[8] *SOHU. https://news.sohu.com/a/710852227_121712999/2023/08/11/https://auto.sohu.com/?spm=smpc.home.top-nav.16.1555312357871pGAAq77*

[9] *Al-Saadi, M., Olmos, J., Saez-de-Ibarra, A., Van Mierlo, J., & Berecibar, M. (2022). Fast charging impact on the lithium-ion batteries' lifetime and cost-effective battery sizing in heavy-duty electric vehicles applications. Energies, 15(4), 1278.*

[10] *Saha, J., Kumar, N., & Panda, S. K. (2022). A futuristic silicon-carbide (SiC)-based electric-vehicle fast charging/discharging (FC/dC) station. IEEE Journal of Emerging and Selected Topics in Power Electronics, 11(3), 2904-2917.*

[11] *Yue Wang.(2024).Advantages and innovations of 800V high-voltage electric drive system in new energy vehicles.Urban Public Transport(01),26-28.*

DOI: 10.54254/2755-2721/130/2025.20289

[12] *Acharige, S. S., Haque, M. E., Arif, M. T., Hosseinzadeh, N., Hasan, K. N., & Oo, A. M. T. (2023). Review of electric vehicle charging technologies, standards, architectures, and converter configurations. IEEE Access, 11, 41218-41255.*

[13] *Li, X., Wu, B., Ni, F., & Song, H. (2022, July). Research on Electric Vehicle Charging Communication Protocol Framework and the Application in ChaoJi Charging System. In 2022 IEEE 4th International Conference on Power, Intelligent Computing and Systems (ICPICS) (pp. 162-166). IEEE.*