Operation Platform of Charging Pile Metering Equipment Based on Big Data

Wei Liu1,*, Chaoliang Wang1, Yang Zhang2, Tao Xiao1, Chunguang Lu1

1State Grid Zhejiang Marketing Service Center (Metrology Center), Hangzhou, 310000, Zhejiang, China
2State Grid Zhejiang Electric Power Co., Ltd., Hangzhou, 310007, China
*Corresponding author e-mail: liuwei@zjmsc.sgcc.com.cn

Abstract. At present, our country’s new energy industry has developed rapidly with the concept of green development, and at the same time, the demand for charging piles and other equipment is also increasing. However, many new energy vehicles need to pay corresponding fees when using charging piles, resulting in bloated data in the original metering system. Based on this, the purpose of this article is to design and research the operation platform of charging pile metering equipment based on big data. This article first analyzes and studies the current status of charging pile metering, and studies its existing problems and shortcomings in combination with big data technology. The feasibility of the system development and the module functions of the charging pile metering equipment operating platform are studied. This article systematically expounds the three basic algorithms of DC electric energy measurement, and uses comparative analysis method, interdisciplinary method and other research forms to study the content of this article. Experimental research shows that the accuracy of the charging pile metering equipment based on big data studied in this paper is within 0.1, which is extremely feasible.

Key words: Big Data, Charging Pile, Metering Equipment, Platform Design

1. Introduction
In recent years, with the excessive development and use of coal mines, the support for the new energy automobile industry has gradually increased [1-2]. As the equipment for new energy vehicles, the problems of cumbersome and inaccurate metering of charging piles are common on the market. Most of them use traditional GPRS modules, which are relatively inefficient [3-4].

In the research of charging pile measurement, many experts and scholars have achieved good results. For example, in order to study the econometric benefit model of charging pile, OT A has deeply studied the distributed photovoltaic power generation shed and energy storage charging pile, and established the risk factor evaluation index system [5]. According to the information security threats and information security requirements of charging piles, Wang Weixian adopts advanced encryption algorithms to improve the information security protection ability of distributed electric vehicles [6]. At present, the research on charging pile has become more and more mature, and the construction of charging station has stepped into the fast lane.
This article aims to improve the accuracy of charging pile metering equipment, and aims to design and research the operation platform of charging pile metering equipment based on big data. By comparing the measurement platform studied in this article with traditional measurement methods, the feasibility analysis of the research results of this article is carried out.

2. Design and Research on the Operation Platform of Charging Pile Metering Equipment Based on Big Data

2.1 The Main Realization of the Platform Technical Analysis

(1) Big data application technology
Initially, the definition of "big" in big data only refers to the amount of data in the data set, but in fact, in addition to relational databases, big data also includes other common data such as videos, audios, files, and emails [7-8]. It also includes the growth rate and validity of the data. Therefore, big data has the characteristics of large data volume, diversity and fast speed [9-10].

1) Hadoop system technology
Hadoop is an open source distributed system infrastructure developed by Apache. It includes Hadoop distributed file system, MapReduce, HBase, Hive, Pig, Sqoop and Flume and other related technologies [11-12].

2) Spark technology
Spark is an open source cluster computing platform that provides fast and versatile functions. It is a general memory parallel computing framework and includes all the advantages of Hadoop Map Reduce. Spark can be used for batch processing, interactive query (Spark SQL), real-time streaming (Spark Streaming), machine learning (Spark MLlib) and graph computing (Graph X).

3) Database
The database used in this article is a relational database, which can be used to improve the synergy between Oracle database and Hadoop, and can be installed in a typical Hadoop cluster.

(2) System development technology

1) Java EE
Java EE application development mainly focuses on middle-tier development. Java EE Server is a service application that implements the Java EE Platform API and can provide standard Java EE services. A Java EE server is also commonly referred to as an application server, and it can pass application data to the client, just like a Web server provides a page to a browser. The Java EE server runs different levels of components in your application in the form of containers, allowing different components to work together.

2) B/S architecture
B / S architecture is browser and server architecture. This is a variant of C / S architecture. Use a common browser to access the server without a dedicated client. It develops and rises with the development of the Internet, and spreads rapidly. In B / s, the business logic of the system is mainly implemented on the server side, and a small part of the logic is implemented on the front end.

2.2 Feasibility Analysis of Platform System
Feasibility analysis is the basis for designing and developing new software. In order to ensure the rational use of resources, this project will conduct research and comparison on resource supply, capital reserves, market demand, construction scale, environmental impact, and profitability. There is no need to make multiple changes after the project starts smoothly. Software design is limited by manpower
and material resources, so a specific feasibility analysis must be carried out according to functional requirements before obtaining system requirements.

(1) Technical feasibility
This time the system does not require much hardware, and general terminals can act as a third party. Therefore, the current design of such a system is feasible.

(2) Economic feasibility
The charging pile measuring equipment management and use system developed this time is mainly responsible for the development and maintenance of charging pile measuring equipment. Therefore, the requirements for manpower and financial resources are not high. The system platform is relatively simple, the development speed is fast, and it is economically feasible.

1) Cost
Considering that the development software used is free or in a trial period, the cost of this design is relatively small. Since this system is a management and use system for charging pile metering equipment, its scale is not very large, and the time it takes is relatively short, so the cost of system development is not very high.

2) Development feasibility
After writing a program in eclipse, compile it, and then generate a file with the suffix APK. After the user gets the APK file, click Install. It can be used after installation. This is consistent with the current development of the Internet of things.

2.3 Functional Design of Charging Pile Metering Equipment

(1) Design of identity authentication module
This system chooses IC card reader to realize the identity authentication function. The identity authentication module is mainly composed of a radio frequency sensor module and a terminal node. The wireless frequency sensor module collects the charging IC card information and sends it to the terminal node in the specified data frame format.

(2) Control module design
This design uses a relay as the control unit. It has an interactive relationship between the input loop (also called the control system) and the output loop (also called the controlled system). It is usually used in automatic control circuits, but it is actually an "automatic switch" that uses a small current to control the operation of a large current. Therefore, the circuit has functions such as safety protection, conversion circuit, and automatic adjustment.

(3) Smart meter module design
This design uses a multi-functional programmable intelligent electrical measuring instrument to collect the parameters of the charging pile. The instrument can measure many common electrical parameters of three-phase systems such as three-phase voltage, current, power, and four-quadrant electrical energy. It also has extended functions such as switch input/output, threshold over-limit alarm, zero sequence current, harmonic component, analog transmission output, and communication.

2.4 The Basic Algorithm of Dc Energy Measurement
The DC charging energy measurement algorithm is the design core of the high-precision measurement verification device. At present, there are three common DC energy measurement algorithms. The first is the average method, and its calculation is shown in formula (1).

\[ W_1 = P_1 \cdot \Delta t = \hat{U} \hat{I} \cdot \Delta t \]  

(1)
Among them, \( W_1 \) is the average value method to measure electric energy, and \( \hat{U}, \hat{I}, \hat{P} \) is the average voltage, average current, and average power within \( \Delta t \) time.

The second is the effective value method, as shown in formula (2).

\[
W_2 = P_2 \cdot \Delta t = U_M I_M \cdot \Delta t
\]

Among them, \( W_2 \) is the effective value method for measuring electric energy, and \( U_M, I_M, P_2 \) is the effective value of voltage, effective value of current, and effective value of power within \( \Delta t \) time.

The third is the instantaneous power integration method, and its calculation is shown in equation (3).

\[
W_3 = \int_{t_0}^{t_0 + T} u(t)i(t)dt
\]

Among them, \( W_3 \) represents the integrated electrical energy of the instantaneous voltage and current in the unit period \( T \), and \( P_3 \) represents the instantaneous power.

However, in actual electric energy measurement, instantaneous electric energy acquisition is not strictly continuous. It is usually necessary to set the sampling interval \( \Delta t \). In the unit period \( T \), the number of acquisitions is \( N \) times. If the value of \( \Delta t \) is small enough, the number of acquisitions is sufficient. The electric energy calculation formula of the instantaneous power integration method can be transformed into formula (4).

\[
W = \sum_{k=1}^{N} u(t_k) \cdot i(t_k) \cdot \Delta t
\]

In an ideal situation, the results of the three calculation methods are accurate and consistent, but the DC signal in the actual environment often contains ripple signals, and it is necessary to calculate and analyze the electric energy measurement error in the ripple environment.

3. Experimental Research on the Operation Platform of Charging Pile Metering Equipment Based on Big Data

3.1 Experimental Protocol

In order to make this experiment more scientific and effective, the purpose of this experiment is to verify the measurement accuracy of the charging pile metering equipment. This experiment is based on the big data-based charging pile metering equipment operating platform studied this time. The three-phase power standard source is set to 1,200,000imp/kWh, and each test point is tested twice, and each test is 30min. On the basis of this experiment, the measurement equipment studied in this article and the traditional measurement equipment are compared and analyzed, and the results obtained are analyzed and counted using the analytic hierarchy process.

3.2 Research Methods

(1) Comparative analysis method

This experiment compares and analyzes the traditional metering method of charging pile metering equipment with the charging pile metering equipment based on big data studied in this article, so as to carry out a feasibility analysis of the research theme of this article.

(2) Interdisciplinary approach

This experiment uses the Internet of Things, Communication Engineering, Computer and other disciplines to conduct a comprehensive analysis. The research data obtained provides a reliable reference for the final research results of this article.
(3) **Mathematical statistics**
Use the relevant software to carry on the statistical analysis to the research result of this article.

(4) **Observation method**
This study observes the test points and analyzes the data, which provides a theoretical reference for the topic selection of this paper.

4. Experimental Analysis of the Operation Platform of Charging Pile Metering Equipment Based on Big Data

4.1 **High-Precision Measurement Function Test Analysis**
In order to make this experiment more scientific and effective, this experiment passed the accuracy test of the charging pile metering equipment based on big data studied in this paper. The data obtained are shown in Table 1.

| Voltage/103 V | Current/102 A | kW | Integral electricity can/kWh | Pulse output frequency/KHz | Power error/% | Avg error/% |
|--------------|--------------|----|------------------------------|---------------------------|--------------|------------|
| 0.75kW (150V, 5A) | 0.150   | 0.050 | 0.7509 | 0.39075 | 0.2605 | 0.042 | 0.04 |
| 2.25kW (150V, 15A) | 0.150   | 0.150 | 2.2502 | 1.1655 | 0.777 | 0.036 | 0.041 |
| 3.75kW (150V, 25A) | 0.150   | 0.250 | 3.7504 | 1.9275 | 1.285 | 0.028 | 0.031 |
| 0.75kW (150V, 15A) | 0.150   | 0.150 | 2.25 | 0.3885 | 0.259 | 0.036 | 0.043 |
| 6.25kW (250V, 25A) | 0.250   | 0.250 | 6.2503 | 3.25 | 2.1667 | 0.04 | 0.038 |

**Table 1.** High-precision measurement function test analysis
Figure 1. High-precision measurement function test analysis

It can be seen from Figure 1 that within the set 30 minutes, the measured integrated electric energy is 1.1655kWh, and the corresponding pulse output frequency is 0.777kHz. The output pulse is connected to the pulse input port corresponding to the standard power supply of the three-phase power supply, and the electric energy error calibration function is turned on, and the final accumulated electric energy error is 0.036%. Therefore, the high-precision measurement verification system can meet the 0.1-level accuracy index and is suitable for the measurement verification task of the charging pile.

4.2 Comparative Analysis of Measuring Equipment

In order to further research and analyze this experiment, this experiment compares and analyzes the charging pile metering equipment based on big data studied in this paper and the traditional metering equipment operation mode. The data obtained is shown in Table 2.

Table 2. Comparative analysis of metering equipment

|          | Accuracy | Robustness | Fault tolerance | Others |
|----------|----------|------------|-----------------|--------|
| Big data | 76.2%    | 72.1%      | 73.0%           | 69.6%  |
| Traditional | 61.2%    | 68.4%      | 67.9%           | 64.7%  |
Figures 2. Comparative analysis of metering equipment

As can be seen from Figure 2, compared with the traditional charging pile metering method, the charging pile metering equipment based on big data studied in this paper is more excellent in operation, especially in terms of calculation accuracy exceeding 15%, which fully reflects the feasibility of the research content in this paper.

5. Conclusions
The purpose of this paper is to research and analyze the operation platform of charging pile metering equipment based on big data. Through the feasibility analysis of the economy and technology of the platform system and the detailed research of each functional module of the charging pile metering equipment, combined with DC power. The basic algorithm of measurement completes the design of the equipment operating platform. Finally, through experiments on the measurement accuracy of the charging pile metering equipment operating platform based on the big data research in this paper, it is concluded that the metering equipment platform studied in this paper has higher accuracy and has good practical significance.

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