POLITECNICO DI TORINO

Master's degree in Automotive Engineering

Exclusive public charging strategy design for Chinese BEV market

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Abstract

Chinese battery electric vehicle (in the following referred as BEV) market is one of the largest and fastest-growing market in the world, attracting global auto companies. And as an infrastructure, the public charging network is greatly affecting the customers' confidence in BEV and their choice of the brand. In this thesis, I fictionalize a European automotive company that had achieved great success in China in the past internal combustion engine (in the following referred as ICE) era. Now in the competition of the electrification, we can increase the brand awareness and the sales of our BEV in China by planning the branded exclusive public charging stations and the premium charging services.

Table of contents

Chapter 1

Background introduction

1.1 Introduction of Chinese BEV market

As the largest and fastest-developing automotive market in the world, China has been in the top position of the sales and manufacturing volume for 12 years since 2009. The following figure refers the data from China Association of Automobile Manufacturers (in the following referred as CAAM) [1] and International Organization of Motor Vehicle Manufacturers (in the following referred as OICA) [2].

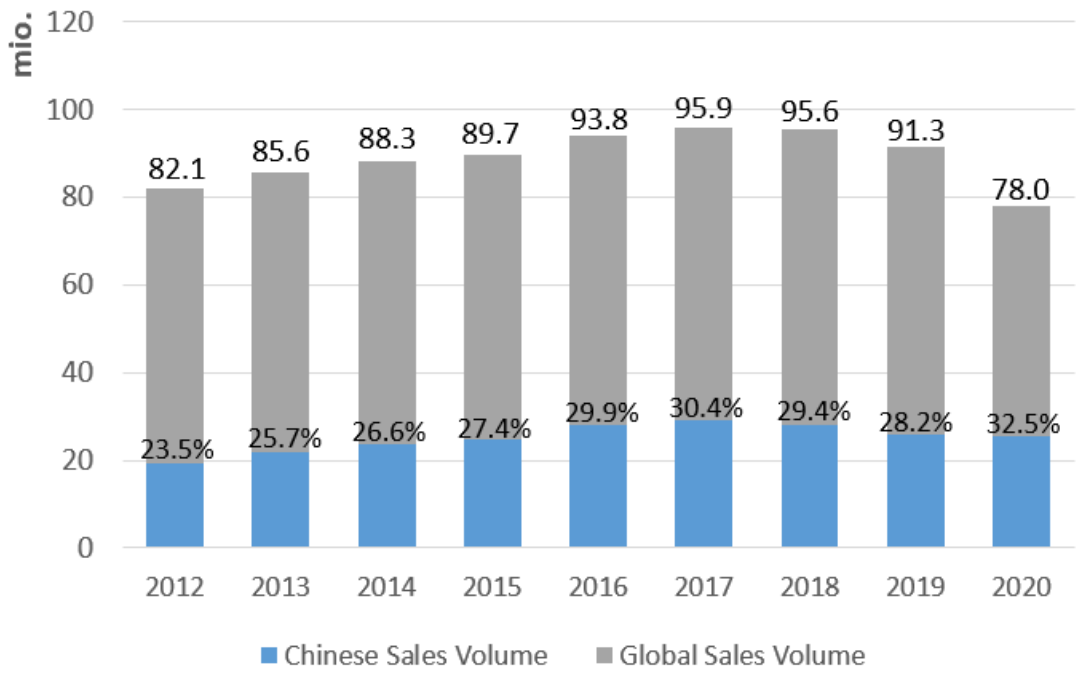

Fig. 1.1 Automotive sales volume

Meanwhile, China is one of the earliest countries starting the electrification transformation in the automotive field, and has been in the leading position of the BEV sales volume since 2015. The following figure refers the data from CAAM [3]

and International Energy Agency (in the following referred as IEA) [4], shows the sales volume of the new energy vehicle (in the following referred as NEV) in China, include BEV and plug-in hybrid electric vehicle (in the following referred as PHEV). The PHEV takes only a very small part.

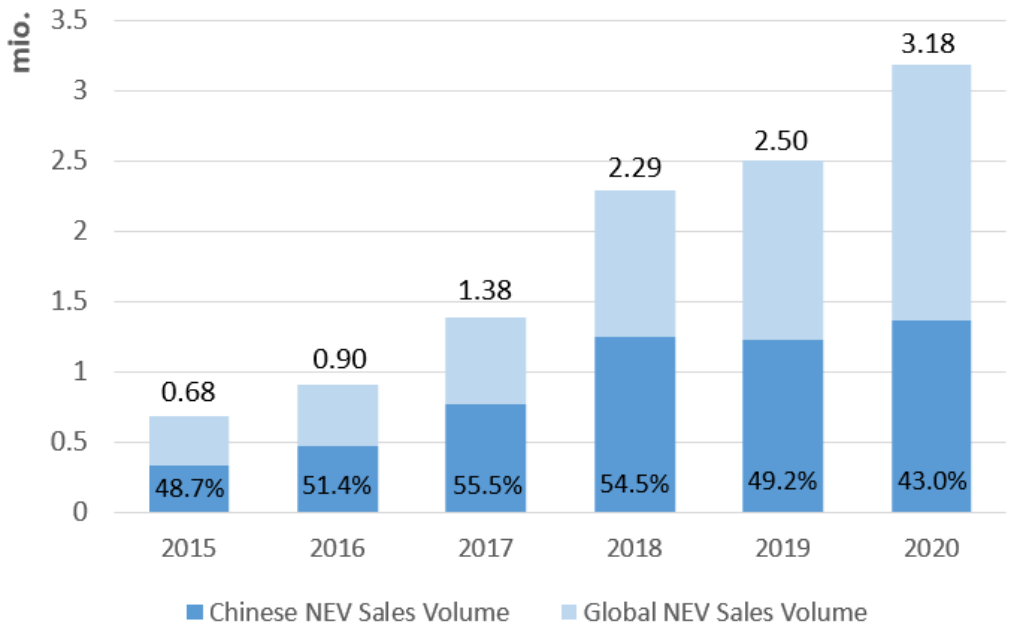

Fig. 1.2 NEV sales volume

The electrification transformation in China includes some new development directions such as networking, intelligence and sharing of the BEV, and at the same time also creating some new industries like the public charging. So, what is driving the electrification in China?

Early in 2012, the State Council had already introduced the "*Notice of the State Council on Issuing the Planning for the Development of the Energy-Saving and New Energy Automobile Industry (2012-2020)*" [5], planned to accelerate the development of the NEV, especially the BEV. The government encourage enterprises to increase research investment and explore business models, and promote the public charging

infrastructure development. Then in the following several years, on one hand, all the commercial vehicles such as taxi, ride-hailing car, and logistics fleets had to take BEV as the first priority. On the other hand, more policies came out and greatly promote the sales of the passenger BEV. The major supportive policies from relative government departments (Ministry of Finance, Ministry of Transport, Ministry of Industry and Information Technology, and National Development and Reform Commission) are as follow:

1. the monetary subsidy:

This subsidy policy started at 2015 and will be extended to 2022 now. The amount of the subsidy is decided by the E-range and the energy density of the battery of the BEV. But with the rapid increasing of the BEV sales volume, this subsidy is slowly decreasing step by step. At the year 2020 the maximum BEV subsidy is about 24,000RMB/car, with the annual cut of 20% in 2021 and 30% in this year. In the next year, maybe this subsidy will be cancelled since the BEV industry is large and steady enough.

2. the tax policies:

There are no Purchase Tax for the BEV (which is usually 10% for ICE cars), and no annual Vehicle or Vessel Tax at the same time, until year 2022. Which means that this waiver of tax will be cancelled next year for the same reason. The government judged that this would not cause an impact to the BEV market.

3. the dedicated BEV license plate:

The BEV has its own ‘green’ license plate, differ from the ‘blue’ plate of the ICE car.

For people living in some tier 1 cities like Beijing, Shanghai and Shenzhen, they don't need to enter the license plate lottery or auction, and have no roadway usage restriction, while enjoying a parking discount. This is the main reason for people living in those cities choosing the BEV.

Besides, to achieve the carbon neutrality goal, the Ministry of Ecology and Environment (in the following referred as MEE) also introduced the strictest regulation *"Limits and measurement methods for emissions from light-duty vehicles (CHINA 6)"* [6]to limit CO2 emissions for protecting the environment, and the dual credits policy for limiting the production of ICE cars. What's more, similar to Europe, some provinces in China have already set clear times of banning the sale of the ICE cars. All the above policies are forcing ICE companies to shift their focus of research to the BEV, and give customers confidence of purchasing a BEV.

1.2 Introduction of the public charging industry

As we mentioned before, early in 2012, the policies had already mentioned the development of the public charging. Before 2015, there are only a small number of charging stations dedicated to the electric bus and commercial vehicles. Then, to stimulate the sales of the BEV, and also because the central government recognized the necessity of the public charging network, a lot of policies came out to promote the development of the public charging. The major 2 policies are listed below:

1. in the 13th Five-year Plan in 2015, public charging has become one of the top six priorities for the country's future economic development. And in the "New

Infrastructure Plan" in 2020, the public charging facility is still on the list.

2. government provides all kinds of subsidies to any public charging companies according to the number of the pillars they build.

3. the cost of the charging facilities building will be partially shared by the utility companies such as the State Grid Corporation.

With policy support, the number of the public charging pillars increased rapidly. And the charging power was also rising from 30 kilowatts to 60 kilowatts, and reach 120 kilowatts now. At the same time, like the Ionity in Europe, a lot of enterprises aiming at the public charging market established. Here in this thesis, we call these companies charging pillar operator (in the following referred as CPO). The following figures shows the development of the public charging pillar each year and the pillar number of the main CPOs, according to the data from Electric Vehicle Charging Infrastructure Promotion Alliance (in the following referred as EVCIPA) [7].

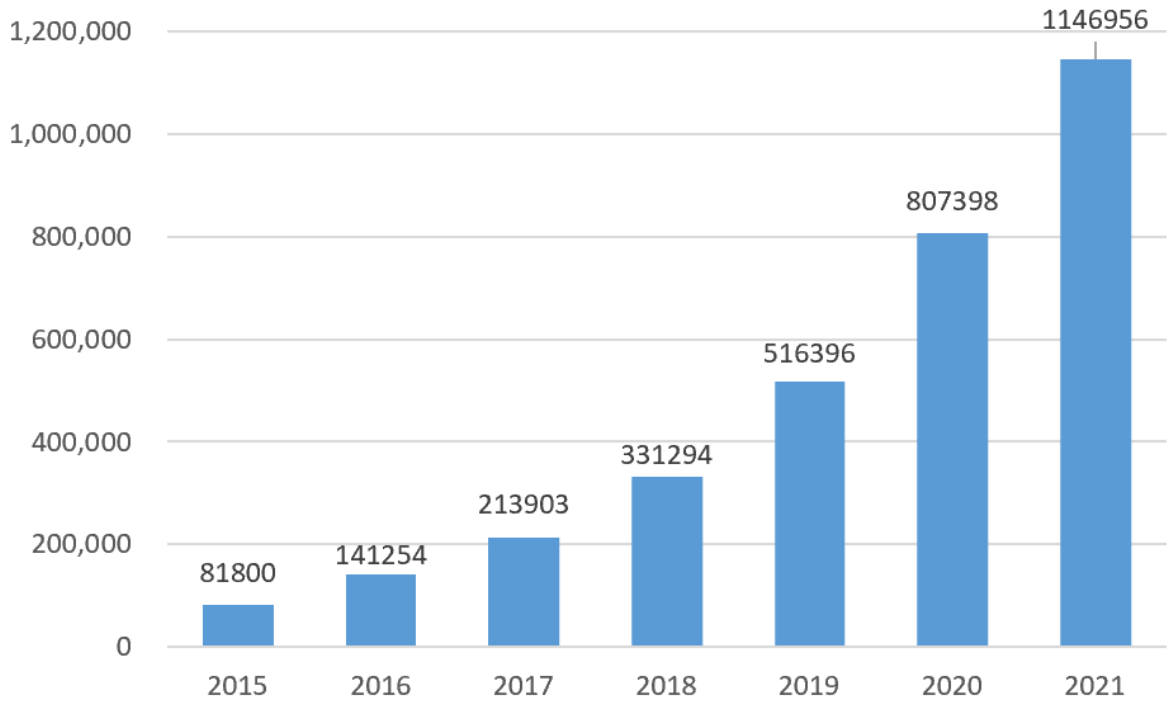

Fig. 1.3 Development of the public charging pillar

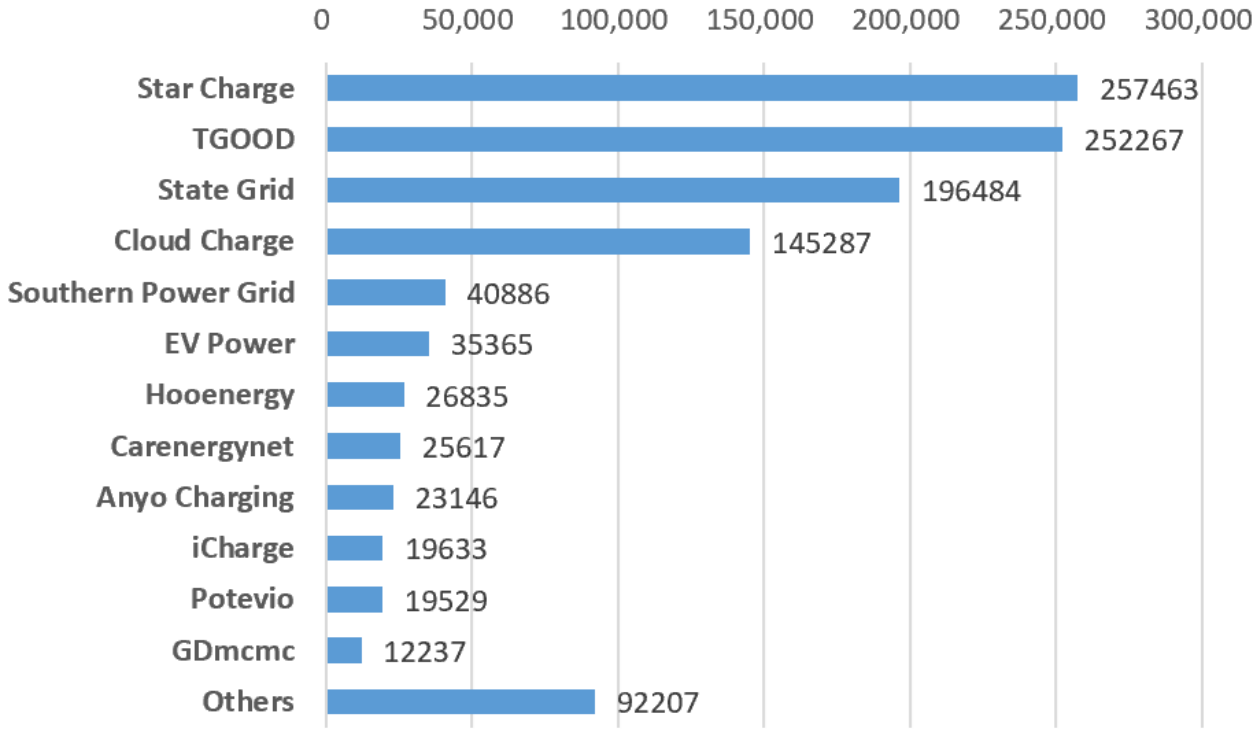

Fig. 1.4 Pillar number of the main CPOs

From the figure 1.4 we can see that, nearly 75% of the public charging pillars on the market are operated by the top 4 CPOs. In fact, around 2019, to get the subsidy from the government, lots of CPO companies are established. They built a large number of pillars without considering the location and the operation. Some of the pillars are in low quality and even never been used by customers. The same goes for the top 4 CPOs, they expanded their charging network rapidly at that time. Then, when the subsidy of the public charging pillar decreased, lots of CPOs stopped running, leaving their pillars with no maintaining. So, on the market existing a certain number of pillars that are not working properly.

In terms of the industrial standard, China had formed a set of mature standards on charging piles in 2015, and has more detailed national standards for both alternating current (in the following referred as AC) charging and direct current (in the following

referred as DC) charging like GB/T 18487-2015, GB/T 20234-2015, GB/T 27530-2015, etc.. Considering that the 2015 version standards are out of time now and have already become a limit to the development of the charging industry, the new national standard named "ChaoJi" is on the way now.

1.3 Introduction of the main players in Chinese BEV market

The following figure shows the sales volume ranking of the main players in Chinese BEV market in the past 2021 according to the data from the database of ASKCI Consulting [8]:

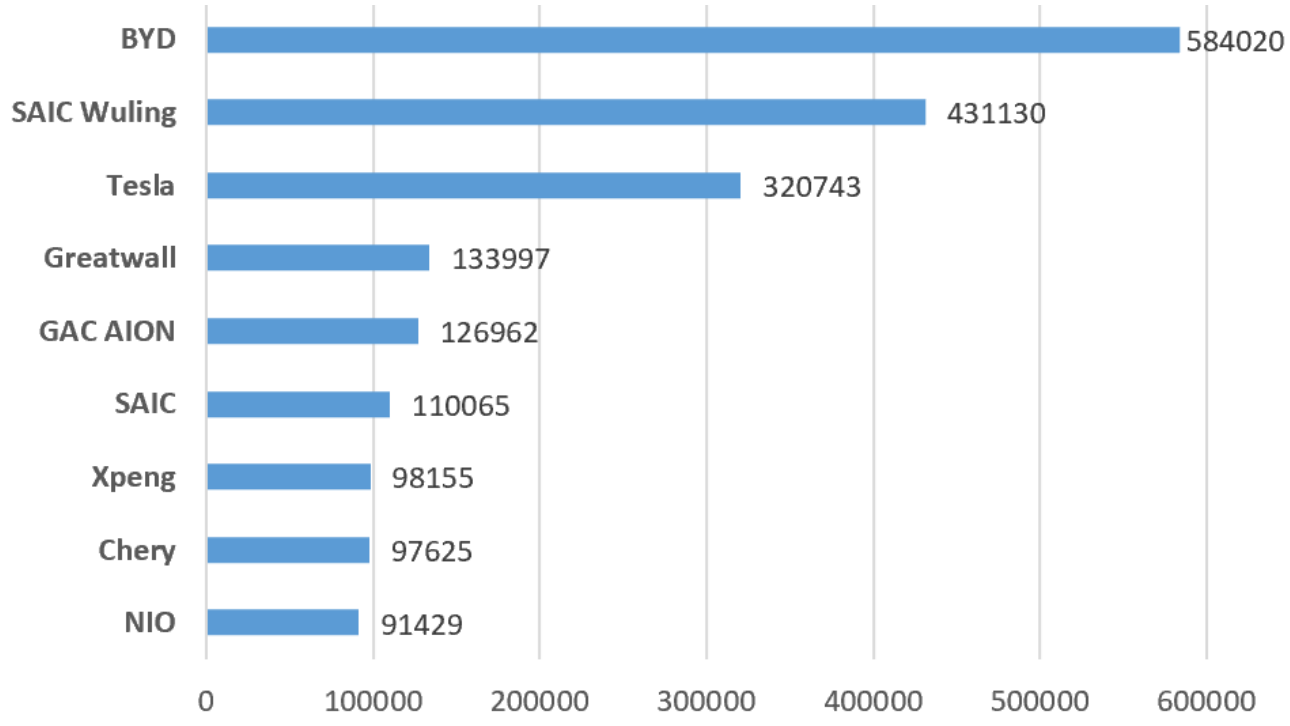

Fig. 1.5 Sales volume of the main BEV brands in 2021 in China

Now in the Chinese BEV market there are mainly 3 types of players. The first types are the Joint Ventures of the traditional ICE brands like FAW-VW, Beijing Benz, and Brilliance-BMW. These types are due to the Chinese policy in the recent years. The

foreign automotive companies have to establish joint ventures with Chinese OEMs to sale their cars in China. The second types are the traditional Chinese ICE brands like Geely, BYD, GAC, SAIC, and Greatwall. They published a lot of sub-brands for their BEV like Zeekr, Han, Aion, Ora, and occupied some market share. All of them are volume brands. The third types are the new BEV players like Tesla, NIO, and Xpeng. These companies are born for BEV, and have the largest market share.

Most BEV brands are targeting at the volume market, with price less than 30k euros. Only Tesla, NIO, Xpeng, and traditional premium brands like Mercedes are targeting at the premium market.

1.4 Introduction of the background of our company

To discuss the branded exclusive public charging topic, I fictionalize this traditional European automotive company and set this background for this thesis (which is similar to the situations of most premium European brands in China). The Chinese branch of this company is in Beijing, and is registered as a management and consulting company. Our company imports and manufactures cars through a joint venture, and has a large number of dealers in most Chinese cities. Our brand is always targeting at the premium market. In the ICE field, we have achieved a great success and have a large market share in China. Customers acknowledge our premium brand positioning; they are willing to pay over 30k euros for our ICE cars. The main competitors of our brand are Mercedes, BMW, and Audi.

In the BEV field in China, we have new competitors in the premium market now,

which are Tesla and NIO. During the electrification transformation process, we started relatively late comparing to those new competitors. Our BEVs on the market are in the same price region with our ICE cars, with the same outstanding quality. But the sales volume of our BEV is far from our expectation, and also far behind Tesla and NIO. Our traditional competitors like Mercedes are in the same trouble. According to the early buyer study, the main two rejecting reasons and the main two dissatisfaction points of our BEV are both the E-range and inconvenience of charging. Comparing to other premium brands, the E-range of our BEV is not long enough, and the public charging we are relying on for now is not convenient enough, and cannot meet our premium brand image.

Our aim now is to promote the BEV sales volume, occupy more market share, re-build and propagandize our premium BEV brand image. This thesis is to discuss about whether we can get close to this goal by developing our branded exclusive public charging stations.

Chapter 2

The necessity of the public charging in China

First we start from the early buyer study I mentioned in the previous chapter. The range anxiety and inconvenience of charging are actually the main reject reasons and the most concerning points for all BEV potential customers. According to the report *"Blue book of the BEV customer insights"* from the AutoHome [9], nearly 80% of potential customers reject BEV for the inconvenience of charging. As for BEV owners, about 47.1% charge when the state of charge (in the following referred as SoC) is still higher than 20%, and even 23.8% charge at any possible time.

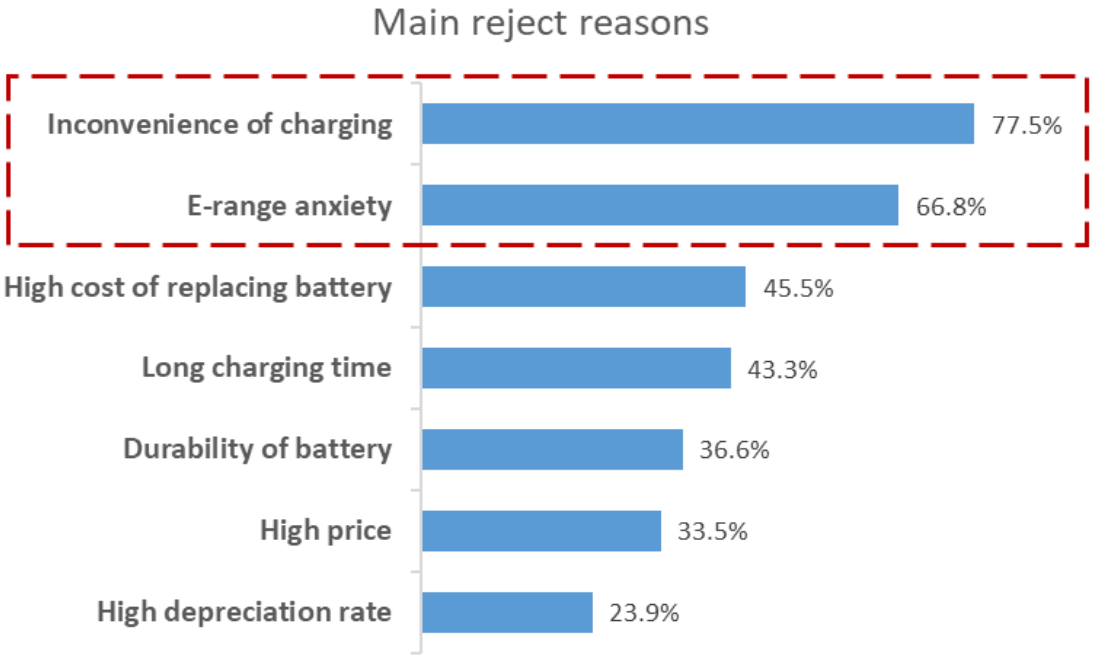

Fig. 2.1 Main reject reason of BEV potential customers

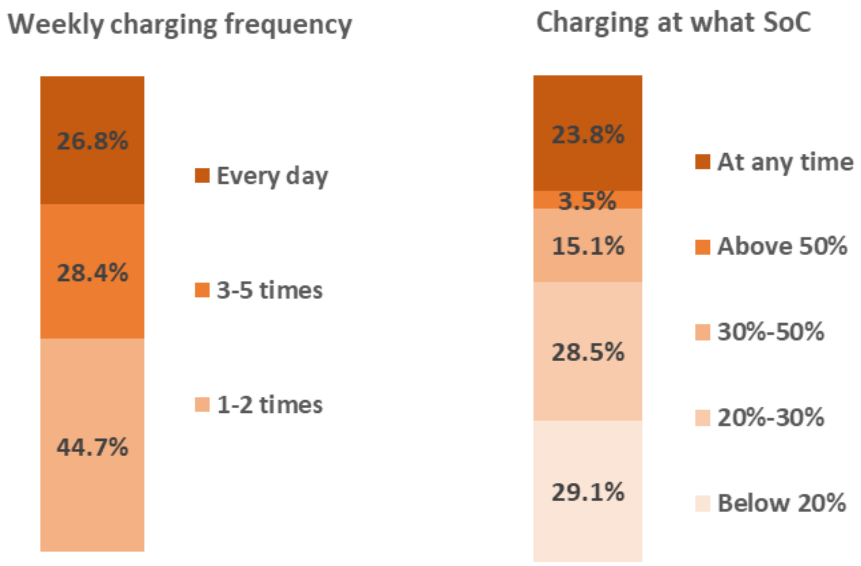

Fig. 2.2 Charging characteristics of BEV owners

It's easy to find out that, range anxiety is commonly existing in all the BEV customers, and is mainly caused by the inconvenience of charging and the short e-range. Here we focus on the charging topic.

Now there are mainly two charging scenarios: home charging and public charging. At Dec. 20th, the CEO of a BEV brand named Weltmeister complained on the social media that, over half of the home charging wall boxes that sent to the customers when buying their BEV, cannot be successfully installed. This exposed a problem that, it's difficult for BEV owners to install a home charging wall box. According to the data from EVCIPA, actually only about 52% of the BEV owners in China are able to successfully install their home charging wall box.

To find the reason of this low home charging wall box installation rate, we can refer to the following chart about the insurance amount of the new BEV in each city in the first 6 months of 2021, which shows the BEV sales distribution in all 661 cities in China Mainland.

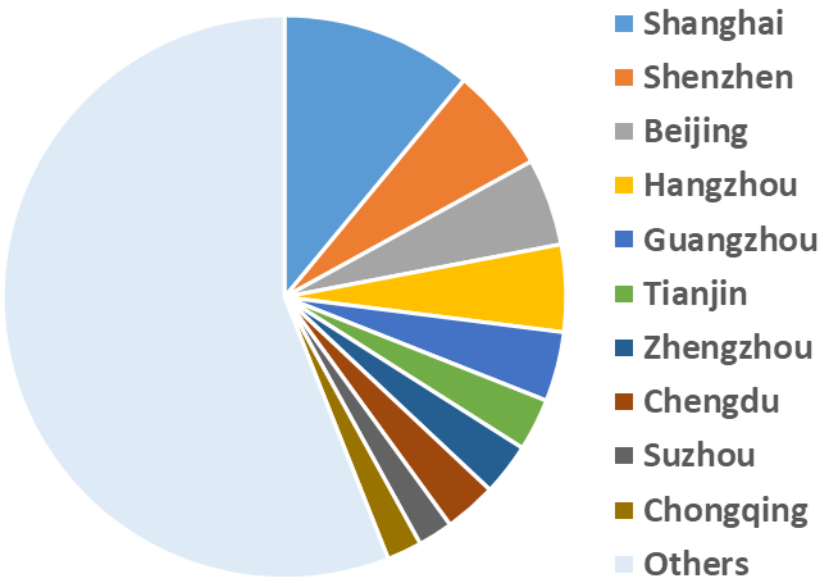

Fig. 2.3 BEV sales distribution in the 661 cities in China Mainland

From this chart, we can see that nearly half of the BEVs are sold in the Top 10 cities like Shanghai, Shenzhen and Beijing. This is mainly caused by the policies in these cities. There is a strict restriction on the new car licenses as I mentioned in Chapter 1. It's extremely difficult to get an ICE license plate in those cities. In 1000 applicants, only about 3 can get their plates. And every week from Monday to Friday, there is a traffic restriction based on the license number. All these policies are only aiming at ICE cars, so that most people have to choose BEV in these cities. And the charging demand is higher in those cities.

For home charging, to install a level 1 or 2 wall box at those cities, there are some limiting conditions. The first one is the private parking slot. The home charging wall boxes have to be installed at the private parking slots only. But usually, it's difficult to have a private parking slot in those large metropolises. Different to Europe, over half of population in China lives in multi-unit high-rise dwellings. Single-family houses are very rare in the urban area. And there is not enough space for parking lots. For

example, in Beijing, according to the report from the Beijing government, the parking slot demand is 3.8 million, but only 2.4 million private parking slots in the compounds. This gap is getting wider now.

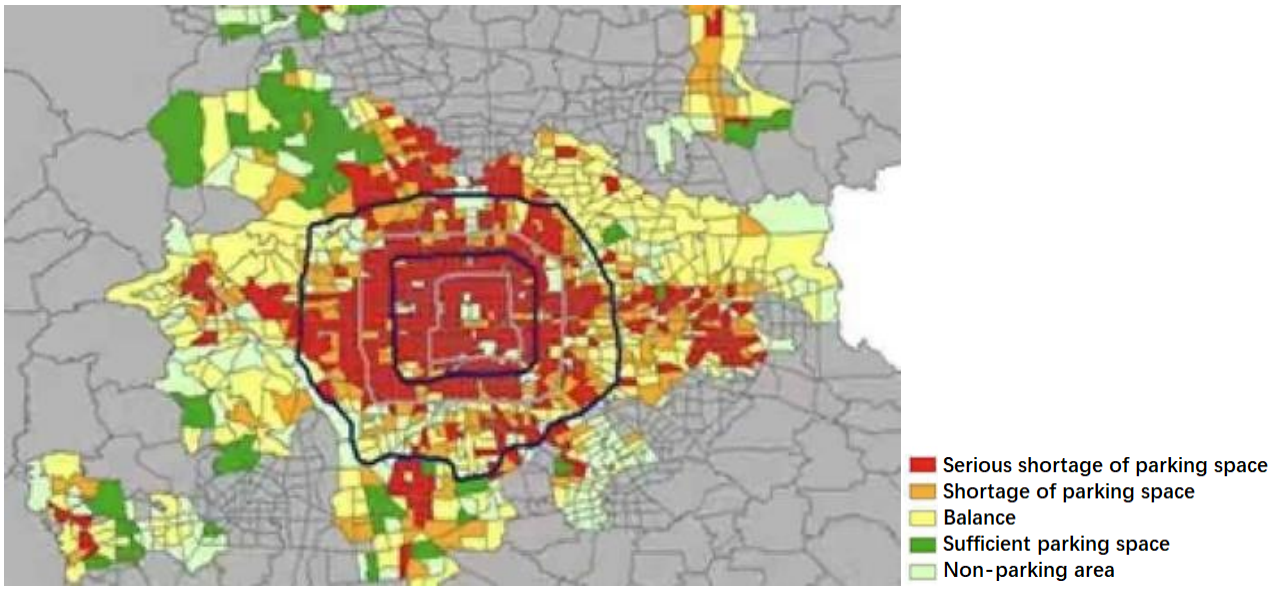

Fig. 2.4 Parking space situation in Beijing

Meanwhile, most private parking slots have already been sold in the past several years. For a customer bought a BEV in the recent years, they can hardly buy a private parking slot now.

The second one is the power capacity. Most people in Beijing are living in those large compounds, most of which in the urban area have already been built for more than 10 years. The power capacity is very limited now and cannot support more home charging wall box.

With the two main limiting conditions above, not to mention those safety regulations for electricity and fire risk, the actual situation now is that, in large cities like Beijing, there are a larger part of BEV customers that could only rely on the public charging.

For the public charging, according to the data in Chapter 1, in China now there are a relatively large number of public charging pillars. And from the following figure we can see that, also the public charging resources are centralized in those tier1 cites.

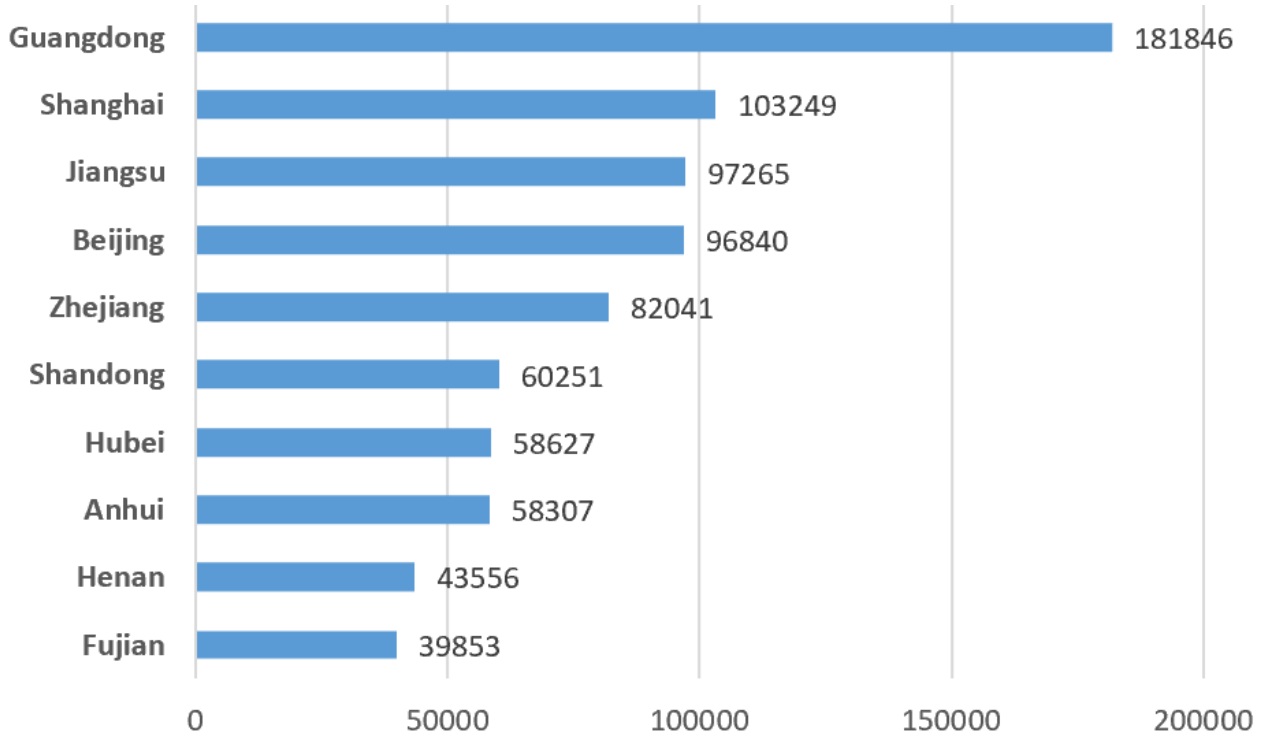

Fig. 2.5 Public charging pillar number in each city at the end of 2021

With such a large number of public charging pillars, why charging is still a problem for BEV customers? Further investigation to the public charging stations in those tier1 cities is needed.

Chapter 3

Public charging station and user investigation

In this chapter, I'm going to make an investigation on the public charging stations in Beijing and the customers charging there, to have a clearer and more comprehensive understanding of the public charging, and dig out the customers' pain point.

3.1 Choose the investigation location

I choose both urban and suburban area of Beijing to make the investigation, for the reason that, nearly all the public charging station brands and branded exclusive stations can be found in Beijing, and also because the Chinese branch of our company is in Beijing. The basic information of the public charging stations in Beijing is shown as follow:

According to the data from EVCIPA, till the end of 2021, there are 5850 public charging stations (96840 charging pillars) in total in Beijing. Most of them are open to the public, while some are built inside the companies or industrial parks, only serving the employees working there.

On the map I can roughly find out that, the public charging resources are mainly centralized at the large shopping malls, city parks, industrial parks, compounds, central business district (in the following referred as CBD), hotel, and office buildings, which is quite reasonable. And when I'm choosing the detailed investigating places, I

mainly consider from the following aspects: the density of the public charging stations in this area should be relatively high; there should be public charging stations from more different CPOs; this area should contain more charging scenarios.

Based on the rules above, the first place I choose is near the east 3rd ring of Beijing (Fig. 3.1, blue box area). This is a large prosperous business region developed very early, contains large old compounds, city parks, shopping malls, and universities. The population density here is very high, leads to high car parc, and high density of public charging stations.

The second place is at the southeast 6th ring of Beijing, which is a typical near suburban area (Fig. 3.1, orange box area), inside which contains large CBDs, industrial parks of large companies, and newly built apartment blocks. The suburban area is developed relatively late, with less population.

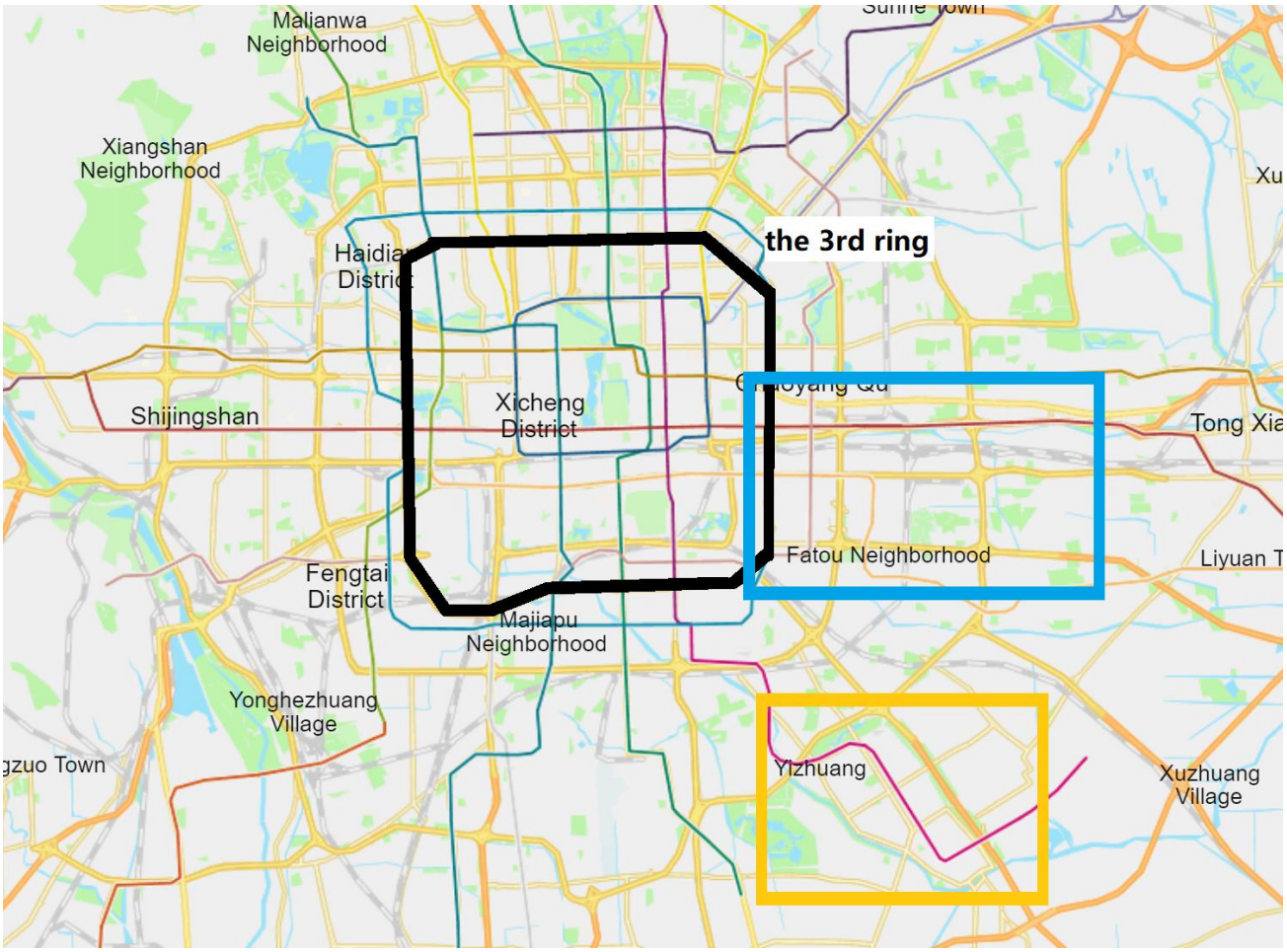

Fig. 3.1 Investigation location

3.2 Doing the investigation

3.2.1 Charging stations investigation:

It took me about one month to investigate over 60 charging stations in the two areas in Beijing, including both public charging stations and branded exclusive charging stations (here in this part I just talk about the public stations).

At the first several days, I rapidly visit most of public charging stations here, to form a general understanding. I'm focusing on the: location of the station, whether it has clear road signage and easy to be found or not; the number of the pillars, operating situation of each charging pillar, charging power; the environment of the station, the charging

fee, parking fee needed or not, whether it has operating and maintaining staffs; the number of the BEVs charging here at that time. Find the difference between each station, and filter out some typical stations for further investigations.

The situation of the first region is shown in the following picture:

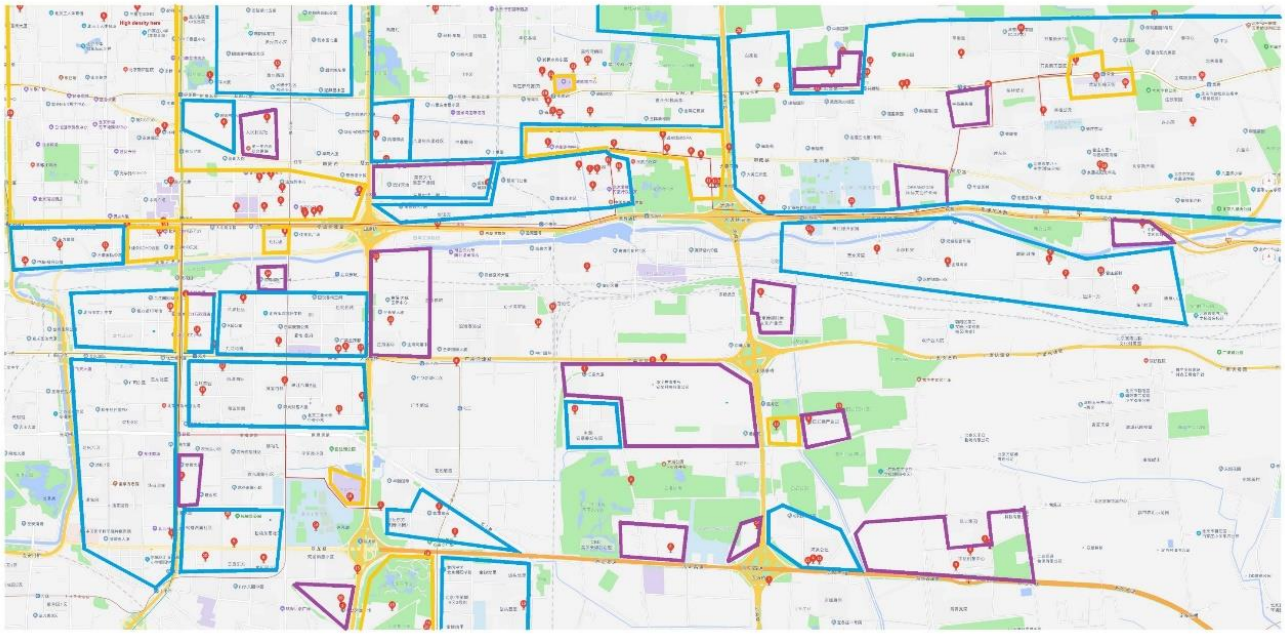

Fig. 3.2 Situation of the urban investigation area

The area of this region is 128.88 km^2, including 130 charging stations. The density is 1.0087 $unit/km^2$. The yellow box in the picture refers to the large business centers and shopping malls. The blue box indicates the living areas and compounds. The purple box refers to the office buildings and companies. And the red dots are public charging stations.

The situation of the second region is shown in the following picture:

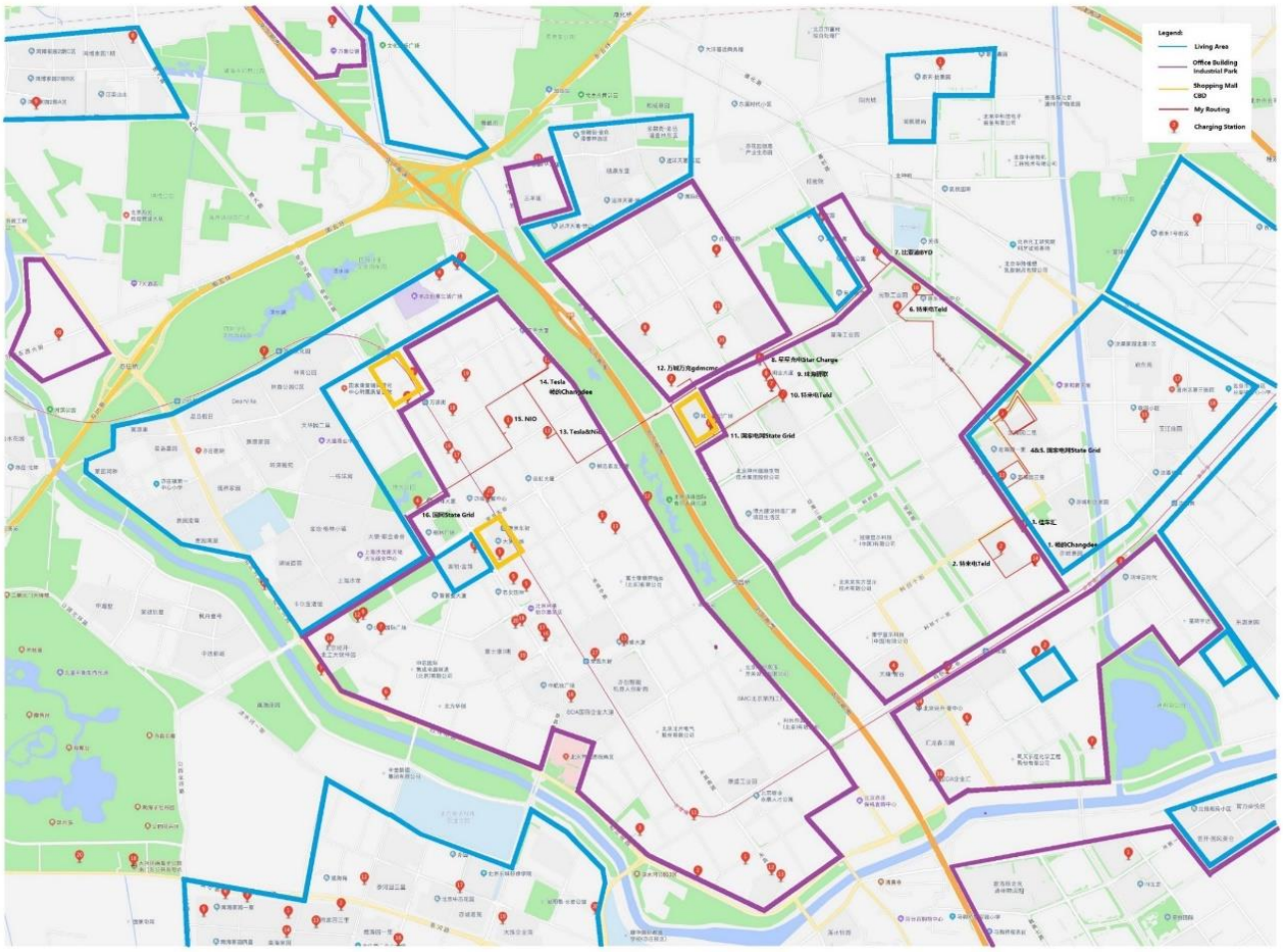

Fig. 3.3 Situation of the suburban investigation area

The area of this region is 89.63 km^2, including 97 charging stations. The density is 1.082 $unit/km^2$, which is very close to the urban area. The yellow box in the picture refers to the CBDs. The blue box indicates the compounds and apartment buildings. The purple box refers to the industrial parks. And the red dots are public charging stations.

And the second step is to focus on those typical stations, spend several hours or even a whole day observing them, analyze the site selection characteristics; record the number and frequency of the costumers, find out the peak time; interview the operating and maintaining staffs (if existing) about the operating situation and

strategies; pay attention to the car type and brand using the public charging stations, and the customer characteristics. And I take a lot of photos as a record for further analysis.

3.2.2 Customers investigation:

I'm also interviewing lots of customers when doing the station investigations, get a better understanding of each user groups, record the problems they meet when using public charging and their expectations. And I mainly focus on: the job/identity of the customer, whether he has the home charging wall box, how do they find this station, the standard of choosing a station, how about his usage experience and satisfaction, their biggest concern, charging frequency, whether has a fixed station to use or a recommended station, the major problems of the public charging, will the branded exclusive charging be a influence factor when selecting the BEV brand, does he wish to have branded exclusive public charging stations, do they have confidence to the intercity long-range trip.

3.3 Investigation Results

3.3.1 Types of the public charging stations and pillars

From the perspective of usage range, there are mainly two types of public charging stations: for everyone, or dedicated to certain people. Different from the branded exclusive stations, the dedicated public charging stations are usually those built in the industrial parks or in the company parking lots, serve only staffs working here. But all the stations usually been shown on the charging Apps, without been differed. This will

lead to a problem which is quite common now, customers go to a public station following the guidance of the Apps, find that they cannot use the station. This will cause the anxious emotion of the customers, especially when the SOC of their car is very low.

From the perspective of charging current, the charging pillars are mainly in two types: DC pillar and AC pillar. The DC pillar is the most used public charging pillar now. The charging power of the DC pillar is usually 60kW and 120kW. Newly built DC pillars now are all 120kW. And there are still some old 30kW DC pillars existing. The AC pillar is similar to the home charging wall box, using 220V or 380V AC power and the AC standard connector. The charging power is usually 7kW or 22kW. Nowadays these types are usually used for the destination charging scenario. Almost no customers are still using the public AC pillar now, for its extremely long charging time. But in China, about 60% of the public charging pillars are AC pillars. These pillars have usually been built for several years due to the low cost and easy installation process. CPOs built a large number of AC pillars at those years, just for the subsidies from the government. This leads to another problem that, seems there are a large number of public charging pillars for BEV customers to use, but a lot of them cannot provide an eligible charging experience.

From the structure point of view, the charging pillar (aiming at DC pillar here) have usually two types: integrated pillar, and separate pillar. The integrated type contains all the power electronic components and the radiators inside the signal pillar, has a large standing box shape. Due to the radiators, this type of pillar is usually very noisy, but

can be designed into one pillar with 2 charging guns. And usually this type can support a higher charging power. The separate type leaves all the components in the power distributing carbonate. So, this type of pillar is usually thin and small, needs less place for installation, and with a larger degree of design freedom. Now most OEMs like tesla and NIO are all choose to use the separate type, for their unique branded design.

3.3.2 Charging fee

Till now there is no standards for charging fee collection. But nearly all CPOs take the same charging model: electricity fee + service fee. The electricity fee has 2 types according to the National Energy Administration, the fixed price, and the wave price. Some CPOs set a fixed price for the electricity fee, usually from 0.8 RMB to 1.2 RMB per hour. (RMB is the monetary unit of China, 1euro≈7.2RMB) Some follows the national energy administration's wave fee standard, 1RMB at busy day time, 0.8RMB at normal day time, and 0.4 RMB at night (maybe slightly different from city to city). The service fee depends on each CPO. And this is nearly the only part that can generate profit for a CPO. To gain more users, some CPOs set this part for free. And there are also companies like Tesla, charge a high service fee for over 1.5RMB/h, for a better service or usage experience.

Another uncertain part of the fee is the parking fee. This part is determined and collected by the parking lot management side, and is very different from place to place, some are free while some are expensive.

3.3.3 The types and characteristics of the customers

The users of the public charging stations in city are mainly these types:

1. Taxi/Ride-hailing car driver.

This is the largest user group of the public charging market, with largest charging demand. In Beijing, a ride-hailing car driver charges 2000kWh per month in average. They usually charge twice a day, stay in car waiting, and leave immediately when charged around 90%. Their BEVs are usually cheap volume brands like BAIC or BYD, belonging to the taxi companies. Usually they don't have fixed charging place. They search for the charging stations on their Apps and choose the nearest one. But if a public charging station is outstanding enough, they will keep in mind and are more willing to go there. From them I collect several outstanding public charging stations and make investigations there.

Their requirements to a public charging station are very basic: charging power, price, and no ICE car occupying the slot. I think they are representing the most basic requirement of BEV drivers to a public charging station, especially the volume brand BEV drivers. They don't care much about the charging experience, only care about whether they can successfully charge their car. The charging power determines the time they need to spend and wait. Whether a slot is occupied by ICE car directly determines whether they are able to charge.

Asking about the satisfaction of the public charging now, their common reply is: barely acceptable. Without concerning much about the environment or service, usually they are able to find a useable charging pillar after trying 2 to 3 times. This result is

acceptable to them.

2. Office workers.

This customer group usually charge at the station near or inside their office building or industrial park. They drive mainly for commuting. So they charge in low frequency, usually once a week. They park and charge their car for the whole day during working. They have fixed charging place, and are less caring about the charging power, since they park their car there for a long time and not in hurry. They usually don't sensitive to the price, and even willing to pay a higher price for station with better environment and service. Their BEVs are usually more expensive than the previous group, like BYD Han and GAC AION. Actually if the industrial park or the office building has a branded charging station, that brand will be the common choice for the workers there.

3. Customers without home charging wall box.

At the public charging stations near the living area, at nighttime, a large number of BEV owners without wall box can be found here. Usually if inside a living area it's not allowed to install home charging facility, all the BEV owners living here need to go to the public charging stations nearby. Like the office workers, they charge in low frequency, usually once a week, and not very sensitive to price. They care about the charging power. And also desire a better charging environment and better service.

4. Female drivers.

In the traditional car market in China, there are only about 25% female drivers, while this figure increase to 42.7% in the BEV market in 2020. Female has a higher acceptance to the BEV. This customer group is very large and increasing quickly, but

quite easy to be ignore on the charging topic. According to my investigation, they have their specific difficulties. For example, the public DC charging gun is very heavy due to the long and thick copper cable. Even for a male driver, it's difficult to plug in and unplug the charging gun. For most female drivers, the charging experience is very unpleasant. Also, female drivers usually care more about the environment and service of a charging station than male drivers. A BEV brand like Tesla and NIO, will get more favor from female drivers if it can provide a better premium charging experience.

3.3.4 Charging successful rate study

According to the investigations of the stations and the interviews of the users, I roughly get the successful rate of public charging, which is about 30%.

To get this data, during the investigation I record the number of the pillars which are unable to work in each station. This number is 32%. Meanwhile, I ask users that, usually how many pillars they have to try until they find one that could successfully charge their cars. The average number is 1.4. This means that, roughly over half of the public charging pillars in Beijing are unable to use for all kinds of reasons not limited to damaged and not functioning, but also including: occupied by other cars, internet problems, difficult to be found, too low charging power, etc..

3.3.5 Pros and cons of the public charging stations now

There are some pros of the public charging stations now, like large in number, widely distributed at most tier1 cities, and can meet the basic charging needs of customers.

But there are more cons, and some are largely affecting customers' using experience:

1. As mentioned in the previous part, the dedicated public charging stations are mixed with other public charging stations on all the charging Apps, with no specific sign for distinction. This will mislead the customers.

2. Most stations are difficult to be found:

A lot of stations have to be built at the deepest place of a parking lot, and cannot set signage and clear logo board on the entrance. Most navigation Apps are usually not accurate enough and may misguide customers. So a common phenomenon now is that, customers are difficult to find the charging station and need to spend a lot of time looking for it.

3. Charging power not high enough:

Over a half of the charging pillars are AC pillars or low power (<60kW) DC pillars, which cannot provide customer a good charging experience. The usage rate is very low. And the highest charging power of the public charging pillars is 120kW, which is not high enough. Lots of BEV brands have already support higher charging power, and the public charging cannot make a use of this advantage.

4. Too many Apps and too complex operating process:

Each CPO has their own App. To use their charging pillar, usually the customers need to download corresponding Apps at first, and need to finish a series of complex process like register, login, pay the deposit, charge their accounts, link the payment App… and finally they could start using the pillar. To start charging, still a long process needs to be finished like scan the QR code. All those processes need internet

connecting, while some charging stations are at the underground parking lots and the signal is weak. Customers might need to try several times and still failed to charge.

Fig. 3.4 Common Apps and the charging process

5. Unstable:

The charging could be interrupted or even terminated due to a lot of reasons like internet fluctuations, while still billing.

6. No standards for charging fee collection (electricity fee, service fee, parking fee). The fee could be very different from station to station.

7. Existing a lot of broken pillars that are not working or stop services.

Fig. 3.5 Disabled charging pillars

8. Most public charging stations have no maintaining and operating staff. The environment of some stations is unpleasant. The facilities lack maintaining. And lots of the problems listed here are due to this reason.

Fig. 3.6 Environment of some charging stations

9. The charging guns are too heavy:

The weights are mainly come from the wire. The wire of most public charging pillars are extremely long(>4m) to fit different types of BEV (like some electric trucks). And due to the National Standards, the highest charging voltage has been limited. So most CPOs take the large current method for a higher charging power. And for heat dissipation, the wires are very think. These two reasons make the charging guns too heavy to be operated (especially for female drivers).

The long wires are easy to get tangled together, and also easy to be crushed by the car wheels, which leads to the safety risks.

Fig. 3.7 Too long cable and the relevant problems

10. Charging slot been occupied:

It’s very common that the charging slots are occupied by the ICE cars which just parking there, or fully charged BEVs but not leaving. Customers come to a station which are empty on the App, but find out that all the slots are being occupied. A lot of BEV drivers say that they are only willing to go to stations with over 6 empty slots, which could barely guarantee at least one usable slot according to their experience.

Fig. 3.8 Charging slots been occupied

11. Lack functions:

Most public charging stations can only provide basic charging function. Customers cannot get plug and charge (in the following referred as PnC) function and reverse function. Even charging pillar state check and remote-control functions are lacking. For high power charging (in the following referred as HPC) function, the highest charging power now for public charging stations is 120kW, and only about 1/4 can realize this power. Not to speak of 180kW or higher power.

12. Distribute unevenly.

Now the public charging resource is distributing very unevenly. Over 40% public charging stations are centralized in the top 4 cities, some of which are in low usage rate while some need to queue up for use. Meanwhile, at most other cities there are only one or even don't have charging station. And on the highway the situation is even more serious. Lots of highways have no charging stations. BEV customers can never choose these highways as their route. On other highways with charging stations, at the normal time nearly no customers using them, but the situation is totally opposite on holidays. For example, at this National Day, the public charging stations on the highway are extremely crowded. People need to wait in line for over 5 hours to charge their car. And since so many cars are charging at the same time, the charging power of each pillar is distributed to a very low level, which made the situation worse.

3.3.6 Some more supporting examples and cases.

I collect some more reports and news during my investigation.

According to the EVCIPA report at Sep. 2021, although the car/pillar ratio is 3:1 now, the average usage rate of the public charging stations is less than 10%.

And even in Beijing, according to the news at Nov. 2021, near the living compounds, there are always people queuing at the charging stations the whole day and night. Similar news can be more commonly seen with the increase of the BEV sales volume.

Fig. 3.9 News about the difficulty of BEV charging

3.4 Conclusions

To sum up, although the public charging pillars are in large number, but still have a lot of problems and could greatly affect the using experience of BEV customers. The public charging now is neither convenient nor premium. The range anxiety is commonly existing and cannot be relieved by the public charging stations now.

Meanwhile, in the early buyer study there is another investigation asking our BEV customers “whether a premium branded exclusive public charging is attractive”, and “are they willing to pay for such a premium charging service”. The result is that, over 80% of our BEV customers want to have a premium charging and about 72% are willing to pay for it. Considering the situation of the public charging now, it’s easy to understand why the branded exclusive station is strongly desired by customers.

Under this situation, developing our branded exclusive public charging stations and

providing our BEV customers with premium charging experience is meaningful and necessary. And this is what most of our competitors are doing.

Chapter 4

Main competitors' strategies on public charging

In the previous chapter, I also made investigations about the branded exclusive public charging stations of all the main players in the BEV market. So in this chapter I'm going to talk about what our competitors like Tesla and NIO have done and planning to do, and their achievement on both market performance and customers' satisfaction.

Comparing to the public charging stations, the total number of the OEM branded stations is very small, but the effect is quite significant. Till now only Tesla, NIO, and Xpeng have already built a relatively large number of stations and formed a charging network. Most BEV companies are at the starting stage.

3.1 Tesla

Tesla is one of the earliest OEMs planning their exclusive public charging networks in China and in the world, and the most successful one. From the sales volume we can see that, although Tesla's self-positioning is a premium BEV brand, the most sold car types are Model 3 and Model Y (over 99%). According to the market analyze report from Landroads Consulting [9], the average selling price of Tesla in 2021 is only 285,000RMB, and is keeping decreasing. The price of the Model 3 is similar to BYD Han and Xpeng P7. So, from the customer's point of view, why Tesla can maintain its premium brand posture under this average price? In addition to the brand image

establishing through its high-end car types like the Roadster and Model S/X in the early days, the branded exclusive charging network is also a key point, and is one of the most important reasons customers choosing Tesla, according to the investigation. A lot of customers said that they didn't even think about other BEV brands when buying the car, just because there are Tesla supercharging stations near the living or working place. From the sales volume we can notice that, Tesla are most sold in Shanghai (23.7%), Guangdong (18.5%), Zhejiang (12.4%) and Beijing (10.2%), while those provinces have the most Tesla supercharging stations.

The public charging network of Tesla including two types of stations: the supercharging station and the destination charging station. Tesla has already built over 1000 supercharging stations with 8000 superchargers, and 700 destination stations up to Dec. 2021 in China.

The destination stations are mainly at the place that customers may park and stay for a long time, such as hotels, restaurants, and malls. Tesla takes them as the cooperators, builds AC charging pillars at their parking lots, attracting Tesla customers to park and charge there. The charging is for free. In this charging scenario, customers come to the destination stations mainly for parking their car for a relatively long time, and charging is a bonus. This is a faster and cost-saving way to extend their charging network.

Fig. 3.1 Tesla wall box

The supercharging stations are the main part of the network, and are built by Tesla themselves. Tesla has their production lines of the superchargers, holds the relative technology, and has the qualification of producing and operating charging pillars. Each supercharging station contains several V2 superchargers with the charging power up to 180kW. And the V3 supercharger has already been mass-produced in China in mid-2020, with the charging power up to 250kW, and will gradually replace the V2 superchargers. This is the highest charging power customers can normally find on the market now. To reach this high charging power without changing the voltage platform of the car, Tesla rise the charging current by using the water-cooling cable.

Fig. 3.2 Tesla supercharger

Comparing to the public charging stations, from the easy using point of view, Tesla supercharger support PnC and HPC. The operating process and payment process are much more convenient than the public charging stations. Customer just need to plug in the charging gun and wait for finishing charging, no need of scanning or extra Apps. And the higher charging power leads to a shorter charging time. Meanwhile, since the supercharger is designed dedicated to Tesla, the length of the wire is very short and fit the car very well. And the water-cooling cable makes the wire very thin. All these lead to a light charging gun and can be operated smoothly even by female drivers. Lots of female Tesla owners mentioned this point during the investigation.

From the exclusiveness and premiumness point of view, Tesla installs ground lock for each charging slot. Other BEV or ICE cars cannot park on this slot. Usually there are maintaining staffs check and clean each supercharger regularly, to make sure all the pillars are clean and are working smoothly. And the exterior design of the supercharger is much too better than all the other public charging pillars, which could also give the users a premium feeling. In addition, the combining of the signage, supercharging stations and the offline sales store, could generate a great brand promotion effect. For example, at one of the largest malls in Beijing, Tesla rents the entire surface parking lot at the front door of this mall, and make it exclusive for Tesla to charge and park. All the other cars can only park at the underground parking lot. The Tesla offline store, the superchargers, and their cars charging here form a strong propaganda function, at the place with the largest flow of people. During my investigation, some BEV drivers even don’t know any other brands have their branded exclusive stations except for

Tesla.

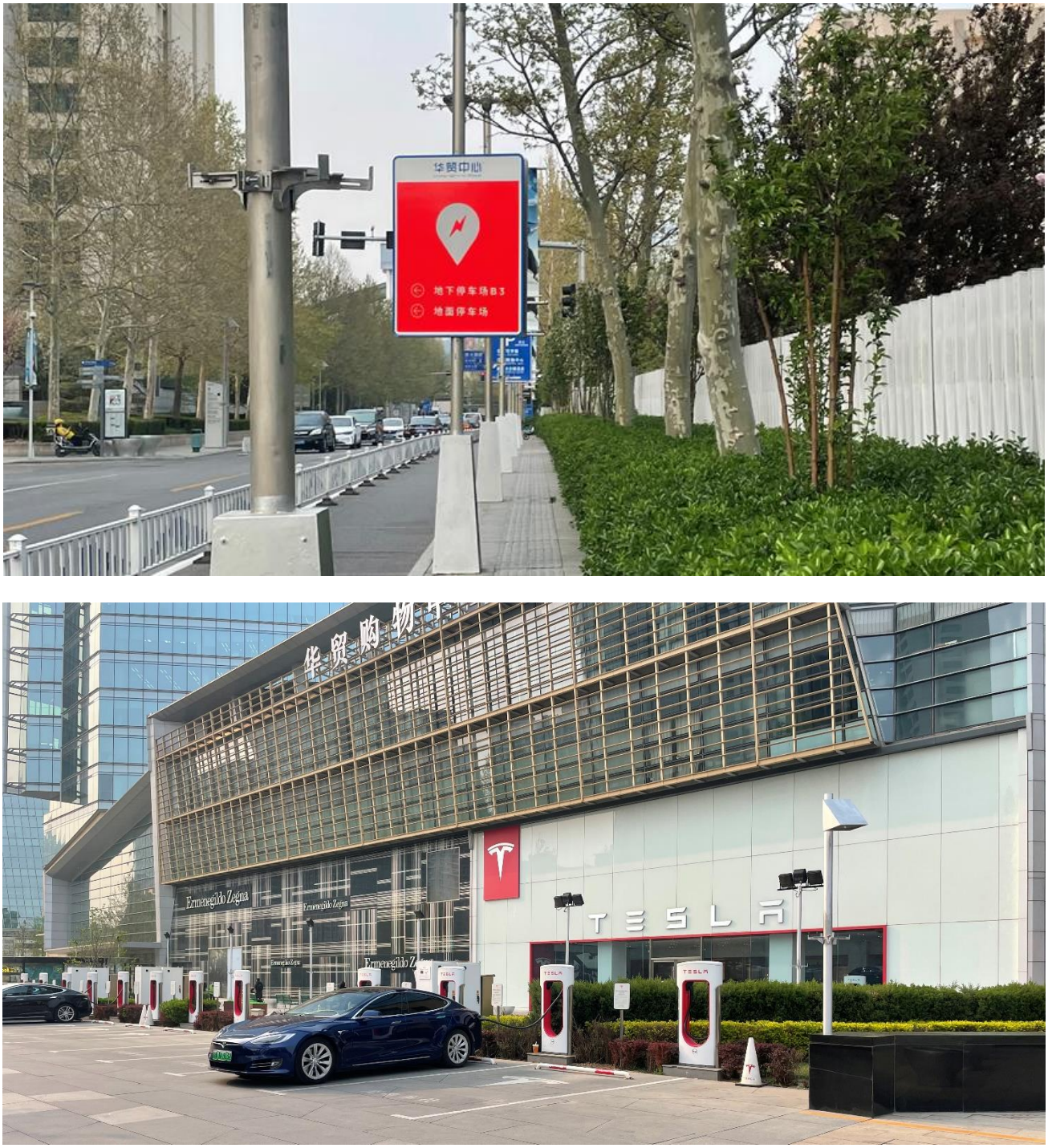

Fig. 3.3 Tesla charging exclusive station and off-line store

And the extra fee for not leaving immediately charging is another feature for Tesla stations. After finishing charging for 5 minutes, every extra minute's parking will cost 6.4RMB/min. Since the ground lock solves the problems of slots being occupied by

ICE cars, the extra fee can make sure that cars will leave after finish charging, so that each charging pillar can reach its maximum service capability at busy time.

From locating and navigating point of view, Tesla supercharging stations are covering nearly all the large malls, office buildings, living compounds and industrial parks in the cities like Beijing and Shanghai. Meanwhile, all the charging pillars support reservation function. Tesla owners can directly search the charging stations nearby, check the usage state of each slot, and reserve a charging pillar. The navigation is accurate. As mentioned before, tesla is willing to pay for setting clear road signage and guideposts to show the way to their customers. And usually, tesla station is at the best position of a parking lot, makes it easy to be found by users.

From the pricing point of view, Tesla supercharger is much more expensive than all the other public stations and branded OEM stations. The price is usually 2.08 RMB/kWh at daytime and 1.68 RMB/kWh at night. This price includes a large part of service fee, for operating and maintaining all those stations, and making this business profitable and sustainable. According to my investigation, customers buying a premium BEV are willing to pay a higher price for a more convenient and premium charging experience. And most Tesla drivers are quite proud of their exclusive charging network.

What's more, due to the power capacity and the parking space limiting, the deployment of the public charging stations is always a "first-come, first-served" matter. At a lot of malls and compounds, Tesla has already occupied all the resources early, which further cemented their leading position and became a barrier between them and

other BEV companies. For example, at the mall mentioned before, no other BEV companies can build charging stations or even park their cars on the surface parking lot.

For another BEV brand Xpeng, whose positioning their flagship P7 as the competitor of Model 3, they are fully following the same way in-city with Tesla, while planning their highway charging stations at the same time. Xpeng now has already formed quite large charging network and links most main cities by highway stations in the past 2021. And their sales volume also increases rapidly at the same time, even catch up with NIO.

3.2 NIO

NIO is trying a quite different way in China. They are not the first company choosing the battery-swap solution, but maybe the most successful one. And at the end of 2021, NIO has already brought their battery-swap station to the western world as a part of the NIO Power and Service, along with the sales of their cars. Different from other traditional companies, NIO has been always emphasizing the importance of service, aiming to provide their customers a worry-free service. And the NIO Power is the most important part of their service.

NIO Power is a whole power supplement solutions covering nearly all scenarios, including home charging wall box (AC and DC), branded exclusive public charging pillars, mobile charging van, and battery swapping stations.

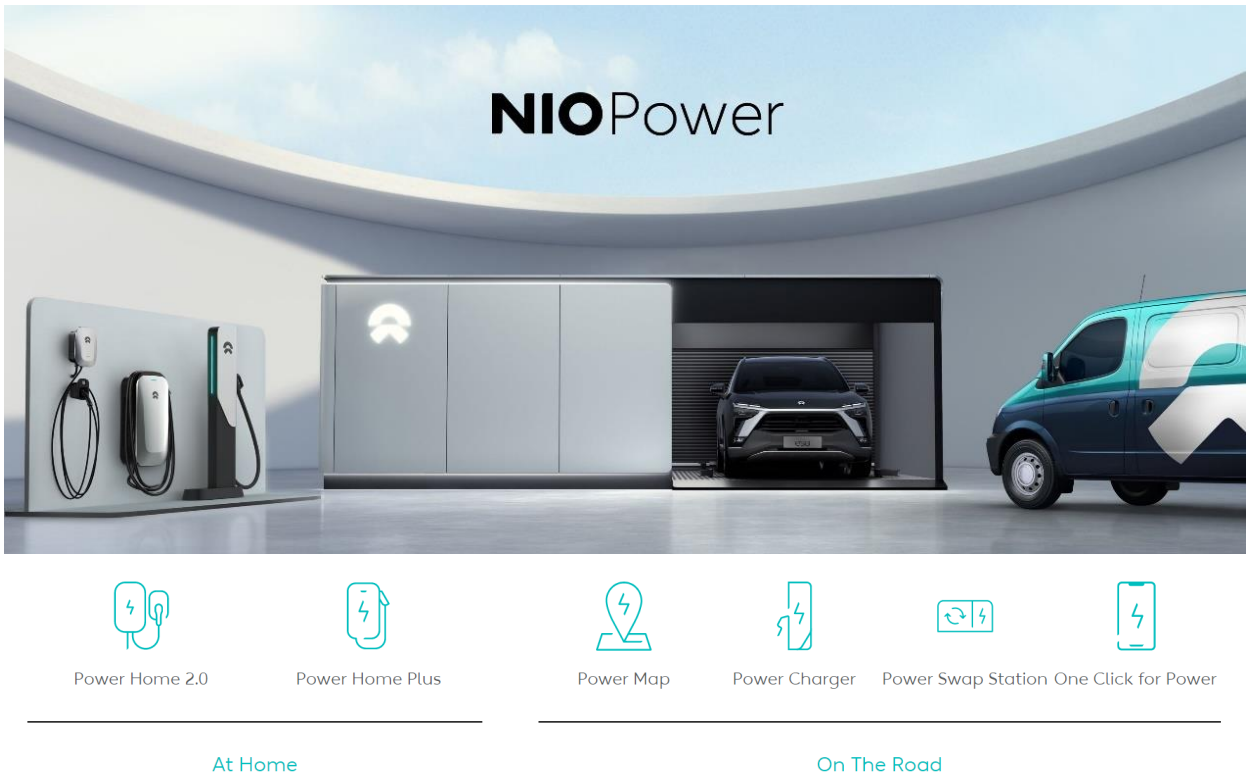

Fig. 3.4 NIO Power services

At the end of 2021, NIO has already built 778 battery-swap stations and 564 branded public charging stations (4582 pillars). And the number of the swap station will be 2000 at the end of 2022. Now the Gen2 swap station can autonomously swap a battery around 3 minutes, and stores 13 batteries inside. The usage experience is fast and relaxing. Customers can search on the car console, and following the navigation to the nearest swap station. Then they can wait in cars for the autonomous swapping process. After several minutes they can go with a fully charged battery. The service capability of a swap station is 312times/day. A swap station at a high-end compound in Beijing serves over 200 customers on average every day.

Fig. 3.5 NIO battery-swap station in a Sinopec petrol station

Now NIO is starting cooperating with Sinopec, building battery swap stations at their petrol stations, sharing the resource from the Sinopec network. In the near future, all NIO customers can have a smooth power supplement experience similar to the ICE cars even on the highway.

At Sep. 2021 they created a concept called “Power House”, which means the house within 3km of a swap station. They announced that, till 2025, over 90% of the house of their customers will become the Power Houses and customers could get the best charging experience. At that time this coverage is about 29%. To make up the disadvantage of the swap stations on the speed of constructing, NIO also has branded charging stations. And at some underground parking lots that cannot build swap stations, charging station is a good substitute. Comparing to Tesla, the 180kW charging power of NIO’s pillar is lower, while lacking reserving function and ground lock. But as an additional solution for the swap station, the decoration of the branded charging station can still give customers a premium feeling. By the way, the charging

stations are open to all the BEVs, except for the PnC and post-payment functions.

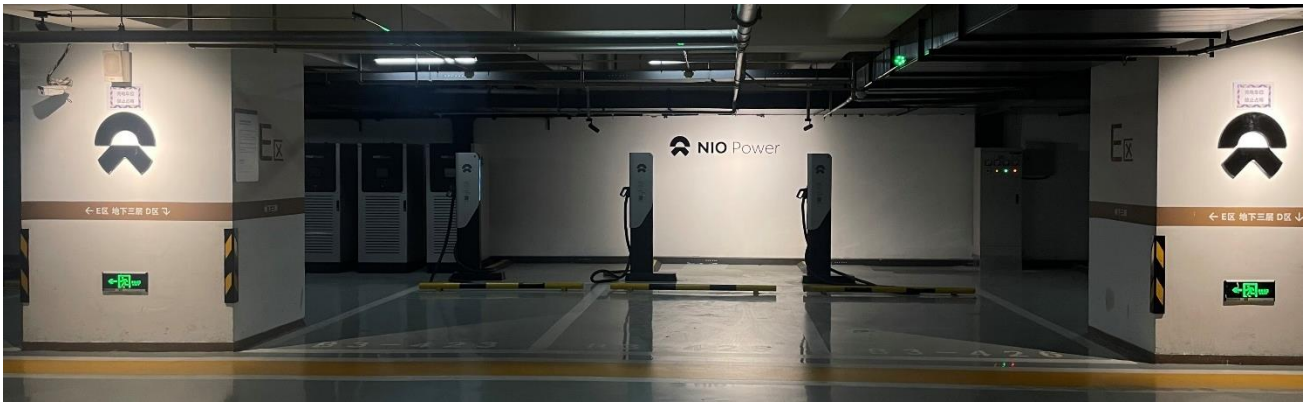

Fig. 3.6 NIO branded charging station

Meanwhile, the valet charging service and the mobile charging van nearly eliminate customers' range anxiety completely. This can provide customers an extremely premium feeling, especially the valet charging service. Customers only need to apply the service on the mobile App, reserve the time and place. The staff of NIO will help customer to charge the car, and send back after finishing charging. One of my interviewees told me that, he even never personally charged his car since the valet charging service can be used for free for 15 times/month.

From the software service perspective, as I mentioned before, customers are highly relying on the mobile apps to search for the charging stations. But most apps are inconvenient to use. Some apps from CPOs only include information of their own pillars, some cannot check the states of the pillars, some cannot provide accurate navigation. So NIO developed an app for public charging, contains information of nearly all the CPO and OEM stations tested by their staffs, and can select most suitable stations for customers, plan the route and provide accurate navigation. For convenient and reliable using experience, this app shares a good reputation among

most BEV customers, not limited to NIO customers. According to an investigation on the Chinese social media Weibo, over 70% of BEV owners think that the NIO charging app is the best app they have ever used. This charging app not only provide their customers a good service, but also could be a good brand propagandizing among all the BEV drivers.

NIO now has already build their brand image as a BEV company that cares most about the experience of their customers. As a new Chinese premium brand, the average selling price is around 450,000RMB, and the monthly sales volume is increasing steadily to more than 10,000 at the end of 2021. Similar to Tesla, the battery swap station has also already become a moat for NIO on nowadays BEV market.

3.3 Geely Zeekr / GAC AION

As the traditional Chinese OEMs, these two are starting to plan their own branded exclusive public charging stations, and use this to promote their new BEVs.

Zeekr is a new BEV sub-brand of Geely Group. Geely want to build Zeekr into a premium brand, and branded exclusive public charging stations are their steppingstone to the premium BEV market. Before Zeekr001 is delivered to the customer, Geely had already announced that they are planning their exclusive charging network, and launched the “Zeekr Power” brand at the end of August 2021, aiming at providing their customers the most premium charging experience. And according to their internal data, the order number of their first BEV rise from 600 at August, to 2448 at September. At the end of 2021, their 360kW supercharging stations have already

covered 14 main cities, serving their BEV owners for free.

Fig. 3.7 Zeekr Power fast charging station

On the other hand, the GAC AION launched their branded charging pillar at the same time. GAC is focusing on the high voltage platform and high-rate battery. The charging power of their new supercharging pillar can reach 480kW, which is the highest charging power now, and can realize 5 minutes charging for 200km driving. Although this supercharging pillar has not been mass-produced now, GAC still use this product to show their public charging plans to customers. The GAC AION used to be a volume brand with car price under 200,000RMB. They are planning to enter the premium market and to complete with companies like NIO and Xpeng. At this moment the launch of their world-fastest supercharger will surely be a boost for them to hit their target.

Fig. 3.8 World record for GAC AION A480 charging pillar

3.4 MB / BMW / Audi

As traditional premium ICE brands, the electrification transformation of Mercedes, BMW and Audi are not as smooth as their new competitors NIO and Tesla in China. From the customers point of view, it seems that they are still exploring a new way different from the past, and their headquarters in Germany are still trying to understand the Chinese market. They need to do more to convince customers of their determinations on electrification transformation.

On the public charging field, they are all planning their branded exclusive charging stations to fit their premium brand image. Mercedes and Audi are still at very early stage. Mercedes now has a few exclusive stations at some airports, and Audi are relying on the exclusive stations of VW. And they are still exploring their most

suitable way to promote the sales of their BEV.

BMW has been working on the “ChargeNow” program since 2020, cooperating with the State Grid and Tgood. They are planning to have over 0.3million charging pillars in China at the end of 2021, and has already built some exclusive stations at Tier 1 cities. For example, in Beijing, BMW built 6 exclusive stations, 2 at airports and 4 at malls. The charging pillars are from Tgood while the operating staffs are from Brilliance BMW. Although there are disadvantages of BMW exclusive stations like, they do not support functions like PnC, HPC, and the payment process is not convenient enough, but the sales volume of BMW’s BEV is much better than Mercedes and Audi.

Fig. 3.9 BMW branded exclusive charging station

3.5 Conclusion

In summary, nearly all the BEV brands, even those volume brands, are planning their

own public charging networks now, and each brand has their own focus and characteristics. For example, Tesla is now focusing on the coverage, NIO is spreading their battery swap stations, and AION is working on higher charging power. Most BEV brands are using their self-building exclusive public charging stations as an important propaganda point, and they do receive desired results. On the other hand, traditional premium brands like BMW are all thinking of an easier way to catch up with others at this period, like cooperating with other CPOs.

So, to catch up with the tier 1 BEV brands, it's necessary for us to plan our branded exclusive public charging network, especially when our BEV product is less competitive and have no advantages on the e-range.

Chapter 5

What should we do and how to catch up with our competitors

From the previous chapters we can get a conclusion that, it's necessary for a premium car brand to build its own charging network. So, we need to decide a strategy of building up our charging network.

5.1 The aim of the strategy

First we need to consider the focus of our public charging stations. The most essential reason is to propagandize our premium BEV brand image while promote the sales of our BEV. So, comparing to Tesla who mainly focus on the coverage and scale of the charging network, we are focusing mostly on the customer experience. And we could set the aim of our public charging service to provide our BEV customers an exclusive and premium public charging experience.

Then, to realize this goal, from the station point of view, a seamless simplicity of operating process and a well maintenance is necessary. We need to ensure the realization of some functions on our stations such as the interoperability, HPC, PnC, reservation and station state checking. And at the same time, from the constructing point of view, we need to shorten the time of building each station while save cost. A large investment will be unacceptable for our headquarters, and will make this strategy

hard to be implemented.

5.2 Difference between public and home charging industry

The next step is to think about how to enter this industry. From my point of view, public charging is completely different from the home charging. On the product side, home charging only contains a single product, which is the wall box. It's easy to mass produce, while the cost and the technical difficulty are relatively low. Due to the low charging power, the potential safety hazard is also small. Now the wall box is generally included with the BEV as an accessory and a supporting facility to the vehicle. But the public charging product contains at least the charging pillars which is harder to produce, the power distributing box, and a large public area for parking. On the service side, the company does not need to consider the installation location and feasibility of the wall box, nor need to communicate with the relevant government departments to obtain producing and operating approval. The installation of home charging wall box is simple and also generally done by the outsourcing. There are no extra maintaining and operating costs for the BEV companies. Remote monitoring and control functions are usually integrated into the Apps. In summary, home charging can be considered as a product steering by a department of the company, the industrial chain is very simple, while the public charging is much more complex. It is more like an independent industry. And we can analyze the industrial chain, see how our competitors are doing and how much do they spend, and decide from which part we can enter this industry that can mostly fit our needs.

The main entities involved in the industrial chain of the public charging include equipment manufacturers, CPOs, BEV OEMs and customers. The equipment manufacturers are the upstream vendor, producing the charging and distribution equipment like the charging modules, monitoring modules, connectors, and transformers. Those CPOs are the midstream companies responsible for the construction and operation of charging pillars and stations. Since the construction and operation have high requirements on financial strength, site selection, and operation management, this is the core link of the industrial chain and requires large professional operators. Now the main 5 CPOs have already taken over 80% of the market share as I mentioned before, and forms the main part of the public charging network. And the downstream is the customers, brings a lot of demand to the public charging market.

5.3 How to enter public charging industry

To enter this industry, the general approach is to be a midstream CPO, or be a customer of a CPO. The former means that, we need to produce charging pillars and build stations by our own, while operate all those facilities. And the latter means that all those works are done by our party B CPO. We only need to make our request, and pay to them. They will provide service exclusively to our BEV customers.

Both methods have advantages and disadvantages:

Become a CPO means we have the full initiative and design freedom on our charging stations. We can guarantee the consistency of service across all our charging stations, the best compatibility with our BEVs, and the highest charging power. But all these

need a large investment of money and time. What's more, be a CPO requires the qualifications from a lot of government departments. For example, the using of electricity needs the qualification from the Electric Power Bureau or the State Grid, the land for parking in the station needs to be approved by the National Development and Reform Commission or the Housing and Urban-Rural Development Bureau. Obtaining these qualifications will take a long time.

Meanwhile, become a customer of a CPO means we can get a large number of charging stations online rapidly, with a relatively small cost. And another key advantage is that we can decide the right time to exit the charging market (this I will talk in detail later). But the price is that, we will meet a lot of limitations. A lot of services and functions like the PnC and the reservation maybe not suit very well.

Here we can first check the choice and cost of our competitors. The following figure lists the choices of our competitors, the role they play, and their investment on China market.

				
Billions of RMB	**Billions of RMB**	**200+ Millions RMB**	**100+ Millions RMB**	**100+ Millions RMB**
Role: Big CPO - self-developed pillar up to 350kW - branded design - self-operating	Role: Big CPO - self-developed pillar - self-developed Battery-swap station - branded design - self-operating	Role: Small CPO - self-developed 800V charging pillar - branded design - self-operating	Role: Customer - branded design	Role: Customer - branded design

Fig. 5.1 Situation of the main premium brands

To decide our way, we can rethink about our requirements. We emphasize the speed of the station on-line, and want to save cost. The stations and the pillars must be the

branded design and be branded exclusive. In addition, the functions like PnC, HPC and reservation are also needed. Considering the most disadvantages of being a CPO is the cost and the time, I think become a customer of a CPO is the most suitable way for us. And also based on another consideration that, as a customer of other CPOs, it's very easy for us to decide when to end this business or cancel some of the stations without any extra cost, and our strategy can be more flexible.

5.4 Set detailed requirements for our strategy

After decided the way we enter this industry, the next step is to think about the specific requirements of our public charging strategy, including the constructing, operating maintaining of the stations, the technical and functional requirements, the online and offline services, and the data collection. This will also become the duty of the CPO company we cooperate with.

1. Branded appearance design.

An impressive and unforgettable look of our branded station and charging pillar is very important. Beautiful design will directly affect the effectiveness of brand promotion. Our R&D department should design a station and pillar appearance that matches our brand at the beginning, and the CPO should do the station construction and decoration strictly following our design, including the color, material, light, and positions of the element, to guarantee the final visual effect and the premiumness, and to ensure the consistency. For example, the following picture shows the render graph and the final look of the tesla supercharging station.

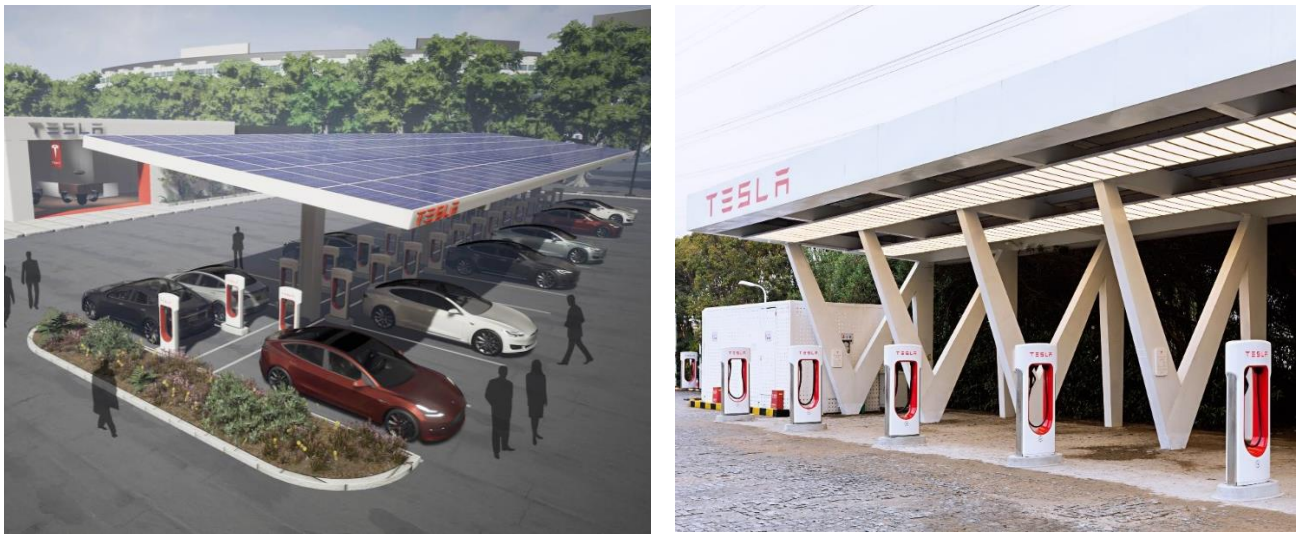

Fig. 5.2 Render graph and the photo Tesla station

2. Detailed configuration and functions of each station

We need to decide the configuration of each station with our CPO company, like the type of the charging pillar, the charging power, the number of the pillars and the parking slots in a station. The functions include not only the basic charging function, PnC, high charging voltage, ground lock, etc., but also the digital functions like the remote monitoring and control, reservation, charging map and navigation, and comment function. The digital functions should be provided by the CPO, and be integrated into our App. All those functions should work properly with all types of our BEV in any case, without any interoperability issue. And all the stations and pillars should support upgrade function in case higher charging power needed or new functions required in the future.

3. Requirements on service

To guarantee the exclusiveness of our branded charging stations, all the services should only serve our BEV customers. The CPO of our station needs to provide customer care and support service including Q&A and problems solving. Wherever

possible, set up rest area and provide basic service like water and food.

4. Requirements on operating and maintaining

All the operating and maintaining works should be done properly by the CPO at all our stations, including cleaning, safety check, guarantee the function of the pillars, etc.. If any problems happened, especially safety problems, the CPO should be liable and afford all the damages caused. Meanwhile, the CPO should support any kinds of promotional activities triggered by us.

5. Requirements on flexibility and expansibility

All the charging stations should be able to have a certain flexibility like adding or cancelling branded charging pillars in a station according to the operating situation. For the stations that need more capacity, the CPO should be able to add more charging pillars and slots, vice versa. And also for some hardware and configurations of the charging pillar should be able to change or upgrade. For example the charging power should be able to be increased in the future by upgrading the power distributing unit or the power unit in the pillar to support higher charging power.

In fact, most CPOs have the technology of realizing the HPC technology on the pillar side. But still most public charging stations on the market now only support up to 120kW charging power. This is caused by several reasons. On one hand, most BEV on the market now cannot support HPC on the car side. Since CPOs are serving all the BEV customers, they don’t need to realize HPC on all the stations. They only need to fulfill the basic charging needs of most customers. And on the other hand, CPOs need to make profit from charging service. The facility upgrading costs a lot of money,

especially when they have already had a large number of stations. It's impossible for them to make a quick technological upgrade for their charging stations. But for us, our BEV as a premium brand, should at least support HPC on the car side. And on the pillar side, our stations are aiming at providing our customers the best charging experience. We don't want to make profit from the stations. If a higher charging power is benefit to our premium brand image and can help to increase the sales volume, the technological upgrade is worthy. So, at that time, we could ask our CPO to upgrade all the branded exclusive stations for us. And due to the higher charging power, the service capacity of our stations also increases, which means less stations are needed. A smaller number of stations also make our facility upgrading easier to be implemented.

6. Fee collection

As a premium charging service, one most basic requirement is free of charge. All our BEV customers should enjoy a free charging experience. The generated electricity fee, service fee, and parking fee if exist, should be borne by CPO and us together.

7. Requirements on data collecting and security

The CPO should provide customer data generated during the station operating period including register data, identity data, usage data, etc., and help to analyze data for improving and optimizing service. All those data should belong to us, and should not be exposed to others for protecting the privacy of our customers. What's more, the CPO should regularly report to us about the operating situation of all the branded stations, adjust operating strategies according to our requirement and advice.

5.5 The future of this public charging strategy

As I mentioned before, one of the advantages of being a customer of a CPO is that we can flexibly choose the time to adjust our public charging strategy. The strategy now may no longer be suitable in the future. This is because that, I think in the near future, which could be year 2025, the public charging resource will no longer be a problem since this had already become an infrastructure construction target of the Chinese government. Meanwhile, with the development of the battery technology and higher voltage platform, the E-range will be greatly extended while the charging time shortened exponentially. These trends will mostly relieve the range anxiety of our BEV customers.

So, I think at that time, the significance of the large branded public charging network will mostly reduce and have a very limited effect on sales volume. For daily in-city charging, the public charging infrastructure will be sufficient and convenient enough. The branded charging strategy now is aiming to win a good start for us, catch up with our competitors, and gain a larger market share. In the future we can focus on the advanced HPC technology, integrate our charging resource, and build more centralized in-city charging hub to provide our customers different charging experience from the other public stations. At the same time, we can consider the highway HPC exclusive stations to explore our service scenario. And the aim of our branded stations at that time will no longer be the fulfilling the charging needs of our customers, but showing the technological leadership of charging while provide best charging experience.

Then we can consider some details during the implementation of this strategy.

Chapter 6

Key factors in the implementation

In this chapter I'm going to talk about two critical factors during the implementation phase, which are the location selecting and the calculation of the needed charging gun number.

6.1 Location selecting

The location selecting has always been one of the most critical factors that affect the usage rate and the publicity effect of public charging stations. And the good location is also a kind of very limited, first-come, first-served resource. Although the CPO has the obligation to provide us with site selection criteria and the suggested locations, we can also consider from the following aspects at the same time:

1. Transfer existing CPO's stations

At the beginning, when we have less experience on site selecting, we can require the CPO to allow us to convert their existing public charging stations into our branded exclusive charging stations. We can choose their well-operated and highly utilized stations, and directly decorate them into our style, and operate them as we asked. And we pay them the equivalent money to make up for their losses. The most advantages of this solution are the speed of construction, and the eliminating of the location selecting process. All the power and electric facilities are already there, and we only need to do

the decoration. The branded station could be online in a few weeks. And the high usage rates of the past have proven the correctness of the site selection. The only disadvantage of this solution is the cost. We might need to pay a higher operating price to the CPO comparing to the newly built branded stations.

2. Build stations at our dealerships

One of our strengths comparing to our new competitors like Tesla and NIO is the quantity of our dealerships. As a traditional car company, we have already had a large number of dealerships in nearly all the Chinese cities. They sale cars for us, and provide services to our customers. Usually there are lots of our cars parking there for show and for test drive. Build charging stations at our dealerships can produce a good publicity effect of our BEV. Customers can directly experience out premium charging service here before purchasing, and charge here in daily use. The advantages of this solution are that, we don’t need to worry about the parking area, no land application process, no power capacity problem, and can branding our BEVs. But the disadvantage is that, the location of the dealership may be not suitable enough for a public charging station. This solution may be more suitable for small cities in China.

3. Select location according to the heatmap

In those large tier 1 cities, we can select locations according to the heatmap of the city at the beginning. For example, the following figure is the heatmap of Beijing. This can help us to figure out the region with highest density of passenger flow. Combined with our previous analysis, we can easily decide the shopping malls, the office building, and the compounds that suitable for our public charging stations.

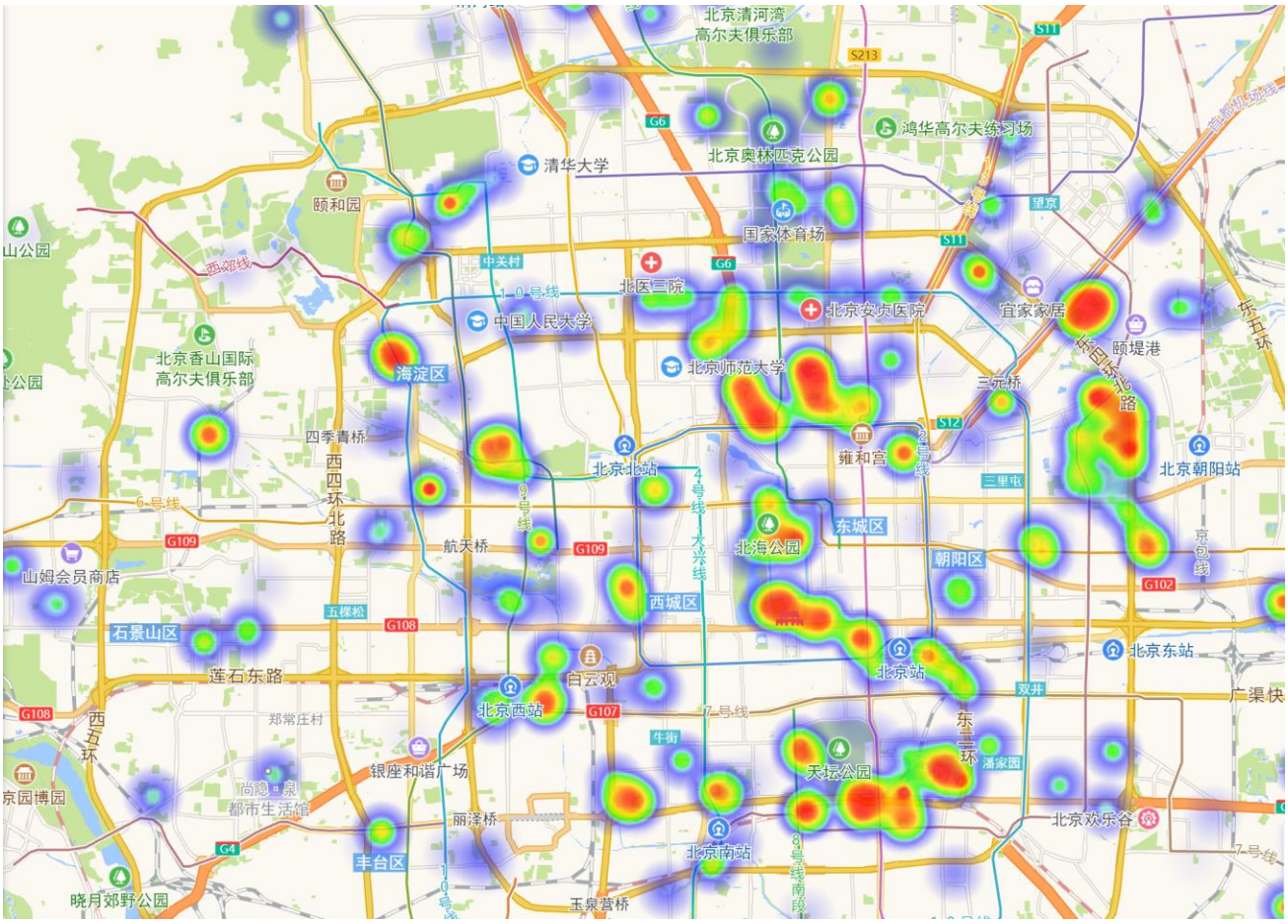

Fig. 6.1 Heatmap of Beijing

This method is suitable for selecting locations at the early stage when we enter a new city, which could mostly guarantee the customer flow. On the other hand, in the long term we could use the heatmap in the opposite way, by selecting area with less customer density. We can identify areas with potential for development, and build our branded exclusive charging stations there. Since the land is far cheaper than the hot area, our station could take more floor space and be more premium. For example, it could be a charging hub including more supporting facilities like the restaurant, the lounge, and more charging slots equipped with the high-power supercharger. This could attract more people coming and charging here. And the waiting people might create a new heat point attracting more business. What's more, we can cooperate with

the local government, build this kind of high-end charging hub at their planned development zone, for a win-win situation. The government provides us with cheap construction land and policy convenience, and we help them increase exposure while attract more business.

6.2 Calculation of the needed charging gun number

To find out the number of the charging stations needed in a city, I think we can use the following estimation method.

The first step is to get the total power demand in a city. We need to have the car parc of our BEVs in this city, and also an estimation of the sales volume in the future. Meanwhile, we also need to know the average battery capacity and the charging frequency of our customers. For the charging frequency, usually we can get this number from our marketing department. After this, we can calculate the electricity needed in a city of our BEV customers.

The second step is to get the power demand of our branded stations. We need to find out the percentage of using the home charging and the 3rd party CPO stations. Since the home charging installation ratio in China is about 50%, I will take 50% as the ratio of the customers using the home charging. In the remaining 50% that using the public charging, to find out the percentage of customers using the branded stations, we can do the customer investigations. Here for doing the calculation, we can estimate that, about half of them are using the 3rd party CPO stations. So, the electricity demand of our branded stations is the one fourth of the total demand.

The final step is to get the needed number of our branded stations. We can get the average charging gun power of each station from our party B CPO. Here I will take an average number of the charging pillars on the market now, which is 100kW. The last data we need is the utilization rate of our branded stations. Here I will also take an estimation data according to the EVCIPA, which said the average usage rate of the public charging pillar is 5% in China now. The average daily using time of a pillar is about 1.2 hours.

Now we can calculate the needed number of the branded charging stations in a city. Here I use the data of Tesla to do a verification of this calculation method. The following figure shows the whole calculating process. Till the end of year 2021, the car parc of Tesla in China is 543k. For the power consumption, every 1kWh battery power can provide 5km of driving on average. And the average driving distance of Chinese people is about 28km/day. The average charging power of Tesla V2 supercharger is 100kW. The following figure shows the needed pillar numbers.

Calculation of the needed charging guns	
NEV Carparc	**543,000**
Home Charging ratio	0.5
Public Charging ratio-3rd party CPOs	0.25
Public Charging ratio-Branded Exclusive Station	**0.25**
Average driving distance (km/day)	**28**
Power consumption (km/kWh)	**5**

⇨

per day, customer charging in total	**760,200**
charging gun power (kW)	100
utilization rate (per day hours)	1.2
charging gun total 2025	**6335**

Fig. 6.2 Calculating process

From the figure we can see that, the needed charging gun number is 6335, which means that in this condition, to fulfill the public charging needs of their customers, Tesla should at least build this number of charging guns. The actual number of charging gun is 8000. The gap between these two figures may be due to the higher

percentage of customers using their branded stations (should be higher than 25%), and could also because Tesla is pursuing a smaller car/pillar ratio and higher service coverage (existing charging gun number / needed charging gun number).

For our branded stations, we don't need to plan such a great number of charging stations, since we are focusing on the premium service. We can make plan according to the demand.

6.3 Ramp up plan

During the construction phase, it's not possible to directly built thousands of stations at the same time at the beginning. I think we can make a ramp up plan for our strategy which is formed by 3 stages. I call the first stage the "pilot stage", the second stage the "catch-up stage", and the third stage the "maintaining stage".

During the first pilot stage, we can try a small number of stations at the main tier 1 cities like Beijing, Shanghai, Guangzhou, etc. At this stage we do not emphasize the quantity and the service capacity of our stations, but for trial operation and brand promotion. For example, we can transfer 5 well-operated CPO stations in top 5 cities into ours, try to operate them as we planned, and make sure there is no interoperability issue. This stage might take half a year.

During the second stage we can start to build stations according to the demand of each city. Since the car parc in each city is increasing time to time, we need to keep adjusting our plan in each city. For example, this stage will take 4 years, and maybe in the first 2 years we can expand our operating area from the 5 cities at the beginning to

20 main cities. Then in the last 2 years we expand our business nationwide. The following figure shows the relationship between the needed station number and the existing station number.

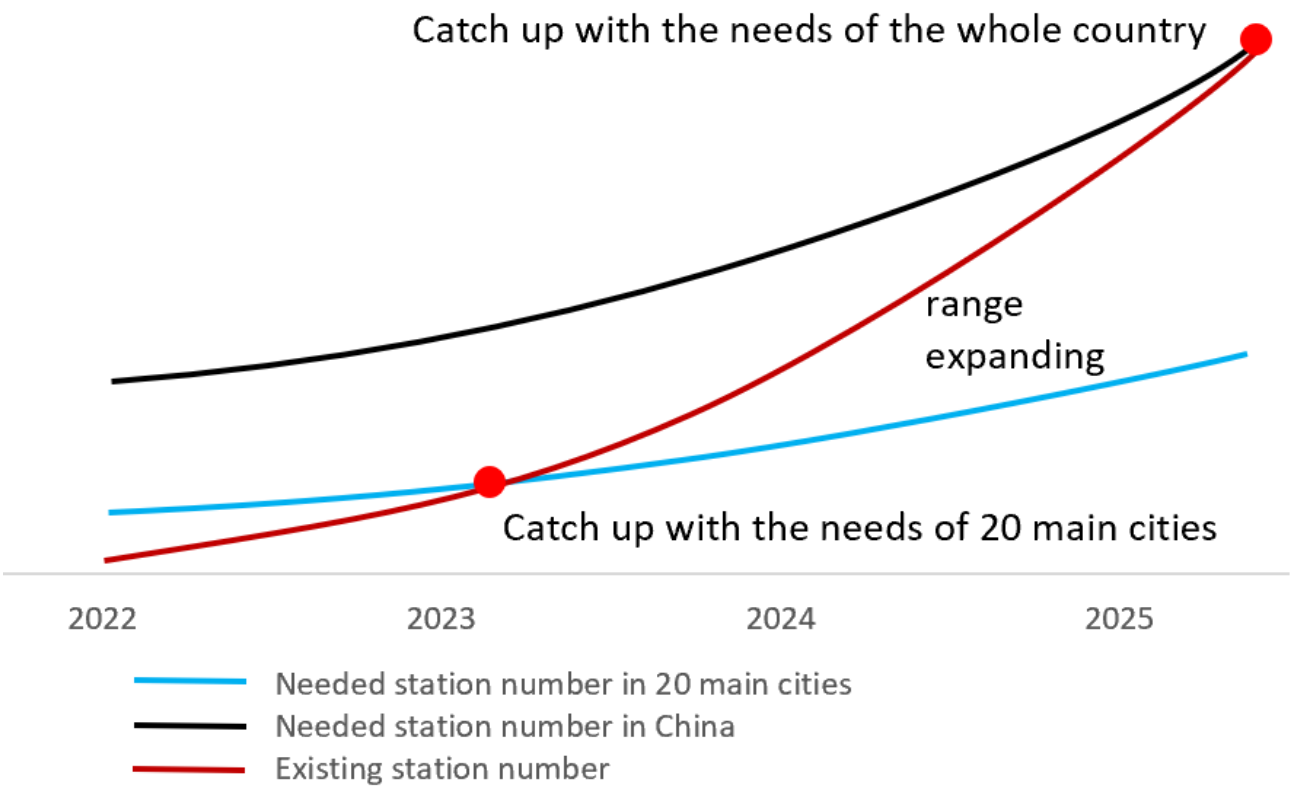

Fig. 6.3 The expanding of the business

Then in the last stage, we can analyze the situation at that time and decide to keep increasing the number of our stations, or just maintain the status quo if the public charging infrastructure is more perfect at that time. Or we can even cancel some of the old stations, and centralize our charging resource in each city, build more premium charging hub to only focus on premium service and advanced HPC technology, without worrying about fulfilling the daily charging needs of our customers. The strategy could be more flexible at that time.

Chapter 7

Conclusion and prospect

In this thesis, as a traditional premium ICE automotive brand doing the electrification transformation, we are exploring a way to improve the sales volume and increase the awareness of our BEV in Chinese market through developing our branded exclusive public charging stations in China.

Through the market research and the customer interviews, I came to the conclusion that, the range anxiety of the customers cannot be alleviated by the public charging. The current public charging station is neither convenient nor premium, and the branded exclusive station is strongly desired by customers. Meanwhile, the study of our main competitors shows that developing branded exclusive stations has already become a consensus of most BEV companies, and can make them more competitive.

Based on the above research I come up with my branded exclusive public charging strategy for our company, to fulfill the charging need of our BEV customers and provide them the premium charging experience.

In the future, the premium public charging service will become our powerful brand image. The nice-decorated and well-operated charging stations in each city will make our BEV more impressive. When our BEV customers have the charging demand, they can easily reserve a charging slot from the Apps, navigate to our branded station and finish charging. And this will surely have a positive effect on our sales.

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