

# Analysis on the Design Scheme of New Energy Vehicle Charging Station

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## Abstract

New energy vehicles will become the focus of the future development and reform of the automobile industry because of energy saving and emission reduction, and the construction of charging stations is the key to restrict the development of new energy vehicles. In order to solve the six problems of charging station, one is the lack of downstream charging pile is an important obstacle restricting its development; Second, due to the unreasonable layout of the charging station structure and poor universality, the utilization rate of some charging stations is low; Three find pile is difficult, charging time is long; 4. Complex operation process of charging facilities, such as cumbersome APP operation; 5. The safety guarantee system of charging facilities is not perfect during charging; The fire control system of charging station is not perfect. Therefore, a new design scheme of new energy vehicle charging station is proposed.

## Keywords

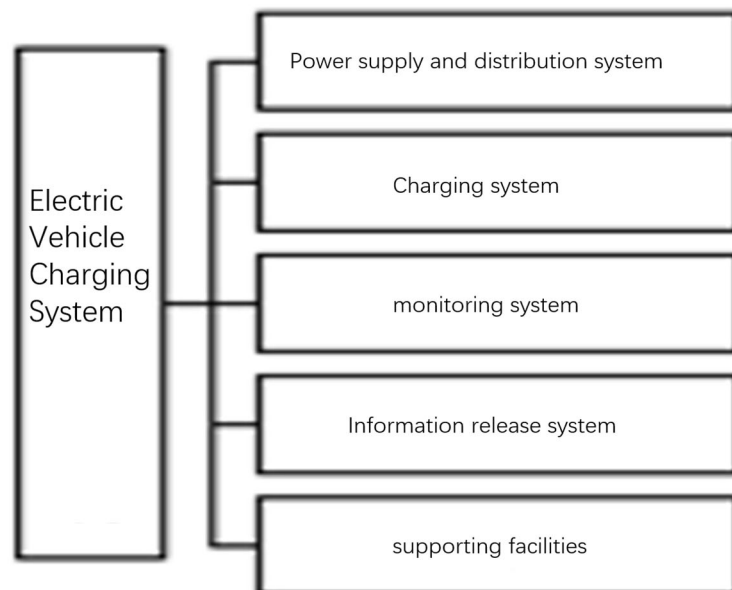
New energy vehicle; Energy conservation and emission reduction; Charging station; Charging facility.

## 1. PREFACE

New energy vehicle charging station is a charging station for new energy vehicles [1], which can better solve the problem of slow charging of new energy vehicles. The charging station system mainly consists of five parts: power supply and distribution system, charging system, monitoring system, information release system and supporting facilities. In this paper, we analyze the monitoring system, charging system and cooling system of the charging station one by one.

## 2. SYSTEM COMPOSITION OF ELECTRIC VEHICLE CHARGING STATION

The design of charging stations has strict requirements, and the charging stations built in accordance with the final requirements can better meet the charging requirements of new energy vehicles. In order to design charging stations in accordance with relevant standards, it is necessary to study the functions of charging stations and reasonable systems, that is, there are strict requirements on equipment maintenance, system inspection and management of charging stations [2]. In addition to the basic functions, it also needs to be equipped with related auxiliary equipment, such as fire safety, equipment operation monitoring and so on. In addition, in order to ensure the quality of charging service, the establishment of real-time information release system can enable car owners to better inquire and make appointments for charging service. Figure 1 shows the overall functional structure.



**Figure 1.** Overall functional structure

### 3. SPECIFICATIONS FOR THE OVERALL DESIGN SCHEME OF CHARGING STATIONS

#### 3.1. Overview

Relevant state departments have formulated specifications for the design of charging stations, which have strict technical and safety requirements. In order to ensure that the construction plan of charging stations conforms to the relevant guidelines and policies of the People's Republic of China, the design of charging stations should comply with applicable national standards [3].

#### 3.2. Location principles of EV charging stations

##### 3.2.1 Overall Plan

The overall planning of the charging station site and building design must conform to the overall planning of the relevant city and the urban and township planning, so that they can meet and comply with the local environmental protection and fire safety regulations. The overall design plan shall make reasonable planning and layout of functional areas such as drainage measures for the construction of the station and roads for traffic entering and leaving the station, and make overall arrangements.

##### 3.2.2 Environment Requirements

When the charging station is designed in the urban area, it is more suitable to be placed in the area close to the urban road sections, rather than close to the urban traffic arteries, busy roads or intersections. As a result, the charging station needs more and is more profitable. It should not be deployed in places with dusty or corrosive gases, near places with high temperature or in low-lying areas to meet the requirements of the charging station for power supply and power quality control.

#### 3.3. General layout of electric vehicle charging stations

A charging station consists of a station house, driveway, charging area, temporary parking lot, etc. [4]. The overall layout of the charging station area should be reasonable, with clear functional zoning, convenient transportation and reasonable regional land planning to meet the needs of the overall planning. Large charging stations can be designed to monitor room, duty

room, customer lounge and other functional rooms, and the final overall design of charging stations should be carried out in accordance with the design plan.

### 3.4. Fire safety requirements for electric vehicle charging stations

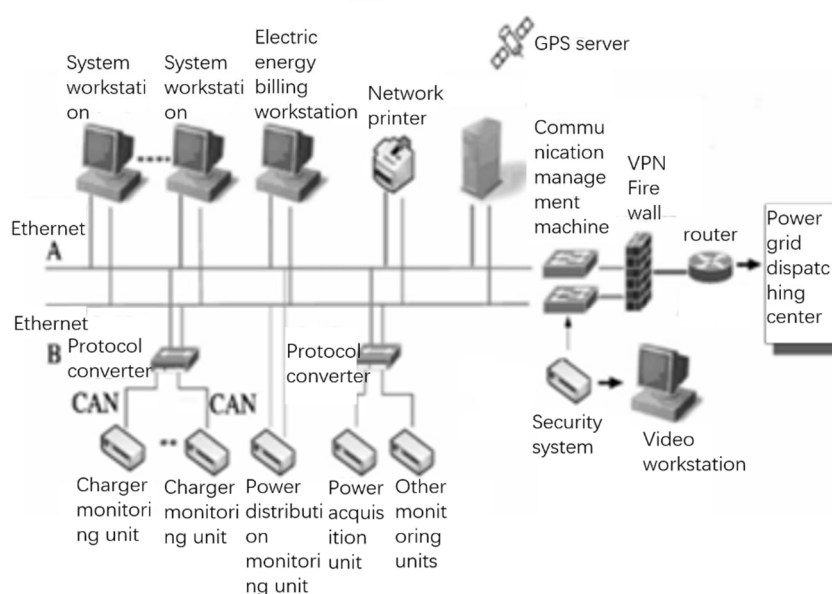
The construction of EV charging stations must comply with national standards and regulations issued by the Ministry of Housing and Urban-Rural Development, PRC, such as fire safety management regulations for EV charging stations.

Charging stations should perform and strictly implement the daily record and management of fire safety of charging stations, regularly carry out fire training and plan drills, implement fire safety responsibilities, regular inspection and record of fire control facilities, monitoring and data application of charging information and fire emergency treatment, so as to effectively reduce deflagration accidents caused by charging.

## 4. DESIGN SCHEME OF MONITORING SYSTEM OF CHARGING STATION

The monitoring system can realize real-time recording of equipment operation information, provide information of charging vehicles and real-time queuing information of vehicles waiting at charging stations, ensure the operation of charging stations and reduce labor costs, and improve the management of charging stations through the monitoring system.

### 4.1. Overall functions of the monitoring system of charging stations

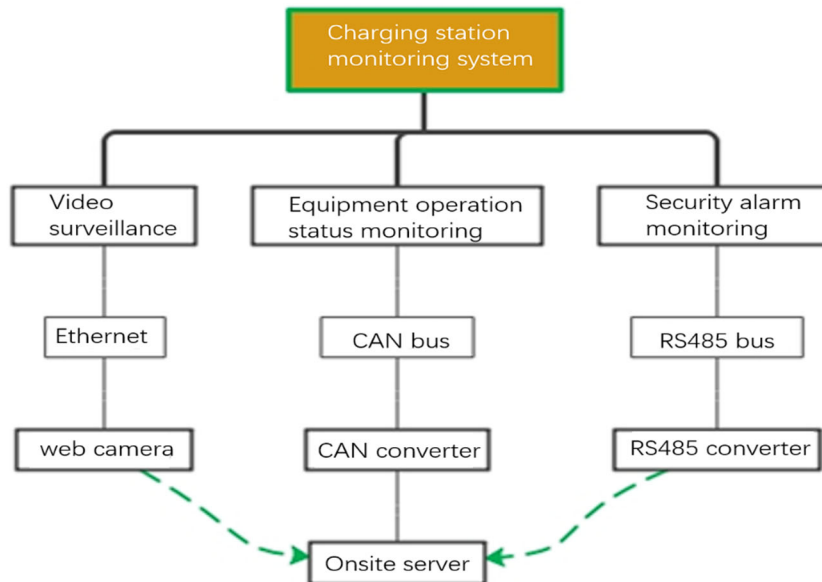


**Figure 2.** Function structure

Figure 2 shows the functional structure of the monitoring system of the charging station. The monitoring system can realize the data acquisition and monitoring of the charging station by means of data communication, equipment performance monitoring and fault alarm light. Charging stations should also have the following functions: first, provide an emergency stop button to ensure emergency stop in case of failure, so as to ensure safety; Second, monitoring data should be transmitted to the background management center and mobile phone control center; Third, in order to prevent system problems, should set up an emergency restart function; Fourthly, it should be equipped with fire alarm. In case of fire, the monitoring system can control the power interruption of the charging station, trigger the fire sound and light alarm, and trigger the fire sprinkler system to work.

## 4.2. Composition of monitoring system of charging station

The monitoring system of charging station consists of three parts: security alarm monitoring system, video monitoring system and equipment status monitoring system. Figure 3 shows the structure of the monitoring system.



**Figure 3.** Component structure diagram

### 4.2.1 Video Surveillance

The following functions can be realized through video surveillance: First, the environment of the site can be monitored to ensure the safety of the charging station; Secondly, the image recognition and face recognition functions of video surveillance are used to monitor and calculate the number of charging vehicles in the charging station and waiting in line for charging vehicles, and the charging information is released to let the owners know the situation of the charging station; Third, video warning function and cloud video storage function can be used as an important basis for events.

### 4.2.2 Security alarm monitoring

Security monitoring includes control room access control system, fire protection system of the whole charging station and RFID control system. The access control system is mainly related to the control room of the charging station. As the information processing and control center of the whole charging station, the room must have high security and only authorized operators can enter it. Every entry and exit must be recorded in detail to minimize the risk of information loss and equipment damage. The control room should also be equipped with a broken glass monitoring system and an infrared microwave interference monitoring system to prevent the use of force to enter the control room.

### 4.2.3 Monitoring Device Running Status

Equipment running status monitoring mainly monitors the running status of charging equipment, control room equipment and network equipment in charging stations. For example, monitor the environmental humidity of the control room, the operation of circuit breakers and the operation of servers.

Status monitoring mainly monitors the running status of all charging piles in charging stations through CAN bus data communication.

The above video monitoring and safety early warning monitoring are the monitoring system required by the entire charging station equipment, while the equipment operation monitoring is to monitor the running state of all charging piles and batteries during charging.

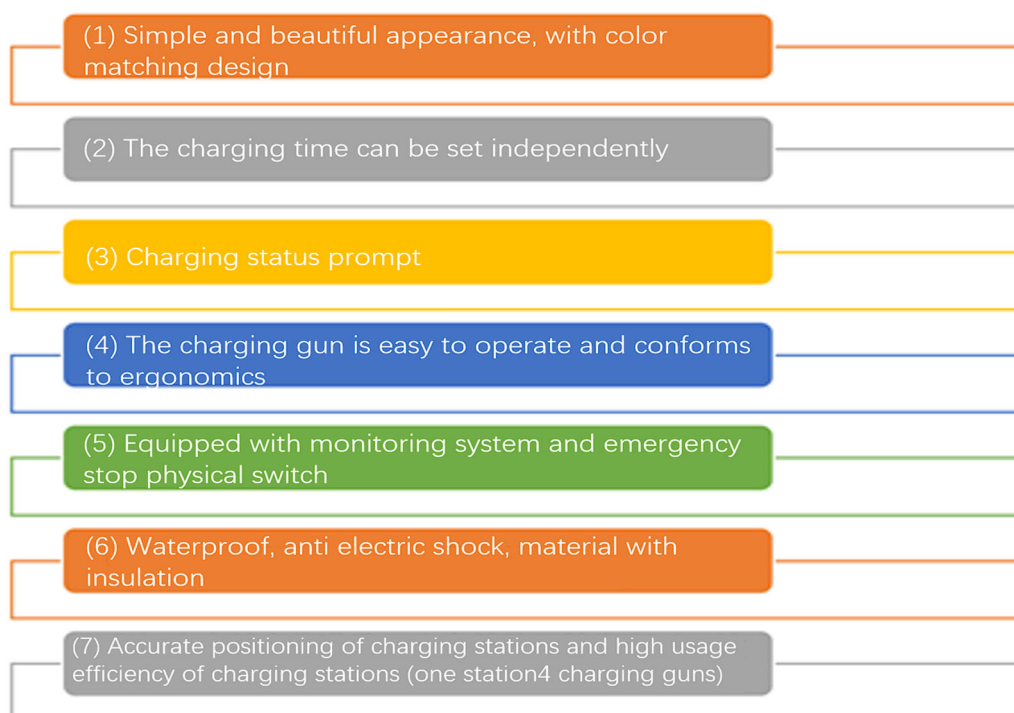
## 5. CHARGING SYSTEM DESIGN SCHEME

### 5.1. Overall design of charging pile

In this paper, the intelligent floor charging pile equipped with four charging guns is studied. It is equipped with two DC charging gun interfaces and two AC charging gun interfaces, which can meet different charging needs of users. Its structure is firm and its performance is stable. Pile body can be rain moisture-proof, and set up safety protection function; Diversified payment methods, can provide users with high-quality charging services; Ac-dc integrated intelligent charging pile.

### 5.2. Product Positioning Analysis

To analyze the function, appearance and operation difficulty of charging piles, we should analyze the charging demand of owners of new energy vehicles and the problems existing in the market by comparing the existing charging piles with the current charging stations. By drawing demand maps from low to high level, we can see the demand of charging piles in a more intuitive way. Figure 4 shows the product requirements.



**Figure 4.** Positioning the product requirements

### 5.3. Application process design of charging pile APP

By adjusting the information structure of the software, the charging pile APP can make the content clear and the operation page simple, so that users can get more pleasant experience and reduce the complexity and difficulty of the operation of the APP interface. Figure 5 shows the flowchart of APP usage.



Figure 5. APP usage flowchart

5.4. Design scheme of charging system

In order to realize its function, the charging system mainly has three key systems: one is the network system, the other is the security system; Third, the charging control system. Figure 6 shows the overall structure of the charging system.

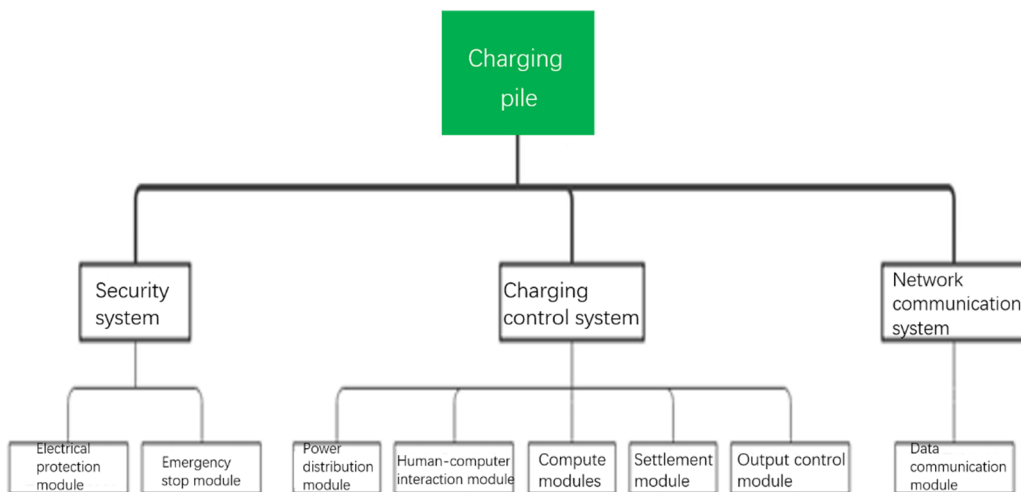


Figure 6. Overall structure of the charging system

In order to protect the safety of operators and the performance of equipment, the security system includes two parts: electrical protection module and emergency stop module. It mainly realizes the following two functions: one is to set the emergency stop switch, when the charging pile emergency, you can disconnect the charging pile power through this switch; Second, an electrical protection module is set up to protect the safety of the line and the safety of electricity [5].

The operation of control equipment and monitoring equipment is the function of the charging control system, which has five parts, respectively: power distribution module, man-machine interface module, measurement module, charging module and input/output control module.



The network communication system is mainly used to realize the two-way transmission of data and realize the communication between the charging pile and the background control system. Specific functions include the following two aspects: on the one hand to achieve the adjustment of electricity price, and can be controlled by remote; On the other hand, the charging pile can send charging process information, charging process data and charging process transaction information to the background control system.

## 6. COOLING SYSTEM DESIGN SCHEME OF CHARGING SYSTEM

With the construction of more and more charging piles, owners of new energy vehicles have put forward corresponding requirements for the charging demand of new energy vehicles, such as the demand for fast charging. Because of the need for fast charging, the demand for charging points will also increase. As the charging speed of the charging pile increases, the current during charging will also increase, which will lead to the increase of the power of the related modules of the charging pile, that is, the internal components of the charging pile will generate more heat. In order to solve the problem of spontaneous combustion of charging station equipment, a cooling fan of charging pile is designed.

### 6.1. Design circuit of cooling system

Based on the charging pile, heat dissipation vents have been set on the charging pile body, and this cooling system is composed of cooling system control unit ECU, actuator cooling fan, CAN network, temperature signal sensor and other components. This cooling system is equipped with CAN network communication, which CAN collect internal temperature signals of charging gun and charging pile body, transmit the signals to vehicle monitoring system through CAN network, and feed back to background management system through the monitoring system. It is also equipped with temperature warning function, and you can consult the cooling system information and warning information of charging pile through mobile phone. The cooling system of charging pile adopts the method of installing cooling fans inside the charging pile body to dissipate heat from the internal components of charging pile, so that the temperature of the charging system can be kept within the normal working range. The cooling system design circuit diagram is shown in Figure 7.

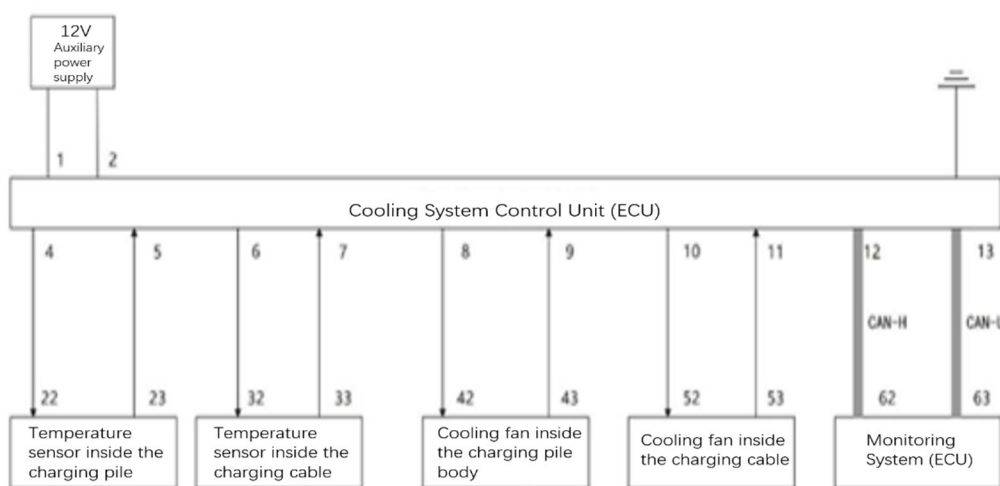


Figure 7. Cooling system design circuit diagram

### 6.2. Working principle of the cooling system

The cooling system set through the CAN network can communicate with the monitoring system ECU in real time, and can share the data of the monitoring system, such as the charging

current, charging state and other information. The cooling system works in three situations: first, when the internal temperature of the charging pile body is too high, the temperature sensor will send the signal to the cooling control system ECU, and the ECU will compare the information and confirm the authenticity of the data. If the internal processing of the ECU is passed, the ECU will execute the control cooling fan operation; Second, when the internal temperature of the charging pile body returns to the normal range, that is, when the cooling fan stops working, the internal temperature detection of the charging gun is the same. However, when the internal temperature of the charging pile or charging gun keeps rising and reaches the dangerous value, the ECU will compare the data and confirm the authenticity of the data through the monitoring system. If the ECU determines that the detection result is true and there is no fault in the system, The charging work of the charging pile will be interrupted, and the charging pile will be restarted after the temperature is cooled. Third, when the monitoring system detects that the power battery temperature is too high, it will also compare with the temperature of the cooling system, so as to perform the corresponding operation according to the situation. Figure 8 shows the working principle of the cooling system.

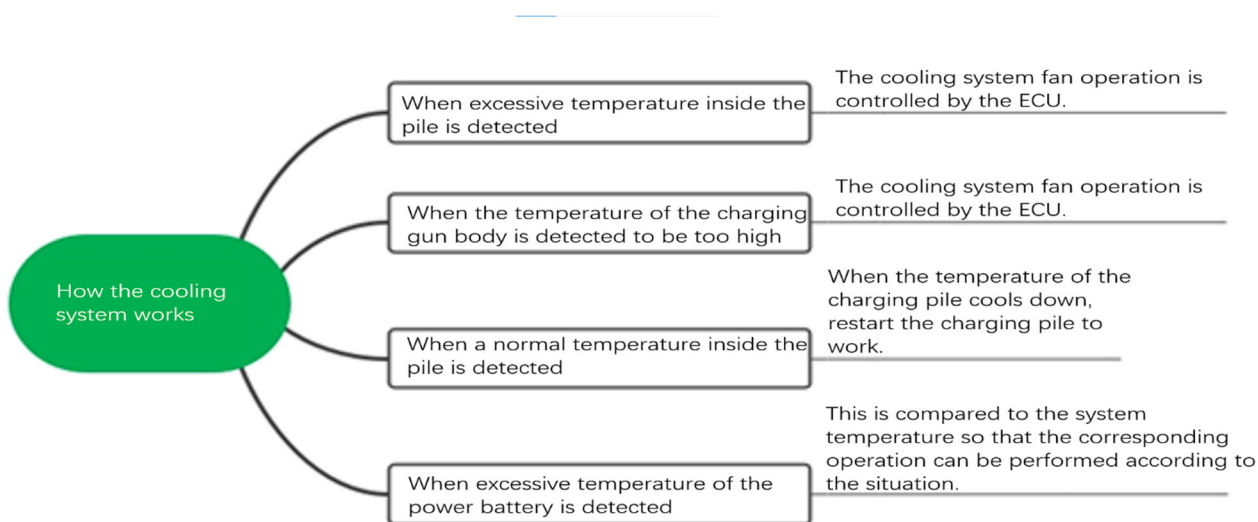


Figure 8. Working principle of the cooling system

## 7. CLOSING REMARKS

This paper takes the design of charging station as the research objective. It summarizes the design standard specification of charging station, the design scheme of monitoring system of charging station, the design scheme of charging system and the design scheme of cooling system of charging system. The research is carried out with an intelligent floor charging pile equipped with four charging guns, which is equipped with two DC charging gun interfaces and two AC charging gun interfaces, which can meet different charging needs of users. With the promotion of the two-carbon policy, the concept of green travel is deeply rooted in people's hearts, and new energy vehicles are attracting more and more people's attention, with huge market potential. As an indispensable part of the development process of new energy vehicles, the supporting charging stations play a key role in the future from the aspects of social demand, power grid optimization and national "carbon neutrality".

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