

# Safe Operation Planning of Electric Vehicle Charging Service Network

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**Keywords:** Electric Vehicle; Charging Service Network; Safe Operation; Optimal Management.

**Abstract:** With the increasingly prominent problems of resources and environment, the voice of green, low-carbon and environmental protection is rising day by day. Fuel vehicles in cities show a passive decline or elimination trend. At the same time, with the continuous reduction of the manufacturing cost of environment-friendly electric vehicles and the breakthrough of battery technology, electric vehicles show a rapid development trend in the global scope. The development of electric vehicles largely depends on the perfection of charging service network. This paper studies the safe charging mode, the layout of charging service network and the safe operation planning of electric vehicles, and puts forward some corresponding solutions according to these factors, hoping to provide new solutions for the research problems of charging safety of electric vehicles, and provide constructive suggestions and references for the safe operation of charging service network.

## 1. Introduction

In face of the dual challenges of environmental pollution and global energy shortage, the focus of governments and industry attention is how to reduce the consumption of fossil energy, and how to develop and promote electric vehicles. Electric vehicles have the advantages of energy conversion efficiency, comfort and cleanness, low noise, no pollution to the environment, easy operation and low cost. They are called green cars. Promoting the application of electric vehicles can reduce dependence on petroleum resources, ensure national energy security, and maintain sustainable social and economic development, in line with the consumption needs of future Chinese people, and more in line with national industrial and energy development strategies [1]. Electric vehicles will be the main means of transportation in the future.

In the process of popularization of electric vehicles, many problems need to be solved one by one. Firstly, in the planning and safe operation of charging service network, due to the current restrictions of electric vehicle technology and battery technology, the electric vehicle still lacks in endurance capacity, so it is necessary to make a reasonable layout in planning scheme, site selection and charging site at the beginning of application, so as to ensure a more reasonable service network. When its network takes shape initially, it also brings new problems such as coordinated control, dispatching operation mode and load forecasting with power supply network [2]. Consideration and research should be made to reduce the impact on power grid, ensure the economic operation of charging operation and the safe and stable operation of power supply network [3].

This paper mainly studies electric vehicles from several aspects such as charging service network layout planning and electric vehicle charging service network evaluation. It introduces the electric vehicle charging station planning scheme, the electric vehicle charging station system model and the electric vehicle charging service network security [4]. The operation mode provides valuable experience for scientific planning and optimal operation mode of electric vehicle charging station, improves the economical efficiency of power grid operation under the premise of ensuring grid safety, and fully utilizes grid service capability to meet the charging needs of electric vehicle users, to ensure the safety and economy of operation [5].

## 2. Charging Mode of Electric Vehicle

The charging process of the electric vehicle is as shown in the structure of Figure. 1. Among them, the energy is simplified into a battery pack, and charging is performed through the positive and negative power lines; the battery control part in the energy management system and the energy supply unit is abstracted as a battery management system, which is responsible for collecting information such as battery voltage, current and temperature, and the battery. The charging process is implemented and managed [6]. The battery information collected by the energy management system is connected to the charger through the communication bus; the charger is a device that connects the electric vehicle to the power grid and supplies power to the battery, and is mainly responsible for adopting a suitable charging mode according to the battery information to realize the dynamics of the charging process[7]. Optimization and intelligent control, and by standardizing the communication protocol between the charger and the charging station, the charging station realizes real-time monitoring of multiple charger status and charging processes to complete monitoring, scheduling, billing and other functions.

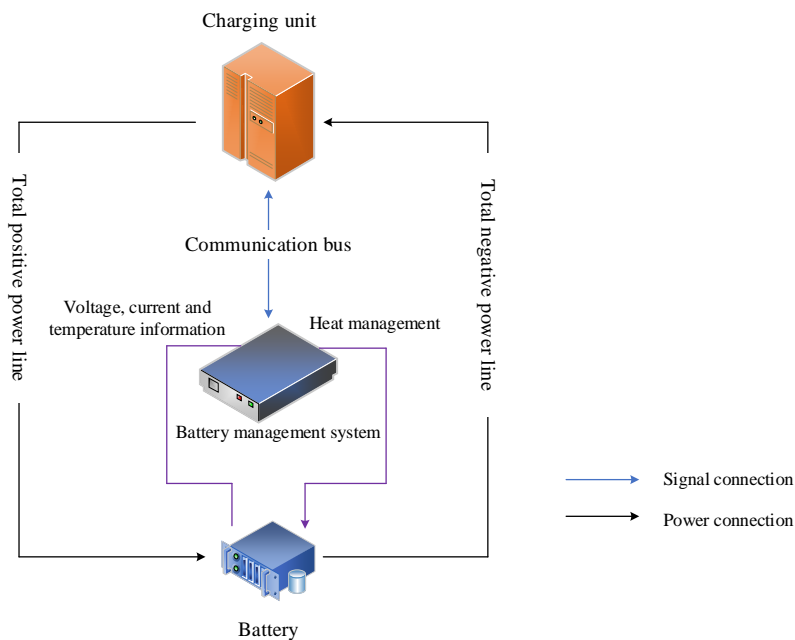


Figure. 1 Electric vehicle energy sub-system structure

## 3. Composition Framework of Charging Service Network for Electric Vehicles

The standard battery-based electric energy supply mode provides continuous power supply to the offline mobile power users through the multi-level service network. Through the implementation of this scheme, the traditional fixed grid transmission energy mode is converted into a "mobile grid" transmission method using standard battery as the carrier, and the breadth and depth of the national grid energy supply mode are expanded [8]. Carry out the construction and operation of the power station with the replacement of the standard battery module as the core, combined with the solid-state energy storage and distributed energy technologies in the smart grid. Building a system based on regions and cities, relying on policy resources, accelerating the promotion of electric vehicles through large-scale demonstrations, improving the electric vehicle service system, and creating a new situation of low-carbon transportation.

With the support of government policies and resources, the State Grid has unified the layout of electric vehicle charging and discharging stations in the role of energy suppliers and established a three-level energy supply service system. Through the flow of standard batteries, a three-tier service network of large charging and discharging stations, medium-sized charging stations, battery replacement service outlets and standard charging piles is formed [9].

The State Grid will be positioned as a professional energy supplier in the whole industry chain of electric vehicles. Reduce the sales cost and operation cost of electric vehicles by scale effect, improve service quality and unify industry standards. It can effectively reduce the single demand of existing transportation for oil and gas resources. At the same time, the construction of charging and discharging power stations under the overall planning can not only reduce peak load and fill valley, but also improve the efficiency of transmission and power consumption. It can avoid the threat of disorderly construction of self-charging system to the security of urban power grid, and use a large number of automotive batteries as energy storage devices, so as to change the national energy storage to the national energy storage and ensure the national energy security.

#### 4. Safe Operation Planning of Electric Vehicle Charging Service Network

##### 4.1. Electric Vehicle Charging Service Network Business Model

The mobile grid management system business model uses standard battery pack management as its core business function, and provides services for electric vehicle users through management functions such as business acceptance and business settlement. Around the management center are charging stations, users, and third-party agencies [4]. The system provides users with direct charging services and battery replacement services through the charging station. The logistics system is an important link to provide these services. Third-party organizations include trading centers and various financial institutions and car service providers. The “Mobile Grid” service site business through these transactions, settlement, services and broader business support functions are shown in Figure 2.

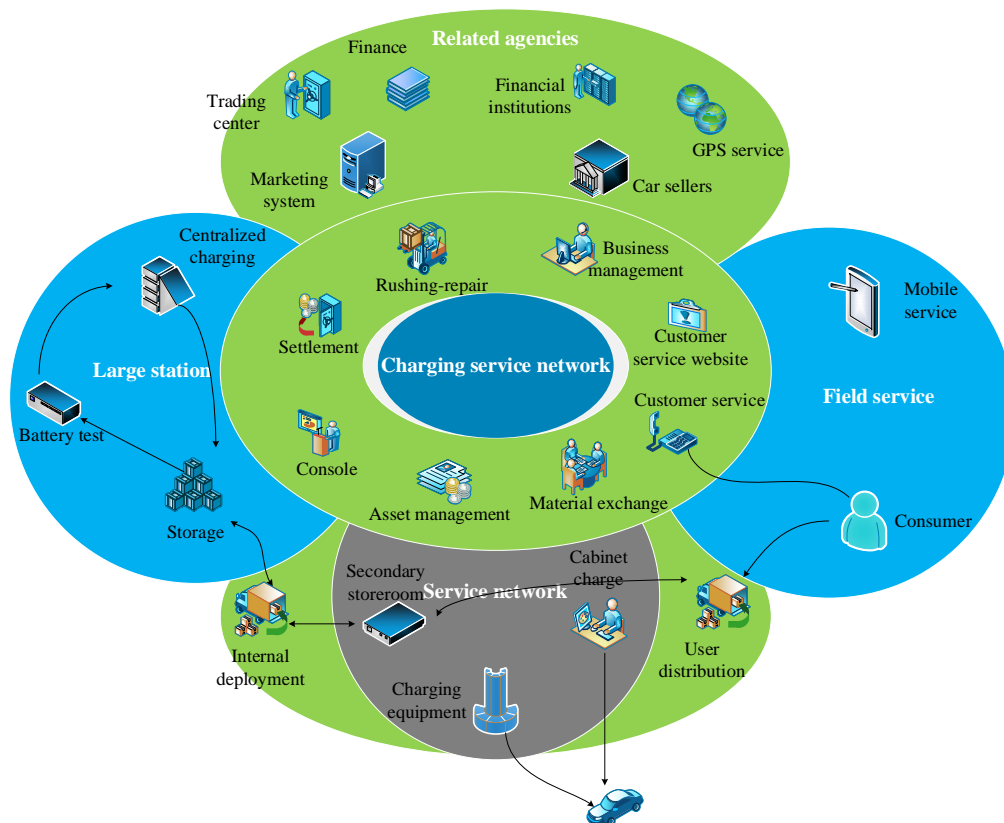


Figure. 2 Business model of charging service network

##### 4.2. Safe Operation Planning of Electric Vehicle Charging Service Network

The charging service network management system functional architecture is generally divided into three levels. The first layer is the management analysis layer, which provides business management and supervision functions, including asset analysis, customer analysis, accounting

analysis, and statistical analysis functions such as business monitoring and logistics analysis, providing business analysis functions for managers [6]. The second layer is the business processing layer, which is the core layer of the system. It mainly includes four business functions: billing and settlement, operation management, customer management and asset management functions. The asset management module undertakes the management functions such as purchasing and verification of chargers, batteries, etc., providing technical support and guarantee functions for operation management; charging station management and logistics management and repair management for operation management are the basis of the charging station management system. The business function provides support for the daily operation of the charging station; the customer service mainly deals with user management and accepts user service requests, and good business operation management is the basis of customer quality service [3]. Through these four business functions, the mobile power grid management system will be able to implement various efficient business management functions. The third layer is the information layer. The system realizes the data interaction and sharing function with the peripheral system through the information integration platform.

The management system database is used as the core server of the system for storage system business data, asset data, billing data, spatial geographic data, and system support platform data, application operating system; management system application server is used to deploy applications and architecture applications, Application operating system; the server is used to deploy the geographic information management platform and geospatial data of the mobile grid management system application, and requires an operating system; the voice and video server is used to deploy the voice and video source data of the mobile grid management system and the voice and video management application; The server is used to deploy the communication management system. In order to ensure the security of the internal network of the power, the external device is generally not allowed to directly access the server inside the network of the power supply company, so the communication server is isolated outside the internal network in the system design. The server, service, and call center servers are used by the customer service center system of the mobile grid management system.

## 5. Conclusion

Because of its unique safety requirements, electric vehicles are directly or indirectly related to people's lives, which determines that the security design of charging service network facilities needs to consider more factors and more complex than traditional industrial equipment. In recent years, with the introduction of new energy policy, the development momentum of electric vehicle is strong, and the need for electric vehicle charging service network facilities is extremely urgent. Therefore, it is of great significance to study the safe operation planning of electric vehicle charging service network for realizing energy substitution, optimizing energy structure and increasing the proportion of clean energy.

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