Research on the Development Status, Strategic Choice and Business Model of China's Charging Pile Industry

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Abstract. The interaction between electric vehicles and power grids can achieve the functions of cutting peaks and valleys of load, participate in frequency modulation, and provide reserve service. It is of great significance for the safe and economic operation of power grids and the ability to improve the capacity of new energy power generation. However, due to the lag of the development of China's charging pile industry, which constrained the development of electric vehicles. This paper analyzes the key issues of market mechanism and infrastructure of charging piles. First, this paper summarizes the development status of China’s charging pile and proposes the research route for the development of charging pile bottlenecks; secondly we analyze China’s policies on different stages and construct implementation path of charging pile. By comparing the basic indicators, related policies and related innovation activities of the charging pile for China, we conclude that the development of the national electric vehicle industry needs to be increased in terms of government policies, business model innovation and public awareness.

1. Introduction
In the past two years, new energy vehicles have developed rapidly, and new energy vehicles have become one of the leading industries in China. According to the data of the Ministry of Industry and Information Technology, in 2017, China's new energy vehicles production and sales reached 794,000 and 777,000. Among the new energy vehicles, 90% are electric vehicles that need to be recharged, so the charging facilities have become an important infrastructure for the development of new energy vehicles [1].

In [2], proposed automatic breaking charging, smooth adjustment of charging mode, and establishment of an orderly charging model. In [3], considered the time of use electricity price and the daily historical load curve, and proposed a wireless charging mode that did not need to establish a charging station and a charging pile, and adopt an orderly charging method in a double-sequence valley period. In [4], the grid selection method was used to obtain the optimal control strategy of electric vehicles by using genetic algorithm. In [5], proposed a simplified formula for the fast calculation of charging stations, and compared with the measured data to verify the effectiveness of the modeling method. In [6,7], studied a fast charging control strategy with energy storage, analyzed the power characteristics of different batteries, and verified the feasibility of the strategy by building a model. In [8], developed electricity price service strategy, and improved charging space and time randomness through charging stations with photovoltaic power.

In this paper, we will first give a comprehensive review of the concept, characteristics and framework of charging piles in China. The paper is organized as follows. Section 2 describes the current development status of charging piles. Section 3 presents charging piles development model, such as policy framework, business model design, and technical support. Finally, the research prospects and main technical challenges of charging piles are discussed in Section 4.
2. Development Status of China's Charging Pile Industry

2.1. The Status Quo of China's Charging Operators
Slow charging adopts constant voltage or constant current mode of small current. Fast charging is the key to promote the use of electric vehicles. In private homes and public places of city, slow charging devices with lower cost and longer charging time can be selected. Due to the high construction cost, large construction area and lack of flexibility of DC charging piles, the proportion of DC charging piles in the market is low. At present, there are more than 100 operators in China's charging pile market, but the top four operators of State Grid, China Potevio, Wanbang New Energy Investment Group Co., Ltd. and Qingdao teld New Energy Co., Ltd. account for 98% of the market share.

2.2. The Operation Mode of Main Charging Industry in China
There are four main operation modes in charging industry: operator-led mode, Hybrid mode of cooperation between electric vehicles and charging piles, crowdsourcing mode and time-sharing leasing mode.

(1) Operator-led mode
Operator-led mode is the main operation mode of charging facilities in China, which represents the State Grid and China Potevio. State Grid is the largest investor in the field of charging piles in China. Take Tesla Company builds supercharging stations for customers in restaurants, shops, coffee shops, rest stations, and around gas stations on major American roads. In China, Tesla and State Grid cooperate to build private charging ports for users.

(2) Hybrid mode of cooperation between EV and charging piles
The hybrid mode can effectively promote the sales of charging piles. For example, BYD and Wanbang cooperated to provide maintenance for 8,000 electric taxis in Taiyuan, and Geely cooperated with rich power technology to quickly open the market for Emperor EV. Charging Pile operator teld and Beijing Automobile Company taken Beijing as a breakthrough point, charging system model and charging network technology platform have been built. Private consumers, taxis and buses are the starting points of the hybrid mode initial business, and actively participate in other areas such as bus, institution bus and other vehicle areas, supporting the construction and operation of charging infrastructure network, and to achieve intelligent charging service.

2.3. Standards for Charging Services in Different Provinces of China
China has liberalized the construction of urban charging pile facilities. It is expected that the market will be dominated by private enterprises under the attraction of market space. The government hopes to attract social capital into the construction of charging piles, charging stations and other facilities. The paper has introduced charging service fee standards in Shanghai, Jiangxi, Qingdao, Hefei, Nanjing, Huizhou, Qingdao, Beijing and Guangzhou.

2.4. Forecast of Construction Volume of Charging Piles in China
High cost results in slow construction of charging facilities, which makes it difficult to make profits in the short term. In China, the State Grid, Southern Power Grid and other companies have invested in charging piles. With the explosive growth of the number of new energy vehicles, the construction scale of charging piles, which are the necessary supporting facilities, has also expanded.

In addition, when purchasing electric vehicles, users mainly consider whether the charging piles are fully equipped, whether charging is convenient enough, and whether it is feasible to install charging piles by themselves.

3. Design of Commercial Service Model for Charging Piles in China

3.1. "Charging Pile + Merchandise Retail + Service Consumption" Model
The European countries represented by Germany and Denmark utilize the charging time of electric vehicle owners to expand their retail and consumer businesses, and take charging and switching business as the center to promote the development of relevant industrial chains. It improves the
stickiness and value-added of charging service. At present, only Tesla co-operates with hotels and shops to build charging stations, which are planned to cover more than 100 cities in China. With the explosive growth of electric vehicles, the attraction of establishing the industrial development model of "charging pile + retail merchandise + service consumption" in the commercial areas of first-tier cities will gradually increase. Figure 1 illustrates the “charging pile + merchandise retail + service consumption” mode:

**Figure 1.** “charging pile + merchandise retail + service consumption” mode

China promotes the construction of parking intelligence, establishes parking database, updates data in real time, and promotes the integration of parking and Internet. Therefore, this model realizes automatic billing and payment functions, and improves the utilization efficiency of parking resources. If intelligent parking and charging piles are combined, the market will reach trillions. At present, most of the social charging piles are built in the existing parking lot, and vigorously develop the lifting and transverse intelligent charging parking lot. In the future, intelligent parking APP will be used to reserve access parking and provide charging services. In addition to charging costs, parking fees generated in the charging process will also be paid.

3.2. “Charging APP+ Cloud Service+ Remote Intelligent Management” Mode

Through the design and application of the APP with strong functional integration, the electric vehicle user is provided with real-time positioning of the charging station, real-time control and charging status remote monitoring service such as charging accident interruption, charging reservation reminder, fault alarm and so on. With the goal of improving user experience and providing convenience, users can freely arrange and change the charging process at any time, while providing flexible payment methods to enhance user stickiness. The charging pile operation can provide flexible management tools for the operators with rich data analysis and convenient payment transaction support. Figure 2 shows the “Charging APP+ Cloud Service+ Remote Intelligent Management” mode:
Figure 2. “Charging APP+ Cloud Service+ Remote Intelligent Management” mode

(1) It can provide a charging diversification pricing option. Business owners can freely price according to charging time, charging process, charging power.

(2) Build an intelligent “cloud service” operation platform, provide an energy metering and management system, and provide charging terminal operators with multiple charging capacity and speed options, which can reduce operating costs by providing flexible charging capacity.

(3) Provide detailed management of big data analysis for business owners, and provide basis for improvement and improvement of services. Based on the “cloud service”, it provides the specific daily utilization hours, peak utilization rate, number of charging demands, and average charging cycle of each charging station. Business owners can log in to the account to get detailed data analysis reports, effectively identify the operation of each site, and focus on the timely focus on charging stations with operational difficulties.

3.3. “Automaker + Equipment Manufacturer + Operator + User” Model

Through the integration of vehicle manufacturers, equipment manufacturers, users, charging station operators, financial institutions and other stakeholders to create attractive products and services, all types of enterprises in the electric vehicle industry chain can see broad market space. Together, promote the development of the electric vehicle and charging pile market. Figure 3 shows the “automaker + equipment manufacturer + operator + user” model:
Figure 3. “Automaker + equipment manufacturer + operator + user” model

The charging pile cooperates with the vehicle manufacturers to build an electric vehicle e-commerce platform and provide online service. Including cooperation with financial institutions such as auto finance and financial leasing companies, launching electric vehicle financial plans, provide a variety of financial products to facilitate car purchases.

4. Conclusions

Driven by new technologies such as big data, Internet of Things, artificial intelligence, and virtual assistants, the charging pile is becoming more intelligent. Currently, charging users who use mobile phones to make sure charging device locations. The charging customer pays for system access and charging through the mobile client. The charging pile master realizes remote monitoring of the charging device to ensure the normal operation of the charging service. In addition, after the pile is paired with the mobile phone, the pile master can remotely charge the peak by the mobile phone, thereby saving the charging cost.

The V2G technology can realize communication of energy flow between the electric vehicle and the power grid, which can effectively manage the charging and discharging process of the electric vehicle and minimize the impact of the electric vehicle load on the power grid. At present, China has carried out V2G pilot research in cities such as Beijing, and has achieved certain research results in V2G discharge load prediction and discharge control strategies. V2G will become an inevitable trend in the charging pile industry.

5. Acknowledgments

This paper is supported by State Grid Home Grid Corporation's technology project (Analysis and Simulation of Ubiquitous Power IoT Edge Computing Performance Based on Typical Scenarios ), State Grid Energy Research Institute Co., LTD.'s Young Talent Project (Research on Key Technologies of Fog Computing for Smart Grid). The authors declare that there is no conflict of interest regarding the publication of this paper.

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