Research on the Development and Application of Charging Piles Based on the Development of New Energy Vehicles

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Abstract. In this paper, based on the cloud computing platform, the reasonable design of the electric vehicle charging pile can not only effectively solve various problems in the process of electric vehicle charging, but also enable the electric vehicle users to participate in the power management. It makes the charging and power consumption of electric vehicles more scientific and reasonable, realizes the communication and interaction between users and power grid, meets the charging requirements of electric vehicles, improves the overall service quality, and contributes to the comprehensive promotion of the technology.

1. Introduction
The development of new energy vehicles has been widely recognized in China's national economy, ecological environment, energy strategic security and other important fields [1-3]. New energy vehicles are becoming the trend of the world. The convenient and fast layout of new energy vehicle charging network is the cornerstone of the good development and popularization of electric vehicles [4-6]. At present, with the large-scale development of electric vehicles, most major cities in China have accelerated the construction of charging piles. From abroad, the development and construction of new energy vehicles are steadily moving towards market advantage with the change of global economic situation.

At present, there are more and more electric vehicles in China, and people put forward higher and higher requirements for charging piles. However, if there are too many charging piles, it is easy to interfere with the safety and stability of the power grid. Therefore, based on the cloud computing platform, it is necessary to reasonably design the charging piles of electric vehicles, and take the right way to effectively monitor and apply them, reduce the number of urban charging piles, and solve the charging problem of electric vehicles. The designer should not only make a perfect design scheme, but also design and build the cloud client and system module effectively, and apply them in practice, so as to provide a good charging service for electric vehicles.

2. Main problems in the application of new energy vehicle charging pile
At present, the domestic construction of new energy vehicle charging piles is still in its infancy, and the number of new energy vehicle charging piles is less than that of new energy vehicles. By the end of 2019, China has produced 313000 new energy vehicles, but only 30914 charging piles, with a ratio of 24.7%, which is far lower than the reasonable level (1:1). The number of charging piles can no longer meet the
demand of new energy vehicles. Statistics show that from 2015 to 2019, the number of charging stations in China increased from 106 to 1523, with a compound annual growth rate of 75.6% [5-8]. As of 2019, the charging network has built 4500 charging points in 248 cities nationwide. According to statistics, by the end of 2018, State Grid Corporation of China has built 918 charging and replacing power stations, 54000 charging piles, 418 new charging and replacing power stations and 35000 charging piles in 2019, as shown in Table 1 and Figure 1.

| Mutual agreement | 2016 | 2017 | 2018 | 2019 |
|------------------|------|------|------|------|
| Accumulated charging station | 454  | 864  | 820  | 976  |
| Accumulated charging piles / 10000 | 3.5  | 3.58 | 3.9  | 5.6  |
| Completion of charging and replacing power station | 679  | 325  | 89   | 539  |
| Build charging piles / 10000 | 2.74 | 2.28 | 2.54 | 2.5  |

In the 12th Five Year Plan for grid intelligence of State Grid Corporation of China, State Grid Corporation of China plans to build 904 charging and replacing power stations and 233000 charging piles during the 12th Five Year Plan, with a total planned investment of 21.71 billion yuan in charging facilities. From 2014 to 2018, the scale of electric vehicle charging stations of State Grid will reach 4000; from 2018 to 2022, the target of constructing charging stations of State Grid will reach 10000, and a complete electric vehicle charging network will be built. According to the original plan, from 2014 to 2018, the scale of electric vehicle charging stations of State Grid will reach 6000, but only 30% of the target will be achieved by 2019.

3. Intelligent charging pile monitoring system and optimization analysis of spatial layout

3.1 Construction of intelligent charging pile system

(1) Hardware design

The countermeasures and suggestions for large-scale application of charging piles are shown in Figure 2. The intelligent monitoring hardware system of charging point includes the main control console, IC card reader, display screen, communication, keyboard, etc. Alternating current is the power
supply of 220 V / 380 V power grid, which directly charges the electric vehicle through the filtering and rectifying of charging module. The IC card identification module is to open the charging post function for the user. The IC card identification module can display the user balance and personal information. The human-computer interaction module can select the charging mode, mileage full, or self selection of charging power, etc.; the billing module displays the current billing, etc.

Figure 2 Large scale application of charging pile

The main control module is the core part of the hardware system, which has many serial ports, network ports and controllers. It is the hub of controlling all modules, monitoring the operation and charging in real time, so as to transmit it to the background in time. In order to effectively carry out real-time detection of charging piles, a protection program needs to be built, as shown in Figure 3. Through monitoring and protection unit to control the voltage and current of charging module and detect the battery system of electric vehicle, in case of abnormality or instability, timely disconnect the power supply, protect the safety of electric pile battery, and ensure the battery of electric vehicle is not damaged.

Figure 3 Composition of monitoring unit
(2) Software design

The design of intelligent monitoring software for charging points needs to be able to effectively communicate with users. The charging process of the user for the electric vehicle is as follows: the user first connects the charging interface of the electric vehicle with the charging input handle of the charging pile, then inserts the IC card, and turns on the charging pile. If the charging interface of the user is not connected with the charging output port, the system prompts an alarm. After the identification is completed, the user can choose the charging mode he wants. If the selected charging mode does not match the current battery state, the system will give an alarm; during the charging process, the screen will display the balance, charging time, charging time, etc. after the charging is completed, the charging will be stopped automatically and the invoice will be printed, and then the system will lock it by itself. All system programs can be divided into central control program, IC card identification program, communication program, display program, detection program and printing program. Each program is independent, but it can coordinate processing work. In the design, the programmer must strictly follow the stability and feasibility of the electric pile system.

3.2. Analysis on Optimization of spatial layout of charging pile location

In this study, the analytic hierarchy process and the sensitivity analysis results of 17 new energy vehicle charging piles are combined, and the relevant data and literature in urban management, transportation and other fields are consulted. After synthesizing the scores of the relevant public officials of the provincial environmental monitoring station, the indexes are evaluated and quantified one by one. In the evaluation and calculation of influence factors, considering the difference of the numerical value of different categories of factors, in order to carry out unified calculation, it is necessary to grade them. According to the characteristics of the new energy vehicle charging piles, the corresponding evaluation criteria are determined in different impact factors. According to the construction principle of evaluation index system, the analysis results of literature and research data processing results are combined to establish evaluation judgment indexes, as shown in Table 2.

| Judgement matrix | Index | Weight |
|------------------|-------|--------|
| A-B1             | Automobile | 0.094  |
|                  | Restaurant | 0.890  |
|                  | Shopping   | 0.096  |
| A-B2             | Medical care | 0.083  |
|                  | Life service | 0.097  |
|                  | Science, education and cultural services | 0.076  |
| A-B3             | Financial and insurance services | 0.076  |
|                  | Company business | 0.051  |
|                  | Metro Station | 0.051  |
| A-B4             | Train station | 0.117  |
|                  | Car park | 0.221  |

Based on the difference of calculation formula of influence factor score index, the result is often not the same order of magnitude. Therefore, this study takes the quotient of the difference between the original value of each score index and the minimum value of the score index and its extreme value in the study area as the output display result, such as formula:

$$V = \frac{(V - V_{\min})}{(V_{\max} - V_{\min})}$$  \hspace{1cm} (1)$$

Among them, the original value of $V$, $V_{\max}$ and $V_{\min}$ respectively represent the attribute value and the minimum maximum value of the evaluation index in the space unit.

Combining the influence factors obtained through the evaluation value in the grid with the set score weight and using ArcGIS to carry out comprehensive operation, the suitability evaluation diagram of new energy charging pile location in five districts of Fuzhou City is finally obtained. According to the
statistics of the comprehensive score of each region, the fishing net is divided into five classes. The higher the comprehensive score is, the more suitable the new energy charging piles are to be set. The higher the comprehensive evaluation score is, the more warm the color of the grid is, indicating that the number of new energy vehicle charging piles in this region should be set more. Combined with the obtained and analyzed data, it can be concluded that the number of existing charging piles in the main urban area of Fuzhou is insufficient, far from meeting the demand after the promotion of new energy vehicles, and the current layout of charging piles for new energy vehicles shows a centralized trend, which is difficult to achieve the purpose of effective utilization.

4. Conclusion
The wide application of new energy vehicles is the general trend, and the large-scale construction and application of charging piles will be in the near future. Through the use of new energy to significantly reduce automobile exhaust emissions, not only part of non-renewable energy can be saved, but also environmental pollution can be reduced, and "green travel" can be realized to a great extent, so as to promote the sustainable, healthy, sound and rapid development of economy. However, if the number of charging piles is too large, it is easy to interfere with the security and stability of the power grid. Based on the cloud computing platform, it is necessary to reasonably design the charging piles of electric vehicles, and take the right way to effectively monitor and apply them, reduce the number of urban charging piles, and solve the charging problem of electric vehicles. The designer should not only make a perfect design scheme, but also design and build the cloud client and system module effectively, and apply them in practice, so as to provide a good charging service for electric vehicles.

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