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Electric Vehicle Charging Service System

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Abstract: The energy crisis is that new energy vehicles have become popular. Electric vehicle charging infrastructure investment is expanding to balance the supply and demand of infrastructure. The project is divided into two parts: research and design results. I have conducted in-depth research on user groups, markets, and technology, and the research results guide my design. After the team's field visit, it was found that the problem of parking and charging electric vehicles has brought difficulties. I designed a service design that balances the basic structure, improving people's congestion in peak periods. Balance the contradiction between supply and demand between electric vehicles and infrastructure and realize the service model of resource rationalization with open community as the core.

Keywords: Service Design; AC Charging Pile; Emotional; Open Community; Social Infrastructure.

1. Introduction

The global economy has maintained a high-speed development posture, and the energy crisis is more prominent. New energy vehicles have become the automotive industry's primary means of energy conservation and emission reduction. The global electric vehicle outlook predicts the development of new energy vehicles and charging piles in 2030. Electric vehicles accounted for 2.6% of global vehicle sales and about 1% of global vehicle stock in 2019, with a year- on-year increase of 40%. Electric vehicle charging infrastructure will continue to expand. In 2019, there were about 7.3 million chargers worldwide, of which about 6.5 million were slow chargers for private light vehicles in homes, multi- residential buildings, and workplaces. The products will be designed for countries with high market shares. China's purchasing power is 350 million electric vehicles, accounting for 25% of the global circulation.

The project is designed to balance the supply and demand of infrastructure for charging new energy vehicles to solve insufficient infrastructure and idle equipment of new energy vehicles. The report is divided into two parts: research and design. The study is "background, stakeholder interviews (through telephone, group questionnaire, and market technical analysis." Use the designer's research methods to find answers, such as user testing, exploratory research, demonstrative research, etc. "The design part includes "service design, product design, and brand culture."

1.1. Research

This study starts with desktop research to preliminarily understand the purchasing power of China's new energy vehicles and the demand for charging piles.

1.1.1. Background

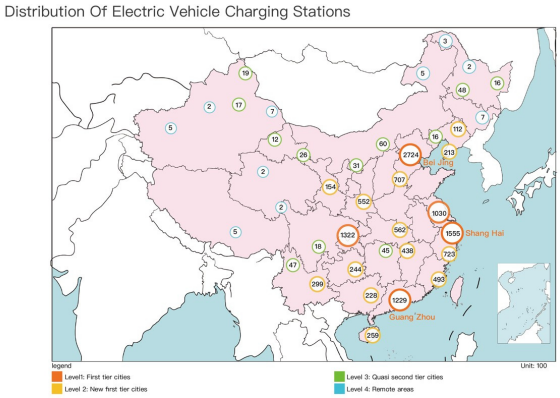


Figure 1. Quantity Map

1.1.2. Comparison between New Energy Charging _Station and Gas Station

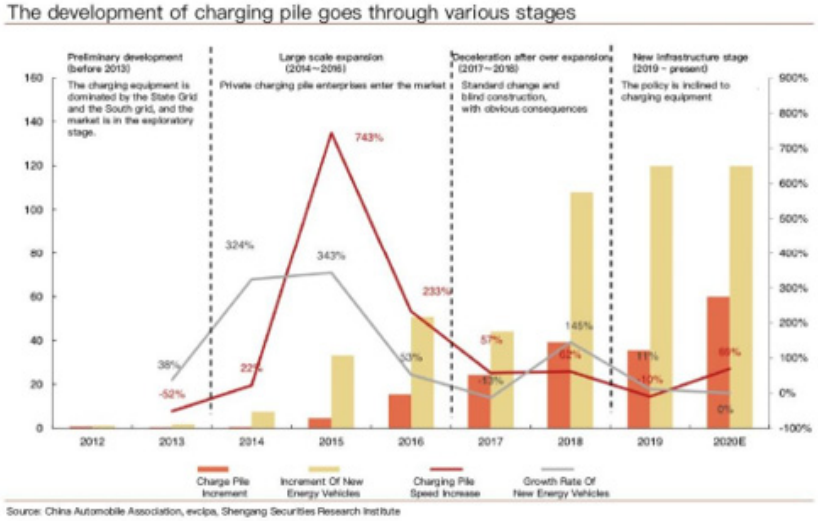


Figure 2. Development of Charging Pile (Securities Research Institute)

In recent years, the domestic charging foundation has developed rapidly under the dual role of policy and market, forming an excellent industrial foundation. By the end of June 2021, there were 924000 public charging piles in China, with a month-on-month increase of 39000 and a year-on-year increase of 65.4% in June. According to Quantum data, in 2021, the electric vehicle charging pile industry will become the focus of major national infrastructure construction and occupy a crucial strategic position in the federal economic structure.

1.1.3. Comparison between New Energy Charging Station and Gas Station

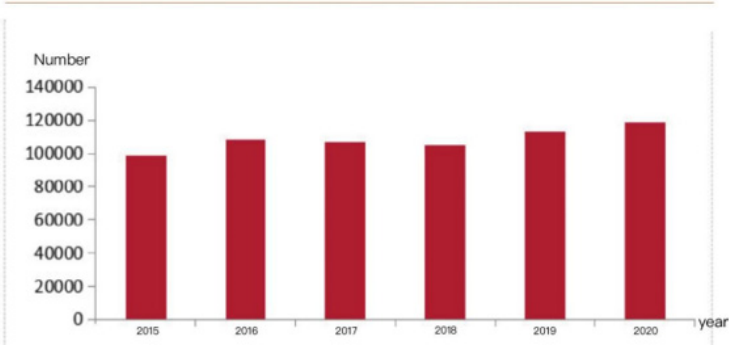


Figure 3. Gas Station (Securities Research Institute)

Although the number of charging piles is far more than that of gas stations, their characteristics are different. Charging piles are flexible, which does not solve the problem of charging users at any time. The service of gas stations is mature and stable.

The charging pile is rapidly rising, and there is no perfect system to establish a service system.

1.1.4. Supply and Demand Relationship of Parking Lot and Characteristics of Different Parking Lots

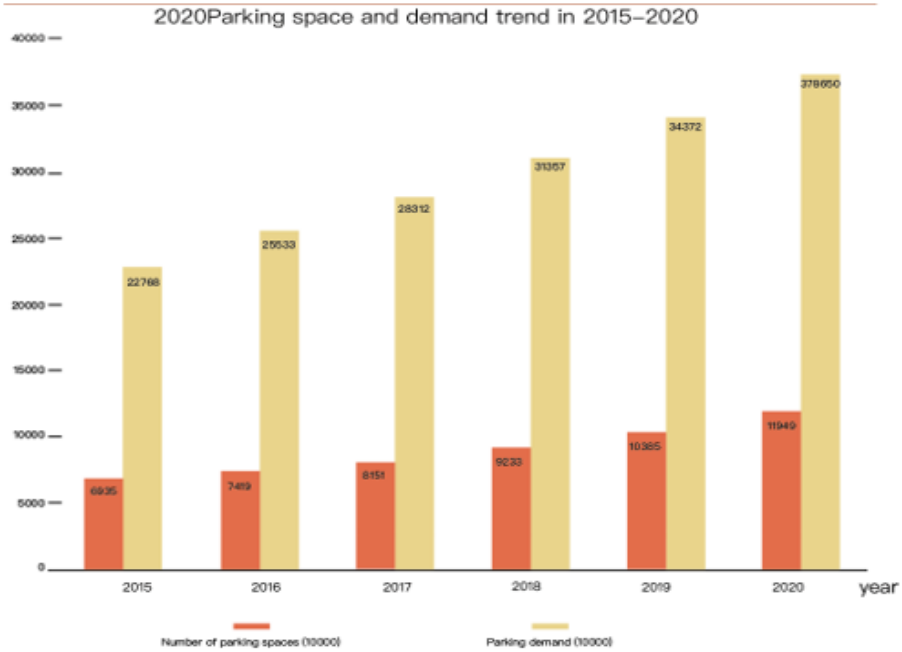


Figure 4. Special parking spaces for rechargeable vehicles (Research Institute)

Now, the number of cars does not match the parking lot. There are always enough parking spaces. Additional parking areas are divided to charge new energy vehicles, which is a waste of public space and is often dissatisfied by users.

1.2. User Qualitative Research

Interview user groups and stakeholders by telephone to tap the real needs of users. Users feedback that they choose new energy vehicles because they think new energy is the future development trend, advocate environmental protection, and reduce their dependence on oil. However, constructing a new energy charging infrastructure is not perfect, and charging is inconvenient. Users hope to form an ideal charging system.

1.2.1. Questionnaire Quantitative Research

1.2.2. Quantitative Questionnaire Research

The total number of questionnaires is 109, and 100 are valid. From the data, most users drive new energy vehicles to work and live in the city and occasionally have long-distance demand. The user's order of charging mode is "mixed charging mode (Home + portable) > Home > public > portable charger." Users prefer to park in the underground parking lot. Users complain that when parking in public areas, they often encounter the occupation of fuel vehicles, failing to charge in time. There is a greater demand for household charging pile installation, which is currently limited by the high cost (charging pile, parking fee, and so on).

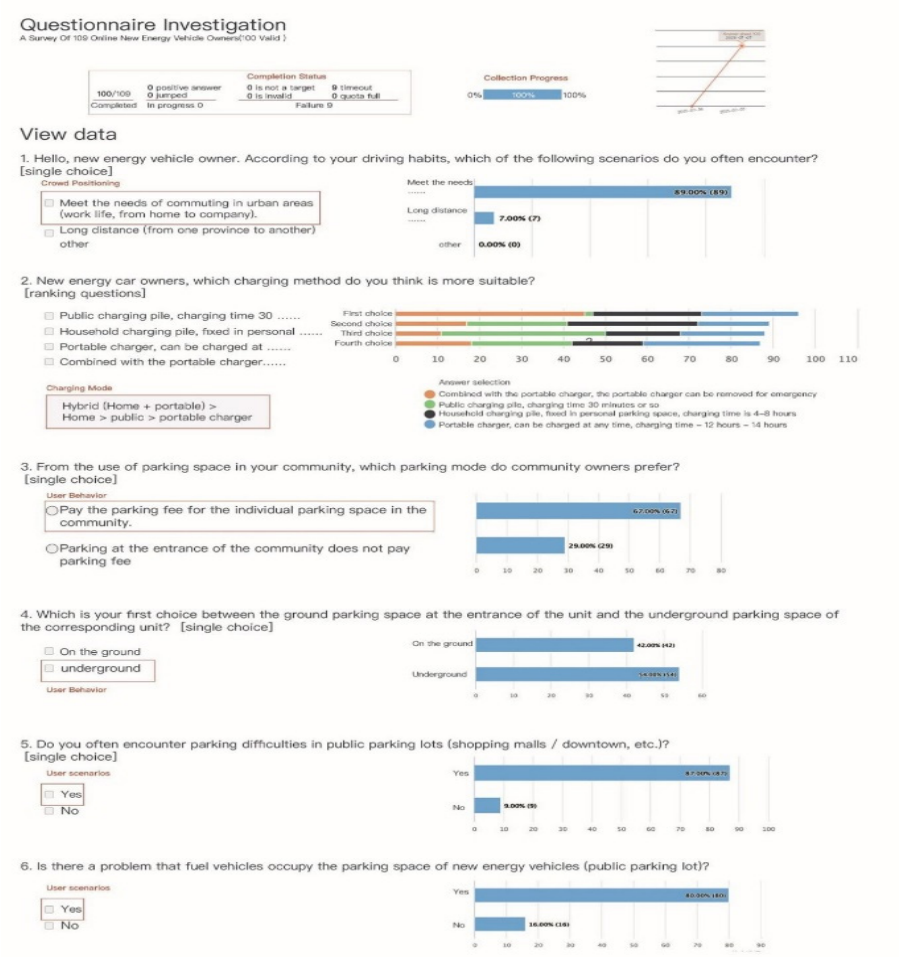


Figure 5. Questionnaire

1.3. Market Research

The state and enterprises vigorously build public infrastructure charging stations, but the cost is high, and the investment is greater than the income. AC charging can better protect the battery. The price of an AC charging pile can be lower than that of a DC charging pile, and it can also maintain the battery.

During daytime working hours, the flow of people converges like the city center, resulting in crowded public parking spaces and high pressure on public spaces. On the contrary, the parking spaces in the community are empty.

1.3.1. Competitive Product Analysis

In the early stage of development, it is essential to select a competitive product accurately. There are three types of competitive products: direct competitive products, indirect competitive products, and potential competitive products. I rank the most popular brands according to price and quality. Tesla's quality and popularity are high. Competitive product analysis helps us position our products and demand a blue ocean.

Whether a company is large or small, it has competitors in the industry. The strategies of these competitors affect the process of making strategic plans. Analyzing an organization's competitors helps to identify their weaknesses and identify opportunities and threats from the industrial environment.

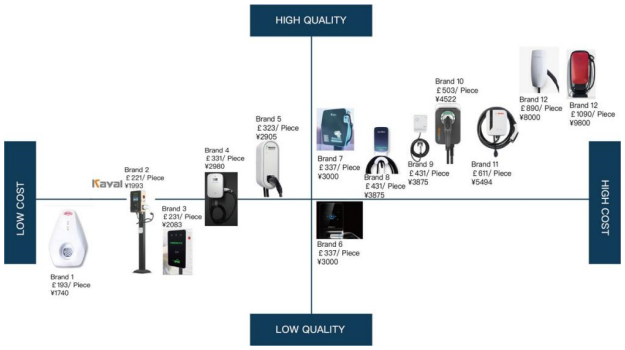


Figure 6. Completive

These brands are my competitors. The price of my products should be about 900 pounds, and the products strive for high quality. The preset volume of the product is larger than the current wall-mounted household charging pile. The purpose is that when charging, the machine's interior is in a high-temperature state and needs timely heat dissipation. However, the volume of the product is too small, and all electronic parts are gathered, increasing the risk of explosion (flame retardant device). Although the price of my products is relatively high, I will design a service system to let the empty car spaces and charging piles idle in the community rent out to form an open society, which means that car owners can rent their spare time to other users, which not only solves the problem of infrastructure supply but also reduces the economic burden of new energy car owners to buy goods.

1.4. Technical Analysis

I compare the two charging methods of DC and AC. From an economic point of view, the price of an AC charging pile is lower than that of a DC charging bank, which is easier to accept by users. Regarding battery life, AC charging can better maintain the car's battery to prolong the service life of new energy vehicles.

Therefore, "AC charging" was selected in the later product design scheme.

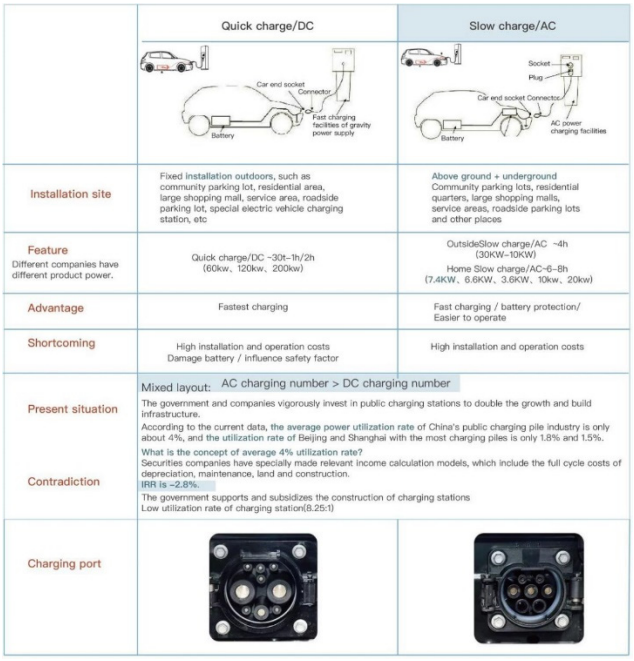


Figure 7. Technical Research

1.5. Electric Vehicle Culture

I have never seen "e-trike" related products in the Chinese market. E-trike has a large volume, which could be more conducive to shuttle in congested sections in China. Scooters should be more encouraged because it is often related to insecurity. Now, the price of buying a car is low. Users with a bit of capital accumulation will choose "car.

2. Design Part

2.1. Service Design

2.1.1. Service Design Principles

Based on the characteristics of service design, service design or service design thinking has five widely recognized principles: user-centered, collaborative innovation, orderliness, tangibility, and integrity. Taking users as the center is to think from users' perspective and always have users in mind. We can think of a question: Why can't traditional industries?

It is not that traditional industries are no longer working, but that some sectors are too "traditional" to keep up with the changes of the times. Times are changing, and user needs are changing. The same thing is to sell items. Users will naturally pass if they are more considerate, more convenient, and better service.

2.1.2. User Experience Mapping

User experience mapping is a powerful technology that can understand what motivates your customers - their needs, hesitations, and concerns. One of the best storytelling tools in business is the user experience map. Deep charging of the AC charging pile can prolong the battery's service life.

Journey mapping creates a complete experience view. It is this process that gathers different data points. It visualizes them to understand product requirements to attract uninterested stakeholders in various groups and promote collaborative dialogue and change. It can help understand the customer experience by revealing a series of frustrating and pleasant moments in the interaction process, revealing opportunities to meet customer pain points, reducing dispersion, and finally making the product stand out by exposing new opportunities to provide added value.

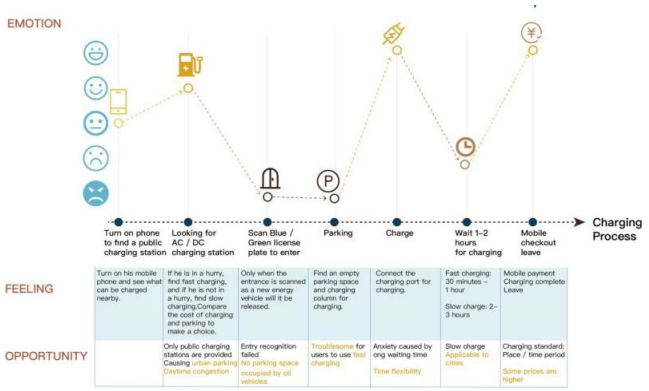


Figure 8. User Journey

Users go out to the company and go home to experience mood changes after using the charging station, which indirectly reflects the users' mood fluctuations on which contacts need to be improved.

2.1.3. Stakeholders

Isidoro,2013 Stated Stakeholders refer to any group or individual interested or interested in the operation of a company or organization - any person who can influence or be affected by its activities. To take users as the core, a successful life experience (Preece et al., 2002). We must consider the broad stakeholders involved in the product and think about the impact it will bring to them. In the user journey canvas, I try to imagine all stakeholders and their emotional changes to establish a "user-centered" service system.

2.1.4. Card Inductive Classification- Qualitative

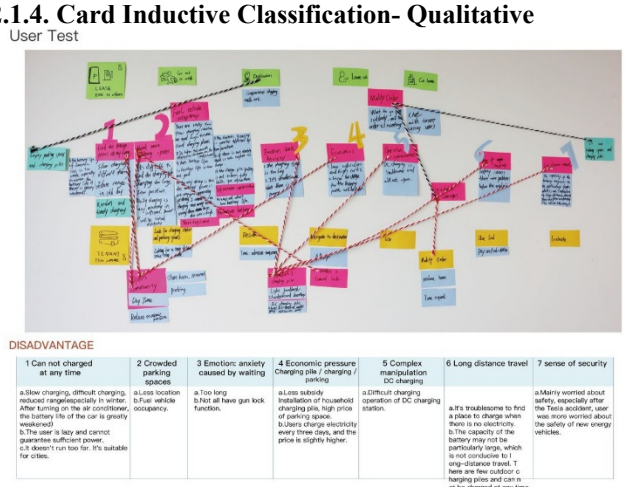


Figure 9. User Test

It is a research method that allows users to classify the cards of representative elements of information structure to obtain users' expectations. The card classification method mainly classifies the fragmented pieces to form a grouped

information structure with an inclusion relationship. I break up some topics and give them to users so they can speak freely, update valuable ideas, and enlarge their feeling of charging in new energy vehicles to find the concept of an "open community." Priority shall be given to solve the problems with the most significant heat.

2.1.5. Regional Map

A domain map is a map that systematically reflects the basic natural and economic situation and regional characteristics of a region. I choose Nanjing as an example to illustrate the distance from the suburbs to the city center and the movement track of car owners visually.

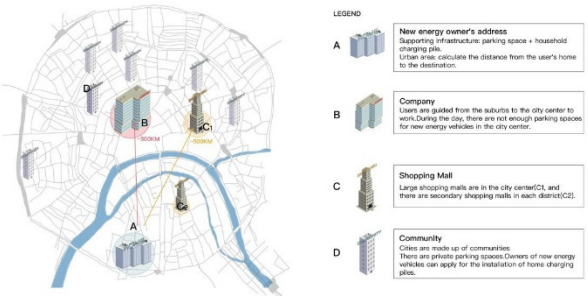


Figure 10. Regional Map

2.1.6. Demonstrative Research Focuses on Collaboration and Innovation

Demonstrate the opinions formed in the investigation process with the facts of the investigation. Partners who strive for major innovation should divide their work and focus on finding solutions for the smaller components of a problem. Each part contributes to achieving a larger goal. I shared the first design results with users and created them together. After much exciting sharing, I produced a complete service flow chart.

The parking spaces and household new energy charging piles in the idle time of the closed community in the city will be rented. Accelerate the construction of urban new energy infrastructure and form an open community atmosphere. Users are both lessors and users and make an appointment to order parking spaces with short idle time through the mobile phone platform. This will solve several problems in the city, such as no parking space, insufficient charging piles, and battery protection.

For the open community to enter the closed society, foreign vehicles must make an appointment on a mobile phone, scan and verify their identity at the gate, and join the community parking lot for charging service. This can share their charging pile and ensure the safety of the owner. The whole system is the account's natural name system, and the community entrance scans the vehicle information. Every community is closed in Chinese culture, and no one else can enter.

Everyone says that people in the city are lonely. Sharing the idle resources of the community.

2.1.7. Service Design Results

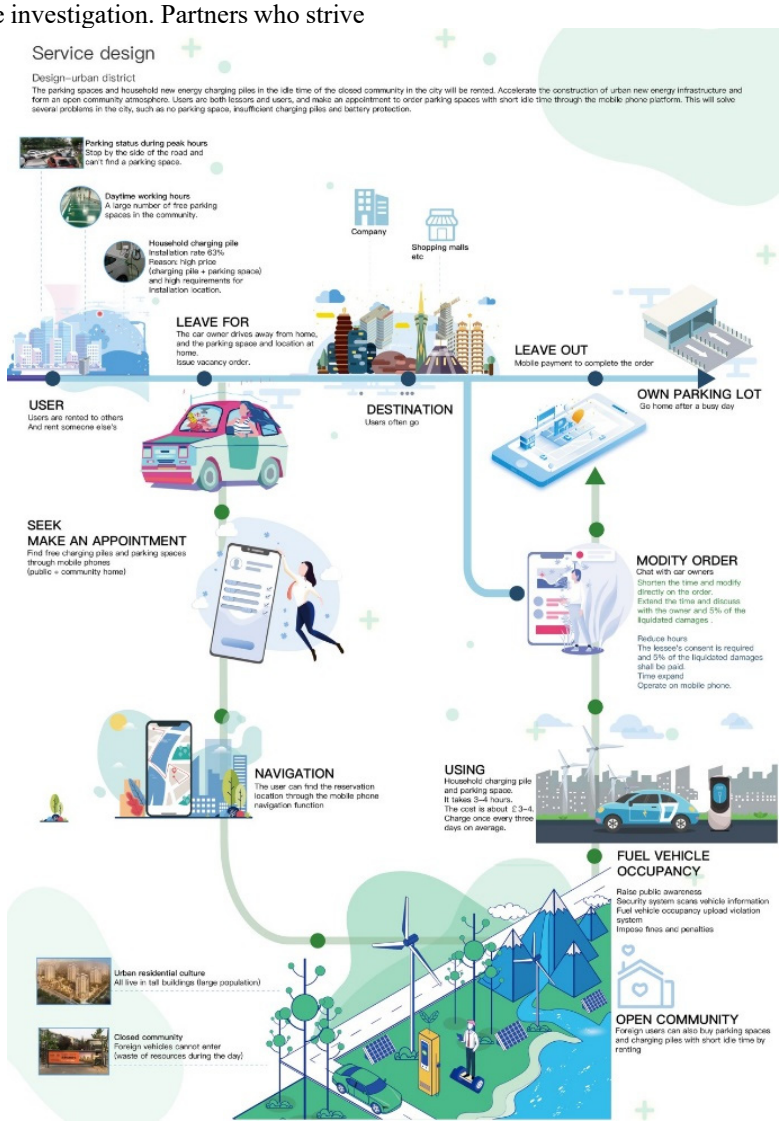


Figure 11. Service Design

User process

As a person who rents out charging piles in his community. The owner drives away from home with the parking space and location at home. He issues a vacancy notice, and the system will release the information that can be reserved. Then, go to the destination and finally get home.

Rent another charging pile as an appointment. Find a free charging pile and parking space through the mobile phone, make an appointment on the mobile phone, and go to the destination for car charging service through map navigation.

The period needs to be extended or shortened, and the rules of the other party need to be respected during mobile phone operations.

Innovation: The open community service model alleviates the pressure caused by expensive charging piles and parking fees. New energy owners can rent-free places in other communities and mobilize new energy owners to buy Household charging piles.

2.2. Product Design

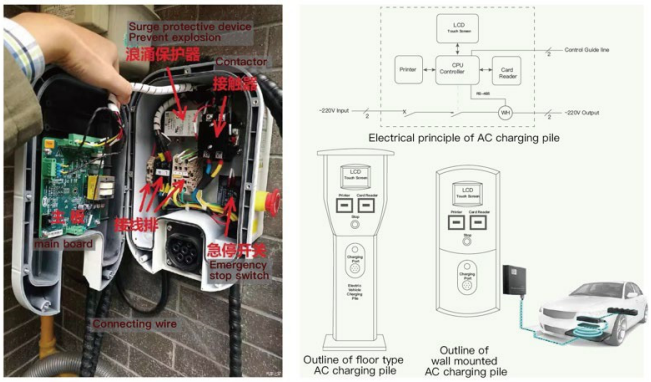
2.2.1. Emotional Board

A situation board is a digital collage or a set of elements that help determine the direction of a website. I chose 8 drawings with a sense of technology to help me find sketch inspiration. The mood board is the accumulation of images, colors, fonts, and words, stimulating my inspiration and setting the mood I want.

2.2.2. Visual Analysis

The landscape board can be regarded as an advanced creative briefing. However, it is not a written description of the website's visual and user interface elements but includes the actual visual and user interface elements. Sharp edges characterize. The inverted foot is about 45 degrees. There is a gap between the body and the body. There are combinations of large and small angles on the face to avoid parallelism and angle repetition.

2.2.3. Technical Principal Analysis



Product design is first function, then shape.

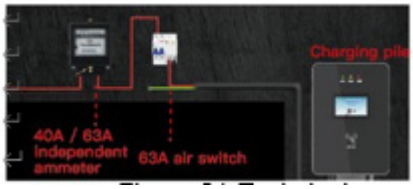


Figure 12. Technical

Product design is first function, then shape. The realization of various functions of the product completely depends on an excellent structural design. Structural design is one of the basic contents of mechanical design, and it is also the most complex work link in the whole product design process. The installation status of the household charging pile is that the relevant equipment is external equipment. Sense of science appearance: The product's sense of science and technology refers to facing the future and can well match the theme of new energy. The approach that guards the kernel's life selectively is more responsive than the watchdog that guards the application's entire life because the latter's waiting time is 1X more than the application's life.

Emotional feedback: Visualization of charging progress, when charging, there is a flowing light bar jumping.

Sense of safety: The equipment outside can be put into the charging pile without crowding, and the size is not small Easy to heat and avoid explosion. Change some fixed behavior: Solve the problem of environmental protection of battery, secondary utilization, and use of advanced technology and materials.

2.2.4. Sketch Design and Iteration

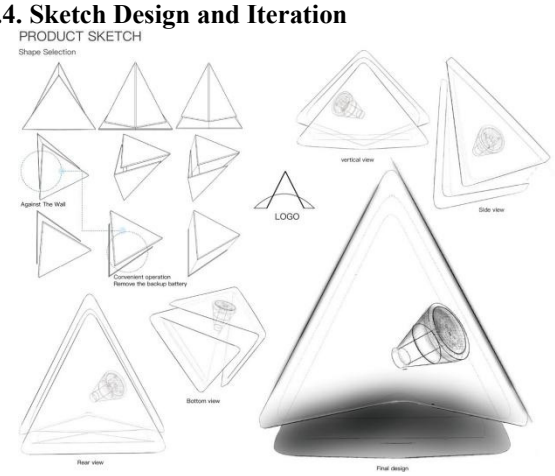


Figure 13. Sketch



Figure 14. CMF

2.2.5. Model

A product model is a three-dimensional image of product design conception and an important expression method for designers to express design ideas. It can intuitively reflect designers' ideas and guide designers to further design divergence.

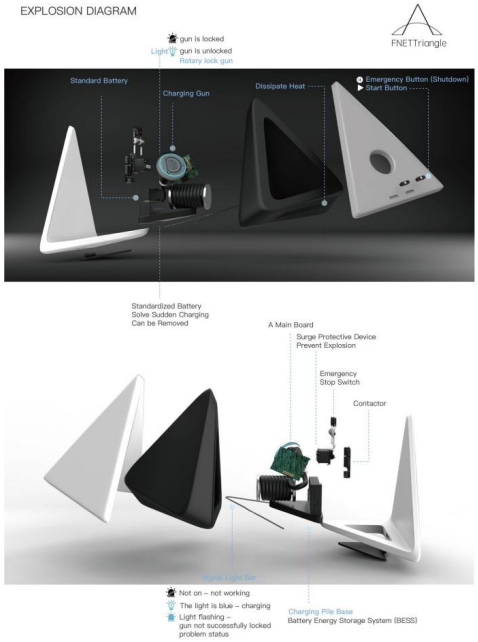


Figure 15. Explosion Diagram

2.2.6. Product Design Results

Innovation 1: Emotional Feedback

The ideal customer feedback analysis should focus on themes and link them to emotions. In addition, this should be unique to each brand, survey, and touchpoint. We connect emotionally with the products and services we use daily. These connections drive our behavior and directly affect the decisions we make. To create products and experiences that create emotional value, the product community needs to focus on designing products that establish positive emotional connections with customers. Customers' thinking, learning, problem-solving, decision-making, and simple consumption information need to be embedded in our product design.

The charging pile products on the market look like a shell without considering users' emotional needs. For example, they can see whether the product works so anxious users can get feedback and feel "safe" emotionally. I choose to use light to convey critical information about the working state of the product.

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Innovation 2: Standardized Battery

Long-distance Travel Reserve Battery. Standardized battery with charging point and vehicle base. Extend the service life of lithium-ion electric vehicle batteries, make them more economical and reduce their carbon footprint.

Innovation 3: Battery sustainability

Apply the latest battery to products. Environmental sustainability must be put in important words. Jackson's experiment led to the development of a new and safe electrolyte. He even tasted the electrolyte before stunned industry observers to prove its benign characteristics - aluminum-air battery. It will take a long time to explore this new technology, possibly in the next ten to twenty years. With the increase in the number and scope of new battery research, an appropriate battery value chain is significant to ensure that electric vehicles continue to contribute to sustainable development goals.

NMC is the most used cathode chemical in lithium-ion batteries for electric vehicles. The energy density of the battery with NMC cathode increases with the increase of nickel content. For these reasons, it is reasonable to believe that the density continues to rise. Although lithium-ion technology has made significant progress in energy density, cost, and cycle life in the past decade, there is still room for improvement. Research is underway to improve all three key components of lithium-ion batteries: cathode, anode, and electrolyte. In addition, the latest developments in battery design and thermal management are mainly aimed at reducing the cost of battery packs and module components.

2.2.7. Brand Design

Brand Culture can be defined as the inherent DNA of the brand. The Logo Production process is that the product shape inspires the logo, and the refined product lines are composed of "triangles and circles. "The sharp corner of the triangle upward reflects the brand's pursuit of excellence, and the circle at the bottom gives the shape a sense of stability and forms a stable foundation. The modeling has a sense of science, technology, and the future. Asymmetry expresses the pursuit of being different. The brand name is composed of "future, next, triangle," which expresses the product facing the future and constantly exploring new technologies to improve humans and the environment. The triangle represents the spirit of continuous exploration.

3. Conclusion

This product aims to balance the supply and demand relationship between car owners and infrastructure with the service mode with the open community as the core. The following points are obtained through the research: The high price of Household charging piles is an obstacle to users' purchasing power. According to the survey data, users prefer Household charging piles. Deep charging of the AC charging pile can prolong the battery's service life.

Design part:

Service design: Lease the household charging pile and parking space to solve charging and parking. Open community refers to the concept wherein users who have installed residential electric vehicle (EV) chargers can share their parking spaces and the time slots for charging with other electric vehicle users, who can then utilize these resources and make corresponding payments.

This open design represents a forward-looking idea related to community management and safety.

Product design: emotional design of the product to alleviate users' anxiety waiting through light feedback. Adopt a new battery to protect the environment; Optimize the product's internal structure to avoid the risk of overheating and explosion. The product indirectly solves the problem of uneven social infrastructure and gives car owners the self-drive to buy Household charging piles.

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